SECTION 1 : FIELD CROP PRODUCTION

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EFFECTS OF SOIL MATRIC POTENTIAL ON TUBER YIELD AND EVAPOTRANSPIRATION OF POTATO

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Abstract
This study has been carried out through field trials with irrigation in the river valley of Southern Morava, near Niš, at the alluvium soil type, in the period 2008-2009. The experimental field consisted of three treatments with irrigation (soil matrix potential of 20, 30 and 40 kPa), as well as unirrigated, control. Irrigation schedule was determined by tensiometers on the basis of the observed soil matrix potential values. The highest potato tuber yield (48.30 t ha^{-1}) was observed at the variant where soil matrix potential of 30 kPa was kept. Potato tuber yield was the highest when water consumption for evapotranspiration amounted from 491.3 to 498.6 mm, while at higher or lower values of water consumption for ET tuber yield dropped. Water use efficiency of potato during the studied period ranged from 81.23 to 98.21 kg ha^{-1} mm^{-1}. The data concerning tuber yield, evapotranspiration and WUE of potato point to the fact that, in order to reach high potato tuber yield and quality, one ought to keep soil matrix potential at levels around 30 kPa for the conditions of south Serbia.

Key words: potato, evapotranspiration, soil matrix potential, water use efficiency.

Introduction
The total world potato production amounts about 330 million tons on 18.3 million ha (FAOSTAT, 2010), or 18 t ha^{-1} as average. In Serbia it is grown on 80.000 to 90.000 ha, reaching the average tuber yield of 10 t ha^{-1} (Stat. Year. Serb. 2008). Genetic potential for potato tuber yield can be up to 100 t ha^{-1}. Water deficiency in soil leads to a decrease of potato tuber yield and quality, caused by the drop of photosynthetic activity per leaf square unit (Van Loon, 1981). Climatic conditions of south Serbia in the last few years were characterized by long drought periods without precipitation, and extremely high temperature during vegetation period. Optimal soil moisture for growing agricultural crops can only be reached in the conditions of irrigation. Insight in values of potential evapotranspiration (PET), or water demands by plants, is a necessary precondition for realizing an efficient water regime. Excessive irrigation leads to deep percolation of nutrients, higher potential for appearing plant diseases and pests, deterioration of soil structure and water losses, causing increased production costs. Potato PET depends on climatic conditions, soil moisture and potato cultivar. Potato evapotranspiration established by many researches amounted from 283-700 mm (Doorenbos and Kassam, 1979; Tanner, 1981; Wright and Stark, 1990; Pereira et al., 1995; Kiziloglu et al., 2006). Evapotranspiration and irrigation of potato in Serbia were studied only in the conditions of Vojvodina Province (Bošnjak and Pejić 1994; Bošnjak and Pejić, 1995; Bošnjak et al.,

1996; Bošnjak, 2006; Milić et al., 2009). Irrigation schedule is pretty important in order to avoid negative irrigation effects. Numerous reports confirmed efficiency of potato irrigation based on measuring soil matric potential (Phene and Sanders, 1976; Eldredge et al., 1992; Hegney and Hoffman, 1997; Pereira and Villa Nova, 2002; etc). Water use efficiency (WUE) is defined by tuber yield divided by water consumed for evapotranspiration (ET) of potato (Doorenbos and Pruitt, 1977). Having in mind the obtained results concerning potato irrigation, this investigation has been aimed to determine soil matric potential, potato PET, tuber yield, and WUE in the conditions of south Serbia.

Material and methods

Field trials with irrigation of potato have been set in the river valley of Southern Morava, near Niš, at the alluvium soil type, in the period 2008-2009. Local coordinates of the location were the following: latitude 43º 19 ', longitude 21° 54', altitude 194 m. The trial was set in random complete block design, and drip irrigation was applied. Elementary plot was 10.50 m^2 of area, and plots were separated by 2.5 m of each other. Determining irrigation term was done by tensiometers. Soil matrix potential (SMP) was measured at 8:30, daily. The experimental field consisted of three treatments with irrigation (SMP of 20, 30 and 40 kPa), as well as unirrigated control.

Potato planting (distance 70 cm between rows and 30 cm in the row) was done in the first half of April in both investigation years, with the cultivar Kennebec, original category, where tuber size was from 35-55 mm. After soil chemical analyses soil was fertilized before cultivation, as well as during vegetation by water soluble fertilizers through irrigation systems. The total amount of nutrients deposited to soil was: N -200 kg ha^{-1}, P_2O_5 - 120 kg ha^{-1}, K_2O - 300 kg ha^{-1}, CaO - 100 kg ha^{-1} and MgO - 60 kg ha^{-1}. During vegetation, the all modern agro technique measures were applied, and tuber harvest was carried out in the third decade of August in both years of the study.

Calculation of water consumption for evapotranspiration in the conditions of irrigation was done for each month and for vegetation period in whole, by balancing water from precipitation during vegetation period, soil supplies, irrigation, and potentially percolated or flown out water after heavy rains (Aksic *et al*., 2011).

The data of potato tuber yield were processed by analysis of variance, and significance of differences in tuber yield was determined by comparing them with LSD values for $P<0.05$ and $P<0.01$. The effect of soil matrix potential and evapotranspiration on potato tuber yield was analyzed by regression analysis.

The obtained values of texture analysis (table 1) were expected, because fractional relations confirm that this is a loamy alluvial soil.

Table 1. Mechanical properties of soil

Depth (cm)	Total sand (%)	Powder (%)	Clay (%)
	> 0.02 mm	0.02-0.002 mm	< 0.002 mm
0-20	42.1	40.5	17.4
20-40	40.3	37.8	21.9
40-60	38.7	36.3	25.0
60-80	36.7	35.9	27.4
80-100	35.1	32.3	32.6

Immediately before the study began, water-physical properties of soil in the experimental field were determined (Table 2).

Table 2. Water-physical properties of soil

Depth (cm)	FWC (weight %)	Specific weight (g cm^{-3})	Bulk density (g cm^{-3})	Total porosity (vol. %)	Capacity for water (vol. %)	Capacity for air (vol. %)
0-20	27.32	2.65	1.35	49.05	36.88	12.17
20-40	25.94	2.58	1.34	48.06	34.76	13.30
40-60	24.44	2.56	1.34	47.65	32.75	14.90

Air temperature was observed at meteorological station Niš and precipitation was measured by a rain gauge at the experimental field (Table 3). Vegetation 2008 was wormer by 1.8 °C than the average, and the greatest difference from the mean value was observed in June, which was wormer by 2.8 °C than the many-year mean. Precipitation regime in this period was basically characterized by a great dispersion of precipitation, and existence of longer or shorter dry periods in May, June, early July, and August, which had a negative effect on the observed potato tuber yield in the conditions without irrigation.

Precipitation deficiency in April 2009 was flagrantly expressed in the first part of the month, causing a decrease of water supplies in soil. High temperatures and precipitation deficiency in May had a bad effect on plants growth and development. June 2009 was characterized by a relatively warm weather with high amount of precipitation, especially near the end of month. The first half of the July was droughty, which had a negative effect to potato crops, being then in full flowering stage. August was deficient with precipitation having a bad influence to tuber growth.

Table 3. Mean monthly temperatures (ºC) and monthly amount of precipitation (mm)

Year	Month					
	IV	V	VI	VII	VIII	IV-VIII
Mean monthly temperatures						
2008	13.1	17.9	22.3	22.6	23.5	19.9
2009	14.3	18.3	20.5	22.8	23.0	19.8
1961-1990	11.9	16.6	19.5	21.3	21.1	18.1
Amount of precipitation						
2008	65.5	38.7	32.5	61.2	24.8	222.7
2009	28.4	27.0	91.5	46.0	38.3	231.2
1961-1990	51.3	66.7	69.7	43.6	43.3	274.6

Results and discussion

Concerning the all irrigated variants, tuber yield was high-significantly higher in regard to the unirrigated control. The highest potato tuber yield (48.30 t ha^{-1}) was observed at the variant with soil matrix potential of 30 kPa (Table 4). Statistically high-significantly important differences in tuber yield were observed between the treatment with SMP of 30 kPa and the treatments with SMP of 20 and 40 kPa. However, at the treatment with SMP of 20 kPa, tuber yield was significantly higher regarding the treatment with SMP of 40kPa.

During the two-year investigation of potato irrigation the highest tuber yield was reached with SMP of 30 kPa, which was in accordance with the results of Shock *et al*. (2002) and Shae *et.al*. (1999). When potato tuber yield is concerned the optimal soil humidity before irrigation (SMP of 30 kPa) observed in our study are in opposition with the following reports: Epstein and Grant (1973) – SMP of 25 kPa; Eldredge *et al*. (1992, 1996) – SMP from 50 to 60 kPa; Hegney and Hoffman (1997) – SMP of 20 kPa; Pereira and Villa Nova (2002) – SMP of 15 kPa; and Kang *et al*. (2004) – SMP of 25 kPa.

Decreased potato tuber yield caused by increased soil humidity (SMP of 20 kPa) is in accordance with the results of Wang *et al*. (2006), Pereira and Shock (2006) and others. Bošnjak (2006), in the conditions of Vojvodina Province (Serbia), also found that higher soil humidity (80% FWC) decreased potato tuber yield. Differences in optimal values of SMP for the irrigation start are primarily caused by irrigation method, soil type and studied environment.

Table 4. Tuber yield of potato (t ha^{-1})

Year (B)	Soil matric potential (A)				Average (B)
	20 kPa (A_1)	30 kPa (A_2)	40 kPa (A_3)	Control (A_4)	
2008 (B_1)	44.71	47.64	36.49	24.52	38.34
2009 (B_2)	45.48	48.97	39.13	26.78	40.09
Average (A)	45.09	48.30	37.81	25.65	39.21
LSD	A	B		AB	
0.05	1.95	1.39		2.76	
0.01	2.15	1.54		3.05	

Tuber yield dependency on soil matrix potential was described as $y=–2440.0+3747.2x–68.3x^2$ based on regression analysis (Figure 1), together with high, positive correlation (r=0.93**). The highest potato tuber yield was observed at the treatment with SMP of 30 kPa, while lower (SMP of 40 kPa) or higher (SMP of 20 kPa) soil humidity led to a decrease of tuber yield.

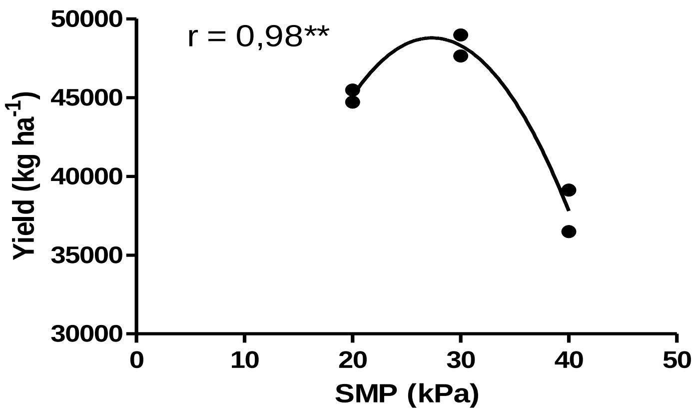

Figure 1. Effect of SMP on potato tuber yield

Regression analysis defined tuber yield dependency on water consumption for ET as follows: $y=22543.9–37.8x+0.2x^2$ (Figure 2). Correlation between these two parameters was high and positive (r=0.93**). The highest potato tuber yield was found when water consumption for evapotranspiration was from 491.3 to 498.6 mm, while at higher or lower water consumption for ET tuber yield decreased.

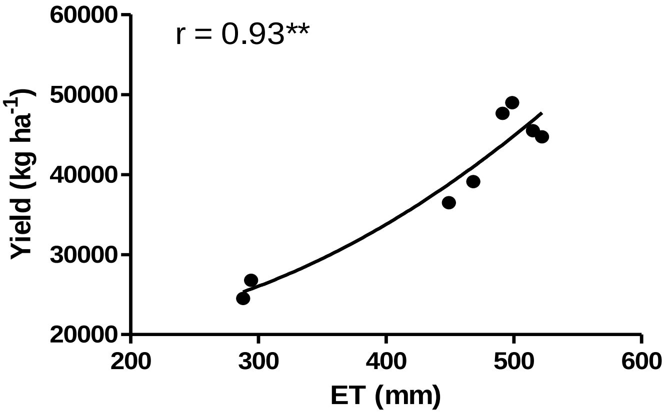

Figure 2. Effect of ET on potato tuber yield

The established value of evapotranspiration in our experimental field ranged from 294.4 mm at the variant without irrigation to 522.1 mm at the irrigated variant with SMP of 20 kPa (table 5). According to many researches water demands of potato vary over a great range, depending above all on studied environment. For high tuber yield vegetation demands of potato for water ranged from 500 to 700 mm, depending on climatic conditions (Doorenbos and Kassam, 1979). During a three-year investigation potato evapotranspiration in Wisconsin (USA) was between 293 and 405 mm (Tanner, 1981). Wright and Stark (1990), stated water consumption of potato for evapotranspiration from 640 to 700 mm in irrigated areas of Oregon and Washington (USA). Pereira *et al*. (1995), found potato evapotranspiration of 283 mm. Kiziloglu *et al*. (2006), stated that in the conditions of Erzurum (Turkey) potato evapotranspiration ranged from 167 mm without irrigation to 610 mm in the conditions of irrigation. According to Erdem *et al*. (2006), in Trakia Region (Turkey) potato evapotranspiration was between 464 and 683 mm.

The highest and also stable tuber yield in the two-year period of study was reached when water consumption for evapotranspiration was between 491.3 and 498.6 mm, so that value could be considered as potential evapotranspiration (PET) of potato, i.e. its water demands in the conditions of south Serbia. The measured value of potato PET in our study is greater in regard to the value of potential evapotranspiration (460-480 mm) established by Bošnjak and Pejić (1994) for the conditions of Vojvodina Province (north Serbia).

Water use efficiency during the studied period was between 81.23 and 98.21 kg ha^{-1} mm^{-1} (table 5). The best ratio between water consumption for ET and potato tuber yield (96.97-98.21 kg ha^{-1} mm^{-1}) was observed at the treatment with SMP of 30 kPa.

Table 5. Evapotranspiration and WUE of potato

Year	SMP (kPa)	Soil water supplies (mm)	P (mm)	I (mm)	ET (mm)	Yield (kg ha^{-1})	WUE (kg ha^{-1} mm^{-1})
2008	20	21.4	222.7	278	522.1	44710	85.63
	30	32.6	222.7	236	491.3	47640	96.97
	40	51.5	222.7	175	449.2	36490	81.23
	Control	65.4	222.7	-	288.1	24520	85.11
2009	20	27.8	231.2	256	515.0	45480	88.31
	30	48.4	231.2	219	498,6	48970	98.21
	40	53.1	231.2	184	468,3	39130	83.56
	Control	63.2	231.2	-	294.4	26780	90.96

Water use efficiency during the studied period was between 81.23 and 98.21 kg ha^{-1} mm^{-1} (table 5). The best ratio between water consumption for ET and potato tuber yield (96.97-98.21 kg ha^{-1} mm^{-1}) was observed at the treatment with SMP of 30 kPa. In the conditions of irrigation the highest average value of potato WUE of 97.59 kg ha^{-1} mm^{-1} was observed at the variant with SMP of 30 kPa. WUE values of potato obtained by this study (from 81.23 to 98.21 kg ha^{-1} mm^{-1}) were similar to the values reported by Wright and Stark (1990) and Beheral and Panda (2009). Our values of potato WUE are not in accordance with the values stated by Wang *et al*. (2006) from 50.4 to 77.1 kg ha^{-1} mm^{-1} in season 2001 and 103.2-131.6 kg h^{-1}a mm^{-1} in season 2002 in the conditions of North China Plain. Values of WUE in our study were higher than the ones determined by Kiziloglu *et al*. (2006), which were from 40.2 to 63.4 kg ha^{-1} mm^{-1}, as well as the ones of Rashidi and Gholami (2008) who stated WUE ranging from 19.2 to 52.5 kg ha^{-1} mm^{-1}.

Conclusions

High and stable potato tuber yield was reached when water consumption for evapotranspiration was between 491.3 and 498.6 mm, so that value could be considered as potential evapotranspiration (PET) of potato in the conditions of south Serbia. The highest water use efficiency of potato, which was from 96.97 to 98.21 kg ha^{-1} mm^{-1}, was observed at the variant with SMP of 30 kPa. Results of tuber yield, evapotranspiration and WUE of potato revealed the fact that, in order to reach high potato tuber yield and quality, one ought to keep soil matrix potential at levels around 30 kPa, for the conditions of South Serbia.

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ЕФЕКТИ НА ПОЧВЕНИОТ МАТРИКС ПОТЕНЦИЈАЛ ВРЗ ПРИНОСОТ И ЕВАПОТРАНСПИРАЦИЈАТА НА КОМПИР

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Апстракт
Ова истражување е спроведено преку теренски испитувања, со наводнување во речната долина на Јужна Морава, во близина на Ниш, на алувијален тип на почва, во периодот 2008-2009 година. Експерименталниот опит се состоеше од три третмани со наводнување (почвен матрикс потенцијал на 20, 30 и 40 kPa), како и еден ненаводнуван, како контрола. Распоредот на наводнување е утврден со тензиометри врз основа на набљудуваните вредности на почвениот матрикс потенцијал. Највисок принос на компир (48,30 т ха-^{1}) е забележан кај варијантата каде почвениот матрикс потенцијал изнесувал 30 kPa. Приносот на компир бил највисок кога потрошувачката на вода за евапотранспирација изнесувала 491,3-498,6 милиметри, додека при повисоки или пониски вредности на потрошувачка на вода за ЕТ приносот паднал. Користењето на водната ефикасност на компирот за време на анализираниот период се движеше 81,23 до 98,21 кг ха-^{1} мм-^{1}. Податоците кои се однесуваат на приносот на клубени, евапотранспирацијата и користењето на водната ефикасност кај компирот за услови во јужна Србија, укажуваат на фактот дека за да се постигне висок принос и квалитет на компир, почвениот матрикс потенцијал треба да се задржи на ниво од околу 30 kPa.

Клучни зборови: компир, евапотранспирација, почвен матрикс потенцијал, користењето на водната ефикасност.

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ANALYSIS OF PRODUCTION AND PURCHASE OF ORIENTAL TOBACCO IN BALKAN

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Abstract

Production of tobacco in the Balkan in the past five years rapidly decline. In Greece, tobacco production is drastically reduced as well, because as a member of the EU (European Union) in recent years high subsidies for tobacco production were available for the reorientation of tobacco producers to grow some other crops. In Bulgaria, tobacco production is also reduced because, as a recent EU member, the country was urged to cut production areas with tobacco (the quota for tobacco production dropped towards production before becoming an EU member). In Serbia, the production of oriental tobacco is almost eliminated, produce only Virginia and Burley type of tobacco (average of 5.000-6.000 tons). Albania, as a producer of oriental tobacco has a symbolic participation of about 2.000 tons annually. Macedonia produce only oriental type of tobacco. The production oscilate from 16.128 tons up to 26.314 tons for the past years. It has stable production with high quality of tobacco well known to the biggest World tobacco companies.

Key words: oriental tobacco, type structure, production, purchase.

Introduction

The production of raw tobacco (1999-2004 year) in Balkan's region is declining, both in absolute amount and average per year (*Arsov, at all.,* 2005). The largest producer was Turkey with 212.835 tons or 48,67 % share in total production, while the lowest was Albania with 5.716 tons or 1,31 %. Macedonia occupied the fourth place with an average production of 22.372 t or 5,12 % of the analyzed period. The share of Serbian oriental tobaccos significantly dropped after 2003, both as a result of the transition period for tobacco industry in this country and because of the lack of interest among the new oweners (Philip Moris, British American Tobacco-BAT etc.), *Filipovski at all.* (2010). The trend of declining production is evident in all countries except Bulgaria, where it period 2001-2004 was increased and Macedonia where there is a stagnated at around 22.897 tones for the same period (*Stojanoska, S.and Stojanoski L.,* 2007). In the world production of tobacco Macedonia participated with 0,32 %, which represented insignificant participation, while all other countries together participated with 6,23 %. Oriental type of tobacco present special group of tobacco which gives bouquet, through the process of blending of cigarettes. The main characteristics are: small leaves and strong specific aroma. The production directly depend on specific soil and climate conditions, mixed with good agricultural practice. Many of the early brands of cigarettes were made mostly or entirely of oriental tobacco. According to official data from the tobacco international market, the demand for oriental type of tobacco is increasing in past few years (Universal Leaf Tobacco Company, 2007/2008).

Purpose of the paper is to analyze the current situation in the Balkan, on the basis of the obtained data and to get recommendations for overcoming the problems facing the tobacco economy.

Material and methods

Data used from Analyses of the Ministry of Agriculture, Forestry and Water Economy of Republic Serbia, Ministry of Agriculture, Forestry and Water Economy of Republic Macedonia, Ministry of Agriculture and Food of Republic Albania, Ministry of Agriculture and Food of Republic Bulgaria. The link of ec.europa.eu/agricultural/markets was used as a source for investigation on the oriental tobacco production in the Balkan's countries (Greece and Bulgaria). The investigations were carried out for the period 2005/2010. For easier data processing tobacco has been grouped, in eight groups of tobacco varieties (types) described in the EU Common Market Organization (CMO) - regulation 2075/1992:

I - Flue-cured: tobacco dried in ovens with controlled air circulation, temperature and humidity;

II - Light air-cured: tobacco dried in the air under cover, not left to ferment;

III - Dark air-cured: tobacco dried in the air under cover, left to ferment naturally before being marketed;

IV - Fire-cured: tobacco dried by fire;

V - Sun-cured: tobacco dried in the sun;

VI - Basmas (sun-cured, oriental);

VII - Katerini (sun-cured, oriental);

VIII - Kaba-Koulak (classic) and similar (sun-cured, semioriental);

Groups VI and VII are related to oriental tobacco and the group VIII applies to semi-oriental tobacco. While the production of certain groups of tobacco (especially to the group VIII) have been drastically reduced during the analyzed period, due to easier data processing all tobacco from VI th to VIII th group have been grouped together in group V, as data in 2011 are already presented from: ec.europa.eu / agricultural / markets.

Data on area and production are presented as crop, but not as a calendar year. The reason for is that buying tobacco usually begins in November, in the same year when the production is, but ends in March next year. The official statistics summarize data by calendar year, so the effect of harvest is not visible because in one calendar year occurs mixing data from two harvests. For data processing, table and figure presentations were used, thereat, mainly the comparative method has been used (natural and financial parameters, searching the movement of official statistical data about production, processing, purchase prices).

Data in these sources are usually represented as absolute indicators, but we calculated data in relative ratio as a need of this work, according to the conception of the authors.

Agricultural Policy for Tobacco Production

Tobacco is one of the most economically important agricultural crop in the world. Tobacco production provide a stable source of income. Also, the processing, manufacture, and distribution of tobacco products provide employment for thousands of other people throughout the globe. EU (European Union) tobacco production represents about 6 % of worldwide production. Only thirteen EU member countries produce tobacco, a few regions in: Italy, Bulgaria, Poland, Spain and Greece being particularly active. From these, only Bulgaria and Greece produce oriental type of tobacco. The arable land devoted to tobacco production in the EU is shrinking rapidly (currently some 100.000 hectares cultivated by approximately 80.000 producers). On average, each producer cultivates 1,25 hectares of tobacco. Tobacco needs at EU level is about 600.000 annually tons. Its own production is around 370.000 tons tobacco and over 50 % meet the needs of the tobacco industry. Exports accounted for about 190.000 tons. The difference to the required quantity (Utilization = Imports + Production - Exports + / - stocks) being met by imports. Tobacco production in EU is strictly based on certain regulations arised from EU Common Agricultural Policy (CAP). During the analyzed period, major changes have occurred in EU policy regarding the production of tobacco. Some of the measures are presented in the Table 1.

The exception to this is Bulgaria[1], where as of 2009 crop subsidies were paid from the state agricultural budget through the Ministry of Agriculture – Department Tobacco Fund. The amount of subsidy was approved by the EU. The subsidy was the highest for oriental tobacco, about 1,6 Euros/kg and 1,0 Euros/kg, for semi-oriental tobacco, while the Virginia and Burley with about 0,73 Euros/kg. Since the end of 2010 Bulgaria's government decided that Tobacco Fund should be closed and tobacco production is subsidized under the scheme of payment per unit area, as any other EU countries. Through the State Fund Agriculture called as national payment, where tobacco is excluded from the scheme subsidies per unit area where funds are obtain from EU funds (Ordinance № 2 of February, 21.2011 – Special Requirements For Participation in National Schemes Approved Payments and Specific Support).

In the analyzed period, Macedonia and Serbia (non-member countries of EU) begin in applying measures to encourage the production of tobacco. Thus, in some countries subsidize quantity produced or obtained subsidy per kilo purchased tobacco regardless of its quality and surfaces. While in other countries, subsidize only the quality of tobacco or higher classes. In both cases the subsidy is paid directly at farmers' account.

Macedonia has the first (linear) system all types and classes of tobacco are equally subsidized. The policy of subsidizing the production of tobacco began in 2006 with 0,24 Euros/kg and then for each subsequent crop is increasing. The subsidy for the last tree tobacco crops (2009-2011) amounted to 0,98 Euros/kg. There is no announced change in the value and way of subsidizing tobacco for the crop 2012.

Serbia in 2005 made changes in the way of subsidizing tobacco. Appropriate regulations and conditions on tobacco subsidies have been changed and directed towards improving the quality of certain types of tobacco, so they are contracted and certain quantities of purchased tobacco per kilogram, depending on the type of tobacco and, as request of primary producers and processing of tobacco. However, in 2006 the subsidy for tobacco was returned per hectare and only for registered farms that are eligible for a premium, in the amount of about 1.000 Euros/ha.

In 2007 the subsidy was made also per kilogram of purchase tobacco, the four-classes quality and the reference yield of 1,3 tons per hectare for Virginia and Burley varieties and 0,7 tons per hectare for the Oriental tobacco. In 2008, the subsidy was also per kilogram of tobacco in the four-class quality, while the reference yield was 1,8 tons per hectare for Virginia, 1,3 tons per hectare for Burley and 0,7 tons per hectare for the Oriental tobacco. In 2009 there were no direct subsidies for tobacco. Producers of tobacco which are registered farmers, have eligible an additional subsidie

[1] Accession of Romania and Bulgaria into the European Union on January 1, 2007

about 200 Euros/ha, and 120 Euros/ha for the reimbursement of raw materials intended for crop production.

Table 1. EU Common Agricultural Policy for Tobacco Production

Crop	Changes	Quotas	Subsidy	Market rules
2004/2005	No changes compared to the current system	Same	Same per kilo	Same
2006/2009	The total aid to tobacco farmers remains unchanged		Farmers will receive of their subsidy at least 40 percent in the form of a “decoupled” payment, without any obligation to produce tobacco. Individual countries can increase this decoupled percentage up to 100 percent, if they wish, for specific varieties or producing areas. The remaining portion of the subsidy (60 percent or less) will be distributed to farmers only if they produce tobacco.	
2010/2012			Farmers will receive 50% of their subsidy in decoupled form. The remaining 50 % will be paid into a Restructuring Fund, to be used to finance alternatives to tobacco farming and processing.	
2013	The entire E.U. Common Agricultural Policy will be discussed			

Source: Common Market Organization (CMO) consensus for tobacco, April 20-21, 2004, Luxemburg, Universal Leaf obacco Company, Inc. Supply and Demand 2006, 2007, 2008.

Results and discussion

Production of tobacco by types and states will be analyzed by the tobacco planted area (ha), purchased quantities (tons) and the average purchase price per kg.

Production of tobacco in the Balkan’s countries represented by area under tobacco production (Table 2).

The data in Table 2 shows that the area under tobacco have large oscillations. After harvest in 2005 the areas under tobacco fall until harvest in 2007 (81,76 %), then there is a growth and an increase in harvest in 2010 (9,17 %) above the areas under tobacco of the harvest in 2005. However, in other tobacco producing countries the situation is different.

Table 2. Areas covered by the contracts

CROP	Albania		Bulgaria		Greece		Macedonia		Serbia		Total	
	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%
2005	1700	100	40200	100.00	48538	100.00	15808	100.00	5000	100.00	111246	100
2006	1630	95.88	27369	66.97	18953	39.05	15072	95.34	5100	102.00	68124	84.45
2007	1590	93.53	27981	68.47	14438	29.75	16844	106.55	5100	102.00	65953	81.76
2008	1530	90.00	31359	76.73	15477	31.89	16764	106.05	5653	113.06	70783	87.75
2009	1445	85.00	41865	102.44	15714	32.37	16212	102.56	4605	92.10	79841	98.97
2010	1568	92.24	49241	120.48	15571	32.08	16140	102.10	5545	110.90	88065	109.17
Average 2005-10	1577.2		36335.8		21448.5		16140.0		5167.2		80668.67	100

Bulgaria has the largest cultivated area under tobacco, averaging 36.335,8 ha, while Albania has the lowest average cultivated area 1.577,2 ha for the analyzed period. Macedonia is on third place with 16.140,0 ha, right after Greece with 21.448,5 ha cultivated area under tobacco. Also the data is noted that the cultivated area under tobacco in some of the analyzed countries has been reduced, and in others increased. The decrease is particularly pronounced in Greece, where the cultivated area under tobacco in 2010 amounted to 32,08 % of the cultivated area which has been in 2005.

Increases were recorded in Serbia, where the increase is 10,90 % and especially in Bulgaria 20,48 % in terms of cultivated area since 2005. In Macedonia, the cultivated area under tobacco registered a small increase of 2,10 %.

Production of tobacco in the Balkan's countries is represented by the purchased quantity of tobacco companies for purchasing and processing tobacco by first prosessor, Table 3.

The data in Table 3 shows that tobacco purchased quantities have large fluctuations and a downward trend. After harvest in 2005 buyout in general decline in all analyzed countries to harvest in 2008 (40,10 %) when it reaches the lowest level. Then there is a growth, so the purchased quantities in harvest 2010 reach a level of 72,48 % compared with quantities of purchased tobacco in 2005.

Table 3. Purchased quantity of tobacco / first processor (tons**)**

CROP	Albania		Bulgaria		Greece		Macedonia		Serbia		Total	
	tons	%	tons	%	tons	%	tons	%	tons	%	ha	%
2005	2231	100.00	58300	100.00	107447	100.00	22806	100.00	7500	100.00	198284	100.00
2006	2350	105.33	41956	71.97	22891	21.30	19681	86.3	7660	102.13	94538	47.68
2007	2241	100.45	30516	52.34	21994	20.47	16288	71.42	8480	113.07	79519	40.10
2008	2211	99.10	36272	62.22	20536	19.11	16128	70.72	8775	117.00	83922	42.32
2009	2145	96.15	48609	83.38	22556	20.99	23163	101.57	7362	98.16	103835	52.37
2010	2272	101.84	83615	143.42	21344	19.86	26314	115.38	10065	134.20	143610	72.43
Average 2005-10	2242		49878		36128		20730		8307		117285	

In other tobacco producing countries the situation is different. Bulgaria has the highest tobacco production, averaging 49.878 tons, while the lowest production of tobacco has Albania with 2.242

tons of analyzed period. It also notes that tobacco production in Albania is quite stable. Macedonia is on third place with an average production of 20.730 tons with large fluctuations during the analyzed period. It has been noted that in some of the analyzed countries, the production of tobacco has trend of reduction and increasing in some of them. The decrease is particularly pronounced in Greece, where production in 2010 amounted to only 19,86% of production in 2005. Increases were recorded in Serbia, where the increase is 34,20% and especially in Bulgaria 43,42% compared to production in 2005. In Macedonia tobacco production has increased for about 15% in the past five years. Regarding the structure of the type of tobacco in analyzed countries some changes are also evident (Table 4, Graph 1). Data presented in Table 4 show that, especially after the conversion the way of subsidizing tobacco of 2006 crop in EU zone, notes a dramatic drop in production of all types of tobacco and then gradually increase the purchased quantity of tobacco. Situation for tobacco of 2010 crop was quite different: the group: Group I – 35,07 %, than Group II – 73,24 % and Group V – 93,02 %, compared to 2005 crop. The greatest reduction is observed in Group I (*Virginia*) and Group II (*Burley*) tobacco. For oriental and semi-oriental tobacco production has gradually stabilized at the level of 2005 crop. Structure of tobacco production by type for the crops 2005-2010 is presented on Figure 1.

Figure 1 shows that participation of oriental and semi-oriental tobacco (Group V) in total quantity produced in the analyzed period is increased from 59,26 % in 2005 crop to 76,07 % in 2010 crop, while tobacco from Group I is reduced from 32,74 % in 2005 crop to 15,85 % in 2010 crop. Tobacco production of Group II is stabilized at around 8 %.

Table 4. Structure of the type of tobacco (analyzed countries)

Crop	Group I	Group I, %	Group II	Group II, %	Group V	Group V, %	Total all types, tons	Total all types, %
2005	64922	100,00	15865	100,00	117497	100,00	198284	100,00
2006	10983	16,92	12496	78,76	71059	60,48	94538	47,68
2007	13981	21,54	5266	33,19	60272	51,30	79519	40,10
2008	15508	23,89	7597	47,89	60817	51,76	83922	42,32
2009	15338	23,63	8770	55,28	79785	67,90	103893	52,40
2010	22768	35,07	11620	73,24	109300	93,02	143688	72,47
Average 2005-10	23917		10269		83122		117307	

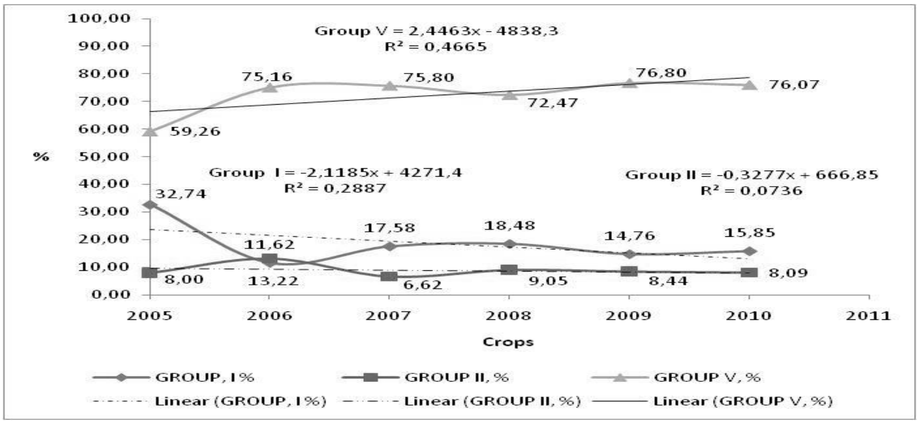

Figure 1. Structure of tobacco production by types from total tobacco production (crops 2005/2010)

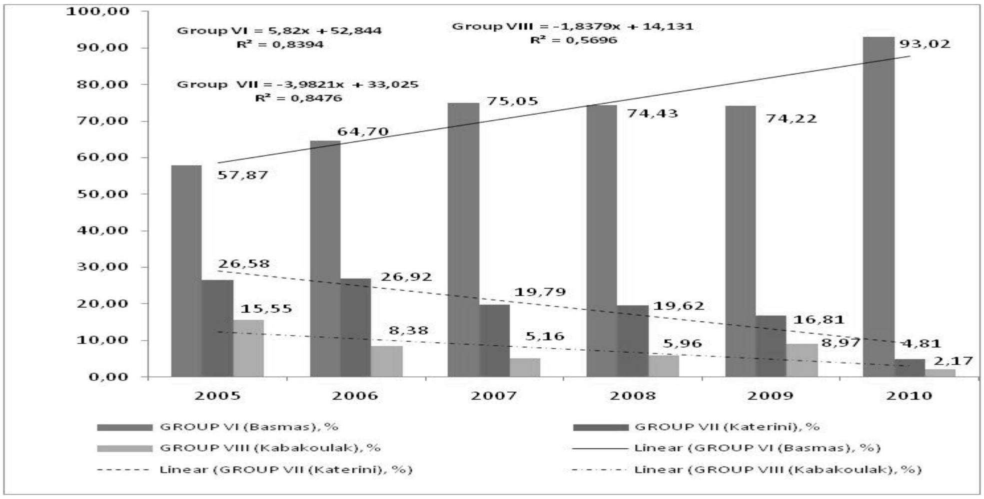

Figure 2. Participation of Groups VI, VII* and VIII in Group V
*Tobacco from Group VII is still grown in Greece and small area in Albania

Production of tobacco in the Balkan is represented by quantity of purchased tobacco from the Group V (Table 5).
Production of oriental tobacco is on the same level for the last five years in Albania (average of 2.242 tons). It is quite stable as well in Serbia, also with average of 407 tons of oriental tobacco. The highest fluctations are in Bulgaria in time when the country entered as a new member in EU and the production failed from respective 39.000 tons on 26.468 tons in 2006 and continue to decrease rapidly on 19.583 tons in 2007. In the year 2010-th, the production was almoust doubled for the last five years with quantity of 61.833 tons. The country is still number one in production of oriental tobacco in the Balkan’s region. Macedonia is right behing with stable average production of 20.730 tons in the last years (because of the bad the weather conditions, crop 2007 and 2008 give low yield per unit area). From total average production for the analyzed period the largest share in

the production of oriental and semi-oriental type of tobacco has Bulgaria 40.10 %, and lowest Albania with 2.70%. Macedonia with 24.95% is in third place, right after Greece (31.76%).

Table 5. Quantity delivered, group V – oriental and semi-oriental tobacco

CROP	Albania		Bulgaria		Greece		Macedonia		Serbia		Total	
	tons	%	tons	%	tons	%	tons	%	tons	%	tons	%
2005	2231	100.00	39000	100.00	53085	100.00	22806	100.00	375	100.00	117497	100.00
2006	2350	105.33	26468	67.87	22177	41.78	19681	86.30	383	102.13	71059	85.51
2007	2241	100.45	19583	50.21	21736	40.95	16288	70.42	424	113.07	60272	72.53
2008	2211	99.10	21515	55.17	20524	38.66	16128	70.72	439	117.00	60817	73.19
2009	2145	96.15	31557	80.92	22542	42.46	23163	101.57	320	85.33	79727	95.94
2010	2272	101.84	61833	158.55	18300	34.47	26314	115.38	503	134.20	109222	131.44
Average 2005-10	2242		33326		26394		20730		407		83099	
% of Total Average		2.70		40.10		31.76		24.95		0.49		100.00

The average purchase price of oriental tobacco (Group V) is different in the analyzed countries (Table 6).

For example, two crops affected by drought (2007 and 2008) have reduced the purchased quantities of tobacco and this has caused greater demand for tobacco in the next 2009 crop, and increase the purchase price. So, in 2010 production has been increased (more agreements) and environmental conditions were also favorable (raw tobacco are distinguished by good quality and higher yield), but the purchasing companies have decided to keep the price lower. At the same time, this situation caused major strikes of farmers in Macedonia and Bulgaria, but the purchase of tobacco was realized as responding to major purchasing companies.

Table 6. Average price (paid by 1st processing enterprises) group V - oriental tobacco

CROP	Macedonia		Bulgaria		Greece	
	Euro/kg	%	Euro/kg	%	Euro/kg	%
2006	1.58	100,00	1.43	100,00	3.50	100,00
2007	2.43	153,80	2.14	149,65	4.10	117,14
2008	2.79	176,58	2.40	167,83	4.23	120,86
2009	3.26	206,33	2.98	208,39	4.20	120,00
2010	2.26	143,04	2.74	191,61	3.50	100,00
Average 2006-10	2.46		2.34		3.91	

Conclusions

The international market for oriental tobacco is mainly consisted from the following countries, the leading producers of oriental tobacco: Turkey, Bulgaria, Greece, and Macedonia. These countries are the largest exporters of oriental tobacco as well.

The volume of tobacco production in every country, producer of tobacco, depend on available land, interest in tobacco production, quality of purchased tobacco, etc. However, as the limiting factor appears supply and demand in the market. In some countries like Greece, a factor that determine the interest subsidies for tobacco production, but in the negative sense. Bulgaria with subsidizing, tobacco production has increased and in a smaller volume in Serbia. For Macedonia positive impact of subsidies is observed only for vintage 2009 and 2010.

Since interest of quality oriental tobacco on the world market is large (due to quality and relatively low export price EUR 4-5 kg^{-1}) and Macedonian oriental tobacco has been entered into the recipes of many international brands of cigarettes, interest and orientation of the country in the future is to take advantage of natural resources and to increase production of quality raw material, designed primarily for foreign markets.

Since some of the factors which influence on production of tobacco are variable sizes, their continuous monitoring and analysis are necessary in terms of economic and technological problems, to find real solution in practice. Only thus is possible to develop an optimal strategy for further development of tobacco production.

After the conversion the way of subsidizing of 2006 crop participation of oriental and semi-oriental tobacco in Balkan's countries (Group V) in total quantity produced in the analyzed period is increased from 59,26 % in 2005 crop to 76,07 % in 2010 crop, while tobacco from Group I is reduced from 32,74 % in 2005 crop to 15,85 % in 2010 crop. Tobacco production of Group II is stabilized at around 8 %. From all these mentioned above, the oriental tobacco production still dominated in the region. As for Macedonia, there is a stable production of 25 % from total quantity of oriental tobacco production in the Balkan.

Purchased prices for oriental tobacco are quite different in each of the analyzed countries, as follows: highest purchased prices has Greece, averaging 3,91 Euros/kg, on the second place is Macedonia with 2,46 Euros/kg, and Bulgaria is third with 2,34 Euros/kg. There are also the large fluctuations in purchasing prices in Macedonia and Bulgaria, while more constant with growing trend are purchasing prices. In Greece the situation is different. There is a higher standard of living. Tobacco producers are stimulated to leave tobacco production and switch to other crops (mainly cotton and olives) *Keyser, J.C.* (2007). So, cultivated area under tobacco in 2010 amounted to 32,08 % of the cultivated area which has been in 2005. The purchased quantity in 2010 amounted to only 19,86 % of production in 2005. Because of that, tobacco production is a steady decline during this period and likely purchase prices are held to a higher level, again in order to increase production.

After all, it seems in future there will be small increasing of oriental tobacco production in Bulgaria and Macedonia. It comes from the fact that the production and purchase of tobacco in Bulgaria is liberalized during 2011 (amended Law on tobacco and tobacco products).

As one market (EU), the produced raw tobacco purchases in Bulgaria and then is being processed in other states-EU members, mainly in Greece where there are facilities for processing and production are reduced. For Macedonia, this means possibility of increasing production, especially because the same companies (in neighboring countries), are present in purchasing and processing facilities in Macedonia. In the last few years, two new and modern facilities for manipulation of soft-drying system and processing of tobacco (SOCOTAB near Bitola, and ALLIANCE ONE in Kavadarci) have been raised in Macedonia as well. This would mean that foreign companies are interested in a presence in this region.

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АНАЛИЗА НА ПРОИЗВОДСТВОТО И ОТКУПОТ НА ОРИЕНТАЛСКИ ТУТУН НА БАЛКАНОТ

Арсов Златко, Кабранова Ромина, Димов Зоран, Спирковска Маријана

Апстракт

Производството на тутун во земјите на Балканот во изминатите пет години опаѓа. Во Грција, производството на тутун е драстично намалено, бидејќи како членка на ЕУ (Европска Унија), во последниве години високите субвенции за производство на тутун биле достапни за пренасочување на производителите на тутун со производство на некои други култури. Во Бугарија, производството на тутун е исто така намалено, бидејќи, како една неодамнешна членка на ЕУ, од земјата беше побарано да го намали производството на тутун (квотата за производство на тутун падна кон производството пред да стане членка на ЕУ). Во Србија, производството на ориентален тутун е речиси елиминирано, се произведува само Вирџинија и Берлеј тип на тутун (просек од 5.000-6.000 тони). Албанија, како производител на ориентален тутун има симболично учество на околу 2.000 тони годишно. Македонија произведува само ориентален тип на тутун. Производството во изминатите години осцилира од 16.128 тони до 26.314 тони. Таа има стабилно производство со висок квалитет на тутун, добро познат на најголемите светски тутунски компании.

Клучни зборови: ориентален тутун, типска структура, производството, откуп.

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UDC:633.15-116.424:631.95 (497.11-13) "2000/2009"
Original scientific paper

CORN YIELD IN SOUTHERN SERBIA IN DEPENDENCE ON CLIMATIC CONDITIONS OF THE YEAR

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Abstract

Corn yields are unstable and largely depends on climatic conditions, hybrids and breeding technology. The aim of this paper is to analyze the variation of corn yield in the period from 2000 to 2009 from the viewpoint of rainfall and temperature regimes. Based on the information given by the Republic Hidrometeorological institute and Agricultural expert and education service in Leskovac, it is analyzed the influence of rainfall and medium temperature of air on the yields of corns in South Serbia (Leskovac). The special emphasis places on precipitation during the three summer months (June - August), because it is considered critical for the yield. Out of nine tested years, there were separated two with unfavourable (2000 and 2008) and two with favourable climatic conditions for the production of corn (2002 and 2005). So, the average corn yield in unfavourable years was 1.7 t ha^{-1} relatively 1.4 t ha^{-1} when the amount of rainfall in the critical months (June - August) was 89 mm relatively 137 mm and the average air temperature in the same period 21.7º C relatively 20.9 ºC. The average yield of corn in favourable years was 4.1 t ha^{-1} relatively 5.7 t ha^{-1} when the amount of rainfall (June-August) was 257 mm relatively 242 mm and the average temperature of 21,4 ºC relatively 19,8 ºC. For the yield of corn it is not important total quantity of rainfall during the year or vegetation, but their arrangement in stages when corn has a great need for water. To achieve genetic potential for yield, which is more than 10 t ha^{-1} (early hybrids) or more than 15 t ha^{-1} (late hybrids), in addition to hybrids and crop management it is necessary benignity agro climatic conditions of the region, especially enough rainfall and their regular schedule.

Key words: corn, yield, precipitation, air temperature.

Introduction

Corn for its economic importance is one of the most important field crops. The great importance of corns derived from a variety of use, big yield and production volume. According to statistics, in the Republic of Serbia, it is grown over 1200000 hectares. Corn yields are unstable and largely depend on climatic conditions, hybrids and breeding technology. Since last year we have drier summers, and that a very small percentage of the area (less than 2%) to be irrigated, production and yield of maize are increasingly dependent on rainfall. To form yield of corn, it is not important total amount of precipitation during the year or vegetation, but their arrangement in stages, when corn has a need for water. Special importance is attached to rainfall in the summer months (June-July-August)

because it is a period when corn has expressed need for water and the period when it is determining the formation of yield. The impact of rainfall and temperature on the yield of corn are spoken and earlier works some authors (Josipović et al., 2005; Šoštarić and Josipović, 2006; Kovačević et al., 2009; Maklenović et al. 2009, Paunović et al., 2010, Kovačević et al., 2010).
The aim of this study was to analyze the variation of corn yield in the period 2000 to 2009, depending on rainfall and temperature regimes.

Material and methods

Based on the information given by the Republic Hidrometeorological institute and Agricultural expert and education service in Leskovac, it is analyzed the influence of rainfall and medium temperature of air on the yields of corns in South Serbia (Leskovac). Special emphasis is placed on precipitation during the three summer months (June-July-August),because it is considered critical for the yield. Of the ten analyzed years it is separated two (2000 and 2008) when the yields of corn were lowest, and two (2002 and 2005) when yields were highest. For the analysis of variations in the yield of corn per year (from 2000 to 2009.) from the standpoint of specific weather events are given appropriate data (grain yield, rainfall and mean air temperature in June-July-August, and the average monthly precipitation and temperature in the growing season from April to September).

Results and discussion

Corn yield

Grain yield is a difficult category on the basis that govern all manufactures and he depands on many factors as well as the production of the region. In table 1 it is given the average yield of corn in the period from 2000 to 2009 in Central Serbia, Vojvodina and Jablanica (Leskovac). Surely that the conditions for corn production it these regions are different, as evidenced by average yields. It is known that the soil in Vojvodina and Serbia better than in the southern part of Serbia, while the southern part of Serbia is warmer.
The average yield of corn in the Jablanica district (Leskovac) during the study period was 3.3 t ha^{-1}, in Vojvodina 5.1 t ha^{-1}, in Central Serbia 3.8 t ha^{-1}, which means that the average corn yield in the region of Leskovac was less to 35.3% than in Vojvodina, or 26.7% than in Central Serbia. Also, the average corn yield in Vojvodina was 25.5% higher than in Central Serbia.These data indicate favourable agro-ecological conditions of certain regions for corn production. During the analyzed period we have selected two years when the average yield was the lowest and two years when the average yields were highest. We note that this are not the same years in all regions, which once again testifies to the diversity of agro-climatic conditions in some regions. Thus, in Central Serbia lowest yields (1.9 and 2.3 t ha^{-1}) were in 2000 and 2007 year, and the highest (4.5 and 5.0 t ha^{-1}) in 2009 and 2005 year. The lowest yield in Vojvodina (2.9 and 3.4 t ha^{-1}) were in 2000 and 2003 year, and the highest (5.9 and 6.5 t ha^{-1}) in 2009, 2004 and 2006, respectively in 2005 year. In the municipality of Leskovac lowest yields (1.7 and 1.4 t ha^{-1}) were 2000 and 2008 year, and the highest (5.7 and 4.1 t ha^{-1}) in 2005 and 2002 year. The difference between the lowest average yield (the unfavourable years) and the highest average yield (favourable years) was 3.3 t ha^{-1} in favour of favourable years. These differences are largely the result of weather conditions. Kovacevic et al. (2010) point out that the below-average rainfall and above-average air temperature in a certain relation to below-average yields of corn.

Table 1. Yields of maize

Year	Grain yields of maize (t ha^{-1})				
	Republic of Serbia and the regions				
	Serbia total*	Central Serbia	Vojvodina	Jablanica area	Leskovac
2000	2,4	1,9	2,9	1,6	1,7
2001	4,9	4,1	5,6	3,8	3,9
2002	4,7	4,3	5,0	3,7	4,1
2003	3,2	2,9	3,4	3,7	3,5
2004	5,5	5,0	5,9	2,3	2,3
2005	5,8	5,0	6,5	5,3	5,7
2006	5,1	4,3	5,9	4,2	3,5
2007	3,2	2,3	4,1	3,6	3,6
2008	4,8	4,0	5,5	1,3	1,4
2009	5,3	4,5	5,9	3,7	3,7
mean	4,5	3,8	5,1	3,3	3,3

*without Kosovo and Metohija

Climatic factors, especially temperature and precipitation, according to many researchers involved in the formation yield of about 30%. Our country, in the course of the year, has sufficient rainfall. However, their distribution is irregular, so that it has the highest when plants are not needed. For many researchers it is very important distribution of rainfall during the vegetation, especially in the months (June-July-August) when it is most needed to corn. According to Rosić and Bajic (1989) the ideal amount of rainfall for corn during the three summer months is 317 mm (127 mm in June, in July 100 mm, and in August 90 mm). Because we are in Tab.2. analyzed the distribution of rainfall and temperature during the growing season of maize (April-September), and the amount of rainfall and average temperatures in critical months of the grain yield of maize (June-July-August). It is analyzed period of 10 years (2000-2009) for the area of Leskovac.Ten-year average precipitation in the growing maize (April-September) amounted 328.9 mm and the average temperature 18.1 ºC.
The average amount of rainfall for the month of June-July-August was 164.6 mm, while the average temperature was 21.2 ºC. In the analyzed period, there were selected two years with at least of rainfall in the June-July-August, and two years with at least with the highest rainfall in the same period. Thus, the years with the highest rainfall (257 mm and 242 mm) were 2002 and 2005, when the average temperature was 21.4 ºC and 19.8 ºC. In those years, the corn yield was the highest (4.1 and 5.7 t ha^{-1}), and total precipitation during the growing season were higher than 400 mm.Years with at least rainfall in the June-July-August (78 mm and 89 mm) were 2007 and 2000, and then the average temperature was 22.8º C and 21.7º C. However, the lowest yield (1.7 t ha^{-1}) was the year 2000, while the 2007 (although it had at least rainfall) yield was 3.6 t ha^{-1}. This is due to heavy precipitation in May (115 mm) which had accumulated enough moisture so it is offset by the lack of rainfall in the June-July-August. We note that the highest yields were achieved in the year with the highest rainfall in June-July-August and favourable temperatures, while the lowest yields were not always in the years when and amount of rainfall in month of June-July-August were the least.
Once again it is confirmed that the climatic conditions, especially in the June-July-August

determine and total yield of corn. Our results are in agreement with results Kovacevic et al. (2010) point out that the weather in the summer months (June - July - August) have a significant effect on the yield of maize in Croatia and Serbia. If corn production takes place in conditions without irrigation, which is most often the case, the consequences caused by adverse weather conditions can be somewhat mitigated breeding hybrids resistant to drought and better agrotechnics (tillage, fertilization, sowing dates).

Table 2. Weather data for Leskovac

Weather data - Leskovac										
Year	Precipitation (mm) and mean air-temp. (ºC) in June, July and August and during vegetation									
	June		July		August		Σ	x	April-september	
	mm	ºC	mm	ºC	mm	ºC	mm	ºC	Σ mm	x ºC
2000	47	18.9	38	22.4	4	23.9	89	21.7	234	18.0
2001	72	18.4	44	21.5	28	22.7	144	20.8	423	17.5
2002	57	20.5	53	23.3	147	20.6	257	21.4	406	18.7
2003	26	22.6	37	22.3	28	24.0	91	22.9	228	18.8
2004	74	19.5	76	21.7	36	19.3	186	20.1	319	17.5
2005	75	18.5	99	21.5	68	19.6	242	19.8	433	17.2
2006	80	19.3	33	21.5	118	20.6	231	20.4	365	17.8
2007	26	22.2	10	22.4	42	24.0	78	22.8	270	18.8
2008	48	18.7	43	21.6	46	22.6	137	20.9	282	17.6
2009	121	19.7	43	22.3	55	21.7	219	21.2	329	18.7
Average	62.6	19.8	47.6	22.1	55.7	57.2	167.4	21.2	328.9	18.1

Conclusions

Based on the analysis of the influence of climatic factors on the yield of maize in Leskovac (Jablanica) we can conclude the following:

In the ten-year period (2000-2009) were separated by two years (2002 and 2005) when the yield was the highest and the two years when yields were lowest (2000 and 2008).

In years when the average yield was the highest (4.1 and 5.7 t ha^{-1}) and climatic factors, particularly rainfall, were favourable.

Years with the lowest average yields (1.7 and 1.4 t ha^{-1}) were characterized by poor climatic conditions, especially precipitation distribution.

Average yields in favourable years were for 3.35 t ha^{-1} higher than the average yield in unfavourable years.

It is consulted influence of the amount of rainfall in June-July-August on yield of corn.

When the precipitation in these months were the greatest and yields were highest.

For the yield of corn is not important total precipitation during the year or vegetation, but their arrangement in stages when corn has a great need for water.

The breeding of resistant maize to drought and better agrotechnics can mitigate the consequences caused by unfavourable weather conditions.

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ПРИНОС НА ПЧЕНКА ВО ЈУЖНА СРБИЈА ВО ЗАВИСНОСТ ОД ГОДИШНИТЕ КЛИМАТСКИ УСЛОВИ

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Апстракт

Приносите од пченка се нестабилни и во голема мера зависат од климатските услови, хибридите и технологијата на одгледување. Целта на овој труд е да се анализира варирањето на приносот на пченка, во периодот 2000-2009 од гледна точка на врнежите и температурниот режим. Врз основа на информациите кои се дадени од страна на Републичкиот хидрометеоролошки институт, земјоделски експерти и образовниот сервис во Лесковац, анализирани се влијанието на врнежите и средната температурата на воздухот врз приносите на пченка во Јужна Србија (Лесковац). Посебен акцент се става на врнежите за време на трите летни месеци (јуни - август), затоа што се смета дека тие се од клучно значење за приносот. Од девет тестирани години, беа одделени две, со неповолни (2000 и 2008) и две со поволни климатски услови за производство на пченка (2002 и 2005). Просечниот принос на пченка во неповолните години беше 1,7 т ха$^{-1}$, односно 1,4 т ха$^{-1}$ кога износот на врнежи во критичните месеци (јуни - август) беше 89 мм, односно 137 mm, а просечната температура на воздухот во истиот период 21,7 ºC, односно 20,9 ºC. Просечниот принос на пченка во поволни години изнесуваше 4,1 т ха-^{1}, односно 5,7 т ха-^{1} кога износот на врнежи (јуни-август) беше 257 мм, односно 242 mm и просечна температура од 21,4 ° C, односно 19,8 º C. Вкупното количество на врнежи во текот на годината или вегетацијата, не е значајно за приносот на пченка, туку нивната распределба во фази, кога пченката има потреба за вода. За да се постигне принос соодветно на генетскиот потенцијал, што е повеќе од 10 т ха$^{-1}$ (кај рани хибриди), или повеќе од 15 т ха$^{-1}$ (кај касни хибриди), во прилог на хибридите и производното менаџирање, неопходни се благопријатни агроклиматски услови во регионот, посебно доволно врнежи и со правилен распоред.

Клучни зборови: пченка, принос, врнежи, температура на воздух.

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GRAIN YIELD OF TRITICALE AND RYE IN DEPENDENCE ON ACID SOILS FERTILIZATION

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Abstract

This paper gives a report on the influence of fertilization systems in acid soils, and the effect of mineral fertilization on 1000 grain mass, hectoliter mass and grain yield of triticale and rye. The trial was carried out in 2009-2010 in the Center of Agricultural and Technological Research - Zaječar, involving three fertilization variants and two plant species (triticale and rye). The first fertilization variant was characterized by NPK ratio of 120:80:53, in the second variant phosphorus content was doubled, and in the third variant, besides NPK fertilizers, there were applied 5 t/ha of lime fertilizer „Njival Ca" and 20 t/ha of manure. The trial was set in random complete block design (RCBD) with three repetitions. This investigation results showed a significant effect of fertilization on increase of 1000 grain mass, hectolitre mass and grain yield. The highest 1000 grain mass in triticale and rye (52.0 and 36.0 g) was reached by the combination of mineral, lime and organic fertilizers, while the highest hectolitre mass (77.9 and 74.5 kg) was obtained by the application of mineral fertilizers with doubled phosphorus dose. The highest grain yield (4180 kg ha^{-1}) in triticale was reached by combined application of NPK, lime and manure, while the highest grain yield in rye (2913 kg ha^{-1}) was obtained by NPK with doubled phosphorus dose. The difference between triticale and rye regarding the average grain yield was 1267 kg ha^{-1}. Numerous reports from our country and worldwide showed that proper application of lime fertilizers, combined with organic and mineral ones, is the most efficient way to remediate low production properties of acid soils, which could double crop grain yield.

Key words: triticale, rye, fertilization, absolute mass, hectoliter mass, yield.

Introduction

By opinion of many researchers triticale is plant species with a high genetic potential for yield and favourable nutritive values, so it is considered as a perspective plant species (Borojević, 1981, Cvetkov, 1982, Đokić, 1988). Rye, as an older grain sort, somewhat forgotten, takes the distinguished place again, at the first place in the organic production system and healthcare food.

In Nozinic and associates researches (2009) rye sorts had proven as very resistible to extremely acid reaction of soil in regard triticale. The same authors emphasize that both of those plant spicies showed satisfactory yield in extremely dry seasons.

According to results Impiglia (1987) triticale has more modest requests in regard wheat and more adaptability on acid soil, as more resistance to common diseases. Vertisols are soils of bad watery-aero and fizicly-mechanicly characteristics. On this kind of soil plant production is unstable. According to allegations of Aniolo and Madej (1996) the greatest tolerance to acid soil shows rye,

than triticale and wheat, yet barley is most sensitive. Numerous researches here and abroad point up that adequate usage of lime fertilizers combined with organic and mineral fertilizers represents the most efficient way of rejection of unfavorable productive characteristics of acid soil and affect to multiply yield increase (Jovanovic et al., 2006; Kovacevic et al., 2006; Jelic et al., 2006).
In selection of the kind and the quantity of fertilizer, it is necessary to consider fertility of the soil. So less quantity of fertilizers is used on more fertile soil than on poor one, in order to achieve the same yield (Jelic and associates, 2002).
The goal of our researches was to determine triticale yield and rye on acid soil in dependence of quotes and used fertilizers sorts.

Material and methods

The trial was carried out in 2009-2010 in the Canter of Agricultural and Technological Research in Zajecar, set up by block system in three repetition, involving control and three fertilization variants – mineral, lime and organic and two plant species (triticale, Tango sort and rye, Rasha sort). Amounts and schedule of nutrients in variants are given in a Table 1.

Table 1. Amounts of pure nutrients used in the experiment

Fertilization variants	Amounts of nutrients (kg ha^{-1})				
	N	P_2O_5	K_2O	$CaCO_3$	Manure
Control	0	0	0	0	0
NP_1K	120	80	53	0	0
NP_2K	120	160	53	0	0
$NP_1K+CaCO_3$ + manure	120	80	53	5.000	20.000

The size of the basic trial parcel was 50m^2. Total amounts of phosphorus and potassium fertilizers with one third of nitrogen are dispersed handy, before the pre-planting soil preparation. In variant with calcization usage lime fertilizer „Njival Ca“ was dispersed and there were applied manure and mineral fertilizer. The remained quantity of nitrogen was used in a sole top dressing in a phase of full tillering. From mineral fertilizers, complex NPK fertilizers (8:24:16), super phosphate (17% P_2O_5) were used, while in the top dressing was used ammonium-nitrat (AN) with 34.4% N. Basic processing and preparation of soil for planting are done on the classical way (to 25cm depth), immediately after the corn harvest and corn stover removal. The rest of technology production used in the trial was standard. The harvest was done in the phase of the dead ripe.
Soil and climate conditions
This is non-calcereous Vertisol soil and is distinguished by high level of acidity (pH in KCl 4,84 – 5,15). The content of nitrogen in profile to 20cm is 0,12% and decrease with depth. The content of the available phosphorus in profile to 20 cm is 16,68 mg/100g, and in deeper layers 12,34mg. This soil is heavy with available potassium (29,53 mg/100 g in the plough-field layer). Those soils have a cubage change predispositions, swelling and hardening tendencies so very heavy for treat. Those soils pertain to minute soils, which means that their optimal term for treat is very short. Repairments are necessary, in order to yield should have been satisfactory.

Table 2. Chemical properties of soil

Depth (cm)	pH		N (%)	Available (mg/100 g)	
	H_2O	nKCl		P_2O_5	K_2O
0-20	5.23	4.84	0.12	16.68	29.53
20 - 40	5.54	5.15	0.11	12.34	27.22

October had a highly amount of precipitation, which had a good influence on harvest and grain germination. During March and April conditions for growing process and development were very favourable, especially for swelling, rooting and increasing of leaves mass of plants. Vegetative development of plants during the spring time had favourable temperature conditions with satisfactory amount of precipitation, witch increased plants development. In final phases of grow and development, during June and July, temperatures were optimal, but heavy precipitations delayed harvest and led to loss of the part of yield and his quality.

Table 3. Meteorological conditions during the experiments

Months	Mean monthly	Monthly sum of precipitation (mm)	Relative
X	12	104	75
XI	9	94	74
XII	1	124	79
I	-2	53	81
II	1	100	74
III	7	59	73
IV	12	72	70
V	17	57	71
VI	20	94	71
VII	23	88	67
Average-sum	10	845	73.5

Results and discussion

Yield and yield components of triticale grain

Absolute grain mass is the significant of its magnitude or grain dimension and its mostly dependable of climate factors and plants density. Triticale has a large grain (40-65g) and surpasses wheat and rye (Popovic and Milovanovic, 1986, Rehmetulin and ass., 1988, Przulj, 1989. etc.).

The highest absolute mass (59g) of triticale is accomplished in third variant, where was used the combination of NPK fertilizers, lime fertilizers and manure, and the lowest was on control variant (52.0) – those differences were statistically very significant. Fertilizers usage led to increase of the absolute mass of grain, although there were no statistically significant differences between variants.

Characteristic of the hectolitre mass is that there were no statistically significant differences between fertilizing and control variants, although the highest values were achieved in the second variant (77.9kg). It is explained by the fact that on the control variant were significantly less number of plants (because of higher presence of weed), which grain were bigger.

Table 4. Components of grain yield of triticale depending on fertilization

Fertilization variants	Components of grain yield		
	Absolute mass (g)	Hectoliter mass (kg)	Grain yield
O. control	52.0	74.9	1927
I. NP_1K	57.9	77.4	3550
II: NP_2K	58.5	77.9	4020
III. $NP_1K+CaCO_3$+manure	59.0	76.8	4180
Average	57.9	76.7	4003
LSD- test			
5 %	3.2	4.6	360
1%	3.5	4.8	378

Fertilizing showed very significant influence to grain yield of triticale. So yield in all variants of fertilizing was significantly higher in regard to control variant. The highest yield (4180 kg ha^{-1}) was achieved on the third variant where was used NPK combination of lime and manure. Yield in the second and third variant was approximately equal, but significantly higher in regard to the first variant, where was used NPK fertilizers with lower dose of phosphorus. Variant with increased dose of phosphorus (II) showed good results in yield increase, so yield in this variant was significantly higher than in variant I. Higher effect of NPK usage with increased dose of phosphorus is result of high soil acidity and lower content of available phosphorus in this soil, also. Positive effect of enlarged doses of phosphorus fertilizers on grain yield height, got also another authors earlier (Jelic et al., 1998; Jovanovic et al., 2006; Kovacevic et al., 2006). Numerous earlier researches showed that on soils of acid reaction, the complete usage of NPK, lime and manure have a significant effect to grain yield (Ognjanovic et al., 1994; Jelic et al., 1995; Jelic et al., 2004), which is in accordance with our results, too.

Yield and grain yield of rye components

Rye belongs to plant species which have a good resistance to soil acidity, significantly better than other grains.

Table 5. Components of grain yield of rye depending on fertilization

Fertilization variants	Components of grain yield		
	Absolute mass (g)	Hectoliter mass (kg)	Grain yield
O. control	31.6	72.5	1077
I. NP_1K	33.6	73.5	2443
II: NP_2K	35.5	74.5	2913
III. $NP_1K+CaCO_3$+manure	36.0	73.7	2727
Average	34.1	73.6	2290
LSD- test			
5 %	2.3	4.1	280
1%	2.9	5.0	294

Absolute mass of rye grain with the fertilizer usage increased from I to III variant. The highest (36g) was in variant III and it was significantly higher in regard to variant I but significantly higher in regard to control variant. There were no significant differences between variants II and III and between variants I and control variant.

Similar to triticale results, and rye results, there were no statistically significant differences in the hectolitre mass, although it was the highest (74.8kg) in variant II, where was used higher dose of phosphorus.

If we compare triticale and rye yield on acid soils in regard to average, we could see it is lower evasion at rye. In opposition with absolute and hectolitre mass, grain yield of rye is significantly increased with fertilizers usage in regard to control. So the highest yield was achieved in variant II, where was used higher dose of phosphorus and it was significantly higher in regard to control and variant I. This confirms the fact of positive effect of phosphorus on acid soils. There were no significant differences in yield between variants II and III, while yield on those variants was significantly higher in regard to control variant and variant I. Differently from triticale, usage of combination NPK, lime and manure, didn't give the highest yield on rye. It could be explained with a fact that rye stands better acid soils and the effect of enlarged doses of phosphorus is more expressed.

Relatively favourable time conditions during the vegetation period, with enough amount of precipitations which were present until the earliest phases of plant development to the maturation phase, made the satisfactory grain yield was accomplished. Numerous researches show that favourable usage of nutrients from fertilizers effects and favourable meteorological conditions, also (Jelic, 1995; Zivanovic-Katic et al., 2000; Jelic et al., 2007).

Conclusions

On the bases of investigation of fertilizing influence on absolute mass, hectolitre mass and grain yield of triticale and rye, we can conclude/abstract the following:

Fertilizers usage positively effected on increase of grain yield of triticale and rye.

The biggest absolute mass in triticale and rye also, is achieved by usage of NPK, lime and manure fertilizers combination.

The highest hectolitre mass in triticale and rye also, is achieved by usage of NPK fertilizers with increased dose of phosphorus.

The highest triticale yield is achieved by usage of NPK, lime and manure fertilizers combination.

The highest rye yield is achieved by usage of NPK fertilizers with increased dose of phosphorus.

Lower evasions in yield from the average, are notified in rye, considering it better stands acid reaction of soil.

Differences in triticale yield and rye yield were 1267 kg ha^{-1}.

In order to raise the level of fertility of acid soils and increase of cultivated plants yield it is necessary to use the combination of NPK, lime and manure fertilizers, and usage of NPK fertilizers with increased dose of phosphorus.

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ПРИНОС НА ТРИТИКАЛЕ И ’РЖ ВО ЗАВИСНОСТ ОД ЃУБРЕЊЕТО НА КИСЕЛИ ПОЧВИ

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Апстракт

Во овој труд е претставено влијанието на системи за ѓубрење во кисели почви, и ефектот од минералното ѓубрење врз апсолутната маса, хектолитарската маса и приносот кај тритикале и 'рж. Опитот беше спроведен во периодот 2009-2010 година, во Центарот за земјоделско и технолошко истражување - Зајачар, со вклучени три варијанти на ѓубрење и два растителни видови (тритикале и 'рж). Првата варијанта се карактеризира со NPK = 120:80:53, во втората варијанта содржината на фосфор е удвоена, а во третата варијанта, покрај NPK ѓубрива, беа применети и "Njival Ca"-ѓубриво со 5 т/ха и 20 т/ха арско ѓубре. Опитот беше поставен во целосно рандомизиран блок систем (RCBD), со три повторувања. Резултатите покажаа значаен ефект од ѓубрењето, со зголемување на апсолутната маса /1000 зрна, хектолитарската маса и приносот. Највисока апсолутна маса беше постигнат со комбинација на минерално ѓубре, варовник и органски ѓубрива, кај тритикале и 'рж (52,0 и 36,0 g) додека највисока хектолитарска маса (77,9 и 74,5 кг) е добиена со примена на минерални ѓубрива со двојната доза на фосфор. Највисок принос (4180 кг ха$^{-1}$) беше постигнат кај тритикалето, со комбинирана примена на NPK ѓубриво, вар и арско ѓубре, додека највисок принос од 'рж (2913 кг ха$^{-1}$) е добиен со NPK ѓубриво, со двојна доза на фосфор. Разликата помеѓу тритикалето и 'ржта во однос на просечниот принос беше 1267 кг ха$^{-1}$. Бројни извештаи од нашата земја и светот, покажаа дека со правилна примена на варовнички ѓубриња, во комбинација со органски и минерални, се постигнува најефикасен начин да се санираат ниските производни својства на кисели почви, и да се добие двоен принос.

Клучни зборови: тритикале, 'рж, оплодување, апсолутна маса, хектолитарска маса, принос.

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INFLUENCE OF FOLIAR FERTILIZATION ON AGROMORPHOLOGICAL TRAITS OF WHEAT AND TRITICALE

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Abstract
The aim of this study was to monitor the effect of nitrogen application both as soil as well as foliar fertilization on agromorphological traits of wheat and triticale. The experiment was conducted at the production fields of Crveni Bregovi, Macedonia, during the growing season 2010/11. Two soft wheat varieties and one triticale variety were exposed to seven fertilization treatments. All treatments included soil application of 200kg/ha KAN (27% N) in tillering phase, and the first one with no additional fertilization was used as a control. The other treatments consisted of various doses and different application time of the fertilizers Magnisal 6 and ammonium nitrate NH_4NO_3 (17.5% N) applied by foliar spraying. Different treatment combinations significantly affected almost all agronomic characteristics. Plant height in cultivar Podobrena Orovcanka (79.4 cm) and kernel weight per spike in cultivar Olga (1.46 g) were not significantly changed by the use of foliar fertilizers. In triticale variety, plant height, spike length, number of spikelets per spike and kernel weight per spike didn't show significant differences when treatment 1 and treatment 7 were applied. Therefore, the results obtained by this research confirm that it is possible to obtain improvement of agromorphological traits of wheat and triticale through soil and foliar application of nitrogen. Furthermore, preliminary information on the influence of split doses of fertilizers at various growth stages to get appreciable growth and agronomic characteristics of these cereal crops is given.
Key words: foliar fertilization, agromorphological traits, wheat, triticale.

Introduction

Cereals are major source of nutrition in the world, because they constitute the main protein and energy supply in most countries (Bos et al., 2005). Wheat is the major cereal crop and is grown around the world in diverse environmental conditions. Triticale is cultivated under a wide range of environments because of its ability to tolerate adverse conditions such as drought, nutrient deficiency, etc. (NRC, 1989). Much of the production (FAO, 2004) is as triticale grain, but triticale is also grown as a forage crop and as a dual-purpose crop (both forage and grain) and is more cost-effective than its competitors, as its high lysine content means less protein supplements are required (Kinaci and Gulmezoglu, 2007).

Balanced nutrition plays a significant role in increasing crop production and its quality and presents an essential component of nutrient management. Nutrients like N, P, K, S and Mg are essential for the major processes of plant development and yield formation (Randhawa and Arora, 2000).

Nitrogen rate, type and timing of its application are important factors to increase wheat yield and improve its flour quality (Garrido-Lestache et al., 2005).
It has been observed that foliar fertilizer application methods ensure the availability of nutrients to crops for obtaining higher yield (Alaru et al., 2003; Arif et al., 2006).
Foliar application of N at different growth stages of wheat and triticale enhances the seed quality, boosts yield components and ensures high yield (Brar and Brar, 2004; Saeed et al., 2012). Efficient remobilization of urea (N) to grain after foliar fertilization on wheat at optimum timings, i.e., at and after anthesis stage, increases grain protein content and improves bread-making quality (Tea et al., 2007). Foliar application of nutrients to triticale may be advantageous when there is a high risk that the necessary nutrients will be unavailable to plant roots due to adverse soil and climatic conditions (Alaru et al., 2003).
The present study was therefore designed to investigate the possibility to improve agromorphological traits and to assess the response of wheat and triticale cultivars to soil and foliar fertilization.

Material and methods

The experiment was conducted at the production fields of Crveni Bregovi, Macedonia, during the growing season 2010/11. The experimental setup was randomized complete block (RCB) design with three replications. Plot size was $5m^2$ with a sowing density of 500 grains/m^2. Two soft wheat varieties (Olga and Podobrena Orovcanka) and one triticale variety (Agrounija), often used in the large scale production, were used for the experiment. Standard agrotechnical measures were applied with no autumn soil application of fertilizer.
All treatments included soil application of 200kg/ha KAN (27% N) in tillering phase, and the first one with no additional fertilization was used as a control (Treatment 1). The other treatments (7 in total) consisted of various combination of dose and application time of the fertilizers Magnisal 6 (NPK 31:0:0 + ME, released by Alkaloid AD Skopje in 2010, consisted of ammonium, nitrate and amid form of N and helated form of Fe and Mg) and amonium nitrate NH_4NO_3 (17.5% N) applied by foliar spraying. Details of the fertilizer treatments are as follows: *Treatment 1:* soil application of 200 kg/ha KAN at tillering phase; *Treatment 2:* soil application of 200 kg/ha KAN at tillering phase + 100 kg/ha KAN at booting stage; *Treatment 3:* soil application of 200 kg/ha KAN at tillering phase + 4l/1000l/ha NH4NO3 at grain filling; *Treatment 4:* soil application of 200 kg/ha KAN at tillering phase + 3l/1000l/ha Magnisal 6 at heading; *Treatment 5:* soil application of 200 kg/ha KAN at tillering phase + 4l/1000l/ha NH4NO3 at heading + 4l/1000l/ha NH4NO3 at grain filling; *Treatment 6:* soil application of 200 kg/ha KAN at tillering phase + 3l/1000l/ha Magnisal 6 at heading + 3l/1000l/ha Magnisal 6 at grain filling; *Treatment 7:* soil application of 200 kg/ha KAN at tillering phase + 3l/1000l/ha Magnisal 6 at heading + 4l/1000l/ha NH_4NO_3 at grain filling.
After the harvest, the influence of these treatments was evaluated on six agromorphological traits: three important characters: plant height, spike length, number of spikelets per spike, number of kernels per spike, kernel weight per spike and 1000 kernel weight. The data for the three replications were analyzed for variance using the statistical package R. The differences between means were compared by Tukey's hsd test. Statistical significance was considered at $P<0.05$.

Results and discussion

The findings of the research showed that different fertilization treatments had significant effects on all analyzed traits in wheat cultivar Podobrena Orovcanka (Table 1) and triticale cultivar Agrounija (Table 3). In wheat cultivar Olga (Table 2), the applied fertilizers did not show significant effect on number of kernels per spike. It is evident from the data that the application of N either as soil applied or as foliar applied had a significant effect on plant height in Podobrena Orovcanka and Agrounija. The treatment 4 had highest positive effect for number of spikelets per spike, number of kernels per spike and 1000 kernel weight in Podobrena Orovcanka (Table 1). For the other analyzed traits, values obtained after application of this treatment did not differ significantly from the highest values. The lowest plant height (69.33 cm) and kernel weight per spike (1.43 g) were observed in treatment 5.

Table 1. Effect of fertilization treatments on agromorphological traits in wheat cultivar Podobrena Orovcanka

Fertilization treatment	Plant height	Spike length	Number of spikelets per spike	Number of kernels per spike	Kernel weight per spike	1000 kernel weight
1	79,40e	10,64bc	18,53ab	33,43b	1,53a	35,90a
2	77,90cde	10,28a	18,50ab	34,57c	1,56ab	47,43d
3	73,28b	10,74cd	19,13b	36,40d	1,60ab	44,10c
4	78,30de	10,72bcd	19,30bc	40,40e	1,89c	48,40e
5	69,33a	10,29a	18,25a	31,58a	1,48a	46,67d
6	76,57cd	10,95d	20,13c	36,50d	1,66b	44,47c
7	75,77d	10,47ab	17,77a	30,83a	1,52a	43,23b

In cultivar Olga (Table 2), the highest values for number of spikelets per spike (22.47), number of kernels per spike (40.40) and 1000 kernel weight (44.10 g) were achieved under treatment 5. Plant height did not differ significantly between treatments 3 (69.07 cm), 2 (70.03 cm), 1 (70.10 cm) and 5 (70.17 cm).

Saeed et al. (2012) stated that the probable reason for increasing plant height could be the increased vegetative growth at high doses of applied N, greater and more efficient absorption of N or the genetic makeup of the concerned varieties. These results are in agreement with those reported by Ling and Silberbush (2002), Matsi et al. (2003) and Bakht et al. (2010). A positive effect of the foliar application of N over different agromorphological traits have been observed by Londero et al. (2003), Seadh et al. (2009), Parvez et al. (2009), Yassen et al. (2010) and Njuguna et al. (2011). In triticale cultivar Agrounija (Table 3), the treatment 7 caused lowest values for number of spikelets per spike, number of kernels per spike and kernel weight per spike, and the highest value for 1000 kernel weight. Plant height had lowest, while spike length and number of spikelets per spike had highest values under treatment 4.

Kinaci and Gulmezoglu (2007) and Gulmezoglu and Aytac (2010) revealed that foliar treatments had significant positive effect on grain yield, spikelet number per spike, number of grain per spike, 1000 grain weight and harvest index of triticale. On the other hand, Londero et al. (2003) observed that in hexaploid triticale the fertilizer effect was negative, except on harvest index.

Table 2. Effect of fertilization treatments on agromorphological traits in wheat cultivar Olga

Fertilization treatment	Plant height	Spike lenght	Number of spikelets per spike	Number of kernels per spike	Kernel weight per spike	1000 kernel weight
1	70,10ab	9,79ab	21,80bcd	33,27a	1,46a	41,17cd
2	70,03ab	10,38b	22,33de	38,10ab	1,61a	43,93e
3	69,07a	10,52b	22,10cde	32,43a	1,42a	40,13c
4	73,57d	9,94ab	21,53bc	36,07ab	1,51a	38,07b
5	70,17ab	10,15b	22,47e	40,28b	1,52a	44,10e
6	72,10cd	9,32a	20,60a	33,40a	1,42a	41,87d
7	71,60bc	10,51b	21,37b	34,27ab	1,52a	33,70a

Table 3. Effect of fertilization treatments on agromorphological traits in triticale cultivar Agrounija

Fertilization treatment	Plant height	Spike lenght	Number of spikelets per spike	Number of kernels per spike	Kernel weight per spike	1000 kernel weight
1	96,20b	9,90a	26,83a	41,18b	1,37ab	35,87cd
2	99,55c	10,46b	29,56bc	53,61f	2,19e	35,70cd
3	103,87e	10,88c	30,42cd	57,63g	2,41e	31,60a
4	86,47a	11,38d	30,98d	47,65d	1,76d	35,24bc
5	105,30f	10,93c	29,50bc	49,73e	1,93d	36,37d
6	102,87d	11,19d	29,11b	45,63c	1,53bc	34,40b
7	95,57b	9,97a	26,59a	35,36a	1,29a	37,70e

The overall positive effect of the foliar fertilization on analyzed traits in cereal cultivars included in this study may be due to the multiple advantage of the foliar application method, such as rapid and efficient response to plant needs, its relatively quick absorption, less product needed and independence of soil conditions (Römheld and El-Fouly, 1999; Yildirim et al., 2007).

Conclusions

The current study revealed that foliar and soil application of nitrogen at various growth stages of wheat and triticale improved the analyzed agromorphological traits. In Podobrena Orovcanka treatment 4 had the highest positive effect on number of spikelets per spike, number of kernels per spike and 1000 kernel weight. In cultivar Olga the highest values for most of the analyzed traits were obtained under treatment 5. Treatments 1 and 7 had lowest effect on almost all traits in triticale cultivar Agrounija, while the other treatments had variable influence. Further research is needed to identify more precisely the effect of various foliar fertilization treatmens (different combinations of application dose and time) in wheat and triticale.

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ВЛИЈАНИЕТО НА ФОЛИЈАРНАТА ИСХРАНА ВРЗ АГРОМОРФОЛОШКИТЕ СВОЈСТВА КАЈ ПЧЕНИЦА И ТРИТИКАЛЕ

Бошев Дане, Ивановска Соња, Јанкуловска Мирјана, Јанкулоски Љупчо, Кузмановска Билјана

Апстракт
Целта на ова истражување беше да се испита ефектот на ѓубрењето со азот, како преку почвата, така и фолијарно, врз агроморфолошките својства на пченицата и тритикалето. Експериментот беше поставен на производното поле на Црвени Брегови, Македонија, за време на вегетацискиот период 2010/11. Две сорти мека пченица и една сорта тритикале беа подложени на седум различни третмани на ѓубрење. Сите третмани вклучуваа почвена апликација на 200kg/ha KAN (27% N) во фазата братење, а првиот беше без дополнително ѓубрење, како контрола. Другите третмани беа со различни дози и различно време на фолијарна апликација, со примена на Magnisal 6 и амониум нитрат NH_4NO_3 (17,5% N). Различните комбинации од третмани значајно влијаеа врз речиси сите агрономски карактеристики на растенијата. Со користење на фолијарна исхрана не беа значително променети височината на растенијата кај сортата *подобрена оровчанка* (79,4 см) и тежината на зрната по клас кај сортата *олга* (1.46 g). Кај сортите тритикале, височината на растенијата, должината на класот, бројот на зрна од клас, и тежината на зрната од клас, не покажуваат значајни разлики при примена на третманот 1 и на третманот 7. Резултатите од ова истражување потврдија дека е можно да се добие подобрување на агроморфолошките својства на пченицата и тритикалето преку почвена и фолијарна прихрана со азот. Дадени се прелиминарни информации за влијанието на соодветни дози ѓубрива во различни фенофази, за добивање значаен пораст и влијание врз агрономските карактеристики на овие житарки.
Клучни зборови: фолијарна исхрана, агроморфолошки карактеристики, пченица, тритикале.

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EVALUATION OF DURUM WHEAT CULTIVARS UNDER ORGANIC FARMING CONDITIONS

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Abstract

Five Bulgarian durum wheat cultivars were grown in the Certificated Field of the Field Crops Institute – Chirpan, Bulgaria under organic farming conditions during two growing seasons with aim to evaluate agronomic traits and identify the most suitable cultivars for this farming system. Weather conditions were more favorable for durum wheat in 2012. Significant differences were found among the genotypes for grain yield and yield related traits – productive tillering, spike length, kernel number per spike, kernel weight per spike. The grain yield of durum wheat genotypes varied from 500.8 kg/ha in cultivar Progres in 2010, to 2330.8 kg/ha in cultivar A-233 in 2012. The modern cultivar Predel showed the best yield - 2070.8 kg/ha average for two years followed by old cultivar A-233 with mean yield of 1995 kg/ha. The conducted analysis of variance determined that the effects of Genotype. Years and Interaction on seed yield were significant. The observed variation of yield under organic conditions is due to the genotype and the year in almost equal extent – 30.5 and 31.3 % respectively from total variation and to the Interaction of both factors in a much lesser extent – 10 %. The highest yielding cultivars were most stable one based on the coefficient of variation: Predel - CV - 14 % and A-233 - 24 %. Both genotypes were characterized by high number of productive tillering, grains per spike, grains weight of spike and lower length of spike.

Key words: durum wheat, organic farming, yield, yield related traits.

Introduction

In Europe there are growing demand for stable crop production characterized by reduced inputs of pesticides and synthetic fertilizers and biodiversity increasing. This demand is reflected in the efforts to integrate environmental aspects into the Common Agricultural Policy (CAP). Organic farming is the strictest production system with low-input defined by Directive 2092/91 EU.

The production of organic food in EU countries is expected to grow steadily in the next 10 years due to the trends in the CAP of EU to restrict the support to conventional agriculture at the expense of broader support to organic production. Cereals are some of the important crops that are grown organically and occupy 40% of the market for organic products in the world.

In Bulgaria area planted under organic farming increased approximately 10 times since 2008 and 25 648 hectares were farmed organically at the end of 2010, constituting only 0.47 percent from the total cultivated area (Apostolov, 2012). The most preferred crops are cereals - mainly wheat, barley, rice, corn and rye. They occupied 5338 ha and represented the greatest percentage - 20.8 % of the total area cultivated under organic way. The durum wheat with high protein content and gluten strength is preferred as raw material for the production of pasta.

Bulgaria is a region with very favorable conditions for growing of high quality durum wheat grain. It is expected the interest in organic cultivation of durum wheat to increase due to rise of scientific evidence that the durum products are very important and desirable part of a healthy diet of the modern mankind (Silano, 2007). At the present 10 % of the total Italian durum wheat area are managed organically and represent more than 20 % of the national organically cultivated area (Camerini et al., 2011).

Recently in Bulgaria despite the steady growth in the organic sector there has been comparatively little research focused on the specific problems of organic cultivation (Stolce, 2005). The choice of appropriate cultivars is one of the key factors for the success of anyone cultivation system. The growing conditions between organic and conventional production system are distinguished to a great extent. The productivity of organic compared to conventional farming strongly depends on soil and climate conditions. Therefore the ideotype of varieties adapted to both farming systems is different. The main traits associated with superior performance of cereal variety in organic system are: efficiency of absorption and use of nutrients, competitiveness against weeds, tolerance to climatic and environmental stresses, stability of the yield and the qualitative parameters (Lammerts van Bueren et al., 2002).

For the time the problems concerning: the defining of ideotype; a choice of appropriate plant breeding methods and funding of special plant breeding programs; production and certification of organic seeds are time-consuming and difficult to resolve (Bozhanova and Dechev, 2010). As first step, conventional varieties testing under organic management can provide useful information to organic farmers in Bulgaria.

The objective of this study is to evaluate agronomic traits in old and modern durum wheat cultivars under organic farming conditions with a view to identify the most appropriate – high yielding and stable cultivars for this farming system in South Central Bulgaria.

Material and methods

Plant materials and experimental design

The experiment was performed at the Certified Organic Field of the Field Crops Institute – Chirpan, Bulgaria (42°12'58" N, 25°17'00" E, 175 m altitude) during two growing seasons 2010 and 2012. Five Bulgarian durum wheat cultivars: two old - A-233 (created in 60th years of the 20th century) and Progres (created in 80th years) and three modern cultivars – Victoria, Predel and Elbrus (created in recent years) were used. The cultivars were sown in a randomized, complete block design with four replications after cotton as predecessor. The total plots were 20 (5 cultivars × 4 replications) at area of basic plot of 10 m^2. The seeds were sown at a density of 400 plants per m^2 at end of October and were grown under organic farming conditions. No fertilizers, herbicides, fungicides and insecticides were applied. The cultivars were harvested in beginning of July at physiological maturity.

The soil and climatic characteristics

The soil type of the Certified Organic Field is Eutric Vertisols (by FAO), characterized by medium organic matter (1.5-2.4 %), with slightly acid to neutral soil reaction, with low to middle mineral nitrogen supply, low content of phosphates (0.5-3.2 mg/100 g soil) and well provided with available potassium (15-38 mg/100 g soil). The soil is clay, with high humidity capacity and small water-permeability, defined by the sand-clay composition. The test field was with bulk weight of the plough soil layer - 1.2 g/m^3, and specific gravity - 2.45. The sorbcium capacity is 35-50 mequ/100 g soil.

Growing season 2009/2010 was characterized with a higher than the usual mean temperatures and rainfall unevenly distributed during the growing season and was favorable for durum wheat growth and development. Growing season 2011/2012 was distinguished with severe drought in autumn and severe winter weather with prolonged snow cover. In early April the temperature rises quickly, leading to a rapid passage of growth stages from stem elongation to anthesis. Despite the unfavorable combination of climatic factors until anthesis, the large amount of rainfall in May-June during the next important growing stage (flowering and grain fill) led to near-normal grain yields.

Collected Date and Statistical analyses

Twenty plants were taken from each replication per cultivar before the harvest and were analysed for the following traits: general and productive tillering, spike length, number of grains in spike, grains weight of spike, TGW. The degree of brown and yellow rust resistance, powdery mildew resistance and leaf spots were expressed by a score in accordance with symptoms of a disease on plants (9 = resistance). Yield was recorded in kg per hectare (kg/ha) after combine harvesting.

The data were analyzed statistically using two-way analysis of variance (ANOVA), and the means were compared by Duncan multiple range test at 0.05 probability level. Basic statistics for means, coefficients of variation (CV) was calculated as the ratio of standard deviation and arithmetic mean, expressed in percentages) and coefficients of correlation was applied, too. The above statistical methods were completed using the statistical software STATISTICA (StatSoft, Inc. (2004). STATISTICA (data analysis software system), version 7. www.statsoft.com).

Results and discussion

Significant differences were found in grain yield and yield related traits among durum wheat cultivars included in our study under organic environment during two growing seasons.

All studied cultivars realized significant higher grain yield during the second growth season – 2011/2012. The average yield of all varieties in 2010 was 1440 kg/ha, while in 2012 the average one was with 45 % higher - 2090,1 kg/ha (Table 1). The causes for this variation can be associated with neither the differences in the applied agricultural technology, nor the disease attack. During the both growing seasons all cultivars expressed resistance to brown and yellow rust except cultivar Victoria – with moderate resistance. All cultivars were affected by powdery mildew and leaf spots an approximately equal negligible extent (2-3 score). A combination of climatic factors in 2011/2012 and especially the large amount of rainfall during the important growing stages was contributed to the realization of a higher yield at all varieties tested.

The modern cultivar Predel was highest yielding average from both growing seasons with 2070 kg/ha followed by old cultivar A-233 with mean yield of 1995 kg/ha, but A-233 realized the best yield 2330.8 kg/ha among all studied cultivars in 2012 (Table 1.). Both cultivars were characterized by high number of productive tillering, grains per spike, grains weight of spike and lower length of spike. The lowest yielding cultivar average from both growing seasons was Progres – 1165.7 kg/ha characterized by lower grains per spike, grains weight of spike and the higher length of spike. The cultivars Victoria and Elbrus gave medium grain yield value (1860.6 kg/ha and 1715.6 kg/ha, respectively).

Table 1. Average yield and yield related traits at durum wheat cultivars grown under organic conditions during two growing seasons

Cultivar	Yield (kg/ha)	Tillering		Spike length (cm)	Number of grains in spike	Grains weight of spike (g)	TGW (g)
		General	Productive				
2010							
Progres	500.8[a]	5.9[b]	3.2[ab]	6.3[a]	33.0[b]	1.4[b]	42.9[ab]
Elbrus	1400.8[bc]	5.7[c]	3.9[c]	6.1[ab]	40.7[a]	1.6[ab]	39.9[b]
Victoria	1640.3[cd]	5.7[c]	3.5[c]	5.5[bc]	38.9[a]	1.7[ab]	42.2[ab]
A-233	1660.0[cd]	7.4[a]	5.7[a]	5.1[c]	42.8[a]	1.8[a]	41.9[ab]
Predel	1980.8[e]	6.6[b]	3.6[bc]	5.7[abc]	38.5[ab]	1.8[a]	46.7[a]
2012							
Progres	1830.5 [a]	3.0[bc]	2.0[b]	6.0[a]	25.7[bc]	1.3[ab]	47.0[a]
Elbrus	2030.3 [a]	2.4[c]	1.9[b]	4.9[b]	22.4[c]	1.0[b]	45.5[a]
Victoria	2080.8 [a]	3.1[bc]	2.2[b]	5.0[b]	28.2[bc]	1.3[ab]	47.1[a]
A-233	2330.8 [a]	4.3[a]	3.3[a]	4.6[b]	35.2[a]	1.6[a]	45.3[a]
Predel	2160.3 [a]	3.5[ab]	2.7[ab]	5.9[a]	33.1[ab]	1.4[ab]	45.6[a]

[*]Mean values (in each column, separately for each year) followed by the same letters are not significantly different at $p<0.05$ according to Duncan's multiple range test.

The conducted analysis of variance for 5 genotypes over two years reveals that the effects of genotype (G), years (E) and interaction of both on grain yield were significant (Table 2). The significance of the interaction G×E complicates the choice of suitable cultivars for organic farming. Percentages of total sums of squares accounted for genotype, year (environment), and G×E interaction were used to indicate the variation attributed to each component. The observed variation of yield under organic conditions is due to the genotype and the year in almost equal extent - 30,5 % and 31,3 % respectively from the total variation and to the interaction of both factors in a lower extent – 10 %.

Table 2. Analysis of variance of yield

Source of variation	*df*	MS	SS	η^2 (%)
Total			135461	
Genotype (G)	4	10337***	41348	30.5
Environment (E)	1	42120***	42120	31.3
Interactions	4	3664**	14656	10.8
Error	30	1245	37337	27.6

*** Significant at $p< 0.001$; ** Significant at $p<0.01$

The effects of the genotype and the year were significant for almost studied yield related traits (productive tillering, spike length, number of grains per spike, grains weight per spike) in contrast to the interaction between both factors (G×E) (Table 3).

The interaction was significant only for TGW, furthermore this interaction determined in the highest degree detected variation for this trait. The observed variation of means for general and productive tillering and number of grains in spike is due to the highest degree of year of cultivation, while for spike length – due to the genotype.

Table 3. Analysis of variance of yield related traits

Traits	Source of variation and % from total variation					
	Genotype (G)		Environment/Year (E)		Interaction (G×E)	
	MS	η^2, %	MS	η^2, %	MS	η^2, %
General tillering	3.77***	11.8	101.12***	79.1	0.44^{NS}	1.4
Productive tillering	3.53**	7.1	161.60***	81.7	1.38^{NS}	2.8
Spike length	1.93***	42.0	1.89**	10.3	0.50^{NS}	10.9
Number of grains in spike	112.56***	20.2	975.16***	43.7	51.30^{NS}	9.2
Grains weight of spike	0.24*	23.5	0.94**	23.1	0.05^{NS}	5.1
TGW	1.97^{NS}	11.4	147.46*	9.8	132.64**	35.4

*** Significant at $p< 0.001$; ** Significant at $p<0.01$; * Significant at $p<0.05$

Our results support the widely accepted opinion that the environment variability had a considerably influence on a genotype's response in organic and low input conditions (Wolfe et al., 2008). As the environmental component in organic agriculture is more variable than in conventional one, the yield stability is more important than yield alone (Lammerts van Bueren, 2002). Furthermore, the information on yield stability is especially important in the presence of a significant genotype-environment (G×E) interaction as in our trial. Taking into account the above fact we evaluated yield stability per each cultivar separately based on the coefficient of variation averaged over replications and years (Table 4). The coefficients of variation on yield of studied genotypes ranged from 14 % at highest yielding cultivar Predel to 63.8 % at lowest yielding cultivar Progres. The other three cultivars are characterized by approximately the same moderately high coefficients of variation from 24 % at A-233 to 27, 4 % at Victoria. It is considered that the coefficient of variation can be useful statistic parameter taking aim at identification of cultivars with high and stable yield (Ortiz et al. 2001). Both high yielding cultivars in our experiment were distinguished by lowest CV - 14 % for Predel and 24 % for A-233 and therefore they were most stable.

Table 4. Basic statistic parameters for yield at durum wheat cultivars averaged over replication and years

Cultivars	Means	Min	Max	CV, %
Progres	117.1± 26.4	26	209	63.8
Predel	207.7± 10.4	158	255	14.0
Viktoria	186.5± 18.1	102	257	27.4
A-233	199.9± 17.1	150	295	24.0
Elbrus	172.0± 15.9	125	260	26.3

These cultivars are selected at different times and at different growing conditions – low and high input. A-233 is an old cultivar, created in 60th years of the 20th century, while Predel is a modern one, certified in 2008 and therefore they considerably differ in theirs morphological and agronomical traits. Our results not fully confirmed the assumption that old cultivars selected under low input conditions are better suitable for organic farming than cultivars selected under conventional high input conditions. Although the old cultivar was one of the best among all studied cultivars and realized the highest yield in one of the growing seasons, yet the modern one showed highest yield and yield stability average from both growing seasons. Thus it is confirming that modern cultivars selected for conventional farming can be also suitable for cultivation under the nutrient restricted conditions in organic farming (Guarda et al., 2004; Hildermann, 2010). Our results do not diminish the importance of conduction of special plant breeding for organic farming and selection for suitable genotypes under organic environments at least in later generations (Löschenberger et al., 2008). Results of conducted correlation analysis between yield and yield related traits separately for each growing season are presented in Table 5. The yield of durum wheat cultivars, grown under organic farming conditions was positively associated with traits: number of grains in spike, grains weight of spike during both years of cultivation. But only the correlation with grains weight of spike was significant and only in the first cultivation year. High positive and significant correlation was detected between yield and productive tillering only in a second cultivation year. These results are in accordance with our previously study at durum wheat grown in conventional conditions (Bozhanova and Dechev, 2009) and findings of other researchers (Koutis et al., 2012, Marque et al., 2004). High negative but not significant correlation between yield and spike length was found during both years of cultivation.

Table 5. Correlation coefficient between yield and yield-related traits in durum wheat under organic growth conditions in different seasons

Correlation coefficient between yield and yield related traits					
General tillering	Productive tillering	Spike length	Number of grains in spike	Grains weight of spike	TGW
2009/2010					
0.41	0.36	-0.69	0.74	0.96***	0.33
2011/2012					
0.76	0.88***	-0.61	0.79	0.63	-0.67

*** Significant at $p< 0.001$

There is contradicting information on the relationship between the spike length and yield and the most researchers pointed that genotypes with longer spike length produce higher yields as compared to those with shorter spike length under the conventional agriculture conditions (Wang et al., 2001, Karimizadeh et al., 2012). In our evaluation the highest yielding genotypes under organic conditions distinguished with shortest but most compact spikes with highest grain numbers. These yield formation strategy is probably a consequence of the combination of specific climatic conditions in our region and conditions of organic cultivation. It is considered that the density of spike in durum wheat is more important for the yield in relatively cool and wet regions (Daaloul et al., 1998) as is the region in which this study was conducted. In the view of achieved results it can be suggested that the traits: productive tillering, number of grains in spike, grains weight of spike and short and compact spike are favorable characteristics for the selection of suitable for organic farming conditions durum wheat cultivars.

Conclusions

Significant differences were found in grain yield and yield related traits among durum wheat cultivars included in our study under organic environment during two growing seasons.

Modern durum wheat cultivar Predel and old cultivar A-233 were identified as high yielding and stable cultivars therefore both cultivars had good capacity to adapt to organic cultivation in South Central region of Bulgaria.

The effects of genotype, years and interaction of both factors on seed yield and almost studied yield related traits were significant. The observed variation of yield under organic conditions is due to the genotype and the year in almost equal extent. Therefore our results support the widely accepted opinion that the environment variability had a considerable influence on a genotype's response in organic and low input conditions.

The identified in our experiment highest yielding and stable genotypes are characterized by high number of productive tillering, grains per spike, grains weight of spike and lower length of spike. These yield formation strategy is probably a consequence of the combination of specific climatic conditions in our region and conditions of organic cultivation.

Some modern cultivars selected for conventional farming could be also suitable for cultivation under the nutrient restricted conditions in organic farming. This fact does not diminish the importance of special plant breeding conduction for organic farming and selection for suitable genotypes under organic environments at least in later generations.

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ПРОЦЕНКА НА СОРТИ ТВРДА ПЧЕНИЦА ВО УСЛОВИ НА ОРГАНСКО ЗЕМЈОДЕЛСТВО

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Апстракт

Пет бугарски сорти тврда пченица беа одгледувани на сертифицираното поле на Институтот за поледелски култури - Чирпан, Бугарија во услови на органско земјоделство, во текот на две вегетациони сезони, со цел да се оценат агрономски црти и да се идентификуваат најсоодветните сорти за овој земјоделски систем. Временските услови беа поповолни во 2012 година. Беа пронајдени значителни разлики меѓу генотиповите за приносот и поврзаните со приносот својства – продуктивно братење, должина на класот, број на зрна на клас, тежина на зрна по клас. Приносот на тврдата пченица по генотипови варира од 500,8 кг /ха кај сортата Progres во 2010 година, за да 2330,8 кг/ха кај сортата А-233 во 2012 година. Атрактивната сорта Predel покажа најдобар принос - 2070,8 кг /ха, просек за две години, следеше старата сорта А-233 со среден принос од 1995 кг/ха. Извршената анализа на варијанса го утврди ефектот од генотипот. Годините и интеракцијата на приносот на семе се статистички значајни. Набљудуваните варијации на приносот во услови на органско производство се должи на генотипот и годината, речиси во иста мерка - 30,5 и 31,3%, соодветно од вкупната варијација, и во многу помала мерка со интеракцијата на двата фактори (10%). Највисоко приносните сорти беа и најстабилни врз основа на коефициентот на варијација: Predel, CV-14% и А-233 CV -24%. Двата генотипа се карактеризират со голем број на продуктивни братимки, зрна на класот, тежина на зрната на класот и со помала должина на клас.

Клучни зборови: тврда пченица, органското земјоделство, принос, карактеристики.

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Expert paper

RESULTS OF THE EXAMINATIONS OF THE BURLEY VARIETY PELAGONEC CMS F1

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Abstract

The aim of these researches is putting on hold the production of Burley type in the Republic of Macedonia and exploring the possibilities for restarting it in order to avoid the total dependence of the Macedonian cigarette industry from raw material of this type of tobacco. Guided by these considerations we decided on prior examinations with some Burley varieties. Our attention was directed at the Macedonian perspective variety Pelagonec CMS F1 which was used for certain examinations during 2008. The results from the examinations (morphological, yield, quality, physical properties and tasting of raw material) confirmed the high economic value of this variety.

Key words: tobacco, Burley, variety, yield, quality.

Introduction

In the Scientific Tobacco Institute – Prilep, in the last decade, as a result of intensive selection efforts, particularly with the Burley type, are created a number of varieties and lines of both, fertile and male-sterile form. From all of them, because of its properties (yield, quality, resistance to diseases, etc.) the most attention got the male sterile hybrid variety Pelagonec. Taking into consideration the fact that in Republic of Macedonia, the production of the Burley type and Virginia type after 2002 was put on hold, Pelagonec variety can present a challenge for activating the production of this type of tobacco in regions where real conditions and interest exist. Otherwise, the Macedonian fabrication will continuesly depend on import of this type of tobacco. All previously said was a challenge enough to conduct certain examinations with this type of tobacco and the Pelagonec variety. The results obtained from these examinations can be a good basis for serious thoughts on reorganizing the production of this type of tobacco in the Republic of Macedonia.

Material and methods

Included in the examinations was the male sterile hybrid Burley variety Pelagonec. The experiment was set on the premises of the Scientific Institute in 2008, on a colluvial type of soil. The first ploughing was carried out in the autumn of 2007, at a depth of around 40cm. In the spring of 2008 the surface was fertilized with 300 kg/ha artificial fertilizer NPK in the ratio of 8:22:20 and was ploughed two more times. Before transplantation the soil was treated with herbicide and harrowed. The healthy seedlings were manually transplanted, transplanting 163 stems with transplanting density of 90 x 50 cm (73,35 m^2). Before the first and second hoeing a manual fertilization was performed with about 5 g/stem of KAN, 26%. Because during vegetation (V – IX month) the total amount of rainfall was 183,3 mm, several additional irrigations were necessary. The morphological measurements were carried out on 30 plants from which the average values were established at the end. The tobacco was hand picked, separately from each priming range (from lugs to tips – seven pickings) in order to get a comprehensive picture of the variety in relation to the total yield. The picked tobacco was manually strung and dried in special dryers for the Burley type (air curing). In order to adjust the classification with the international classes which apply to the international commerce with this type of tobacco, the classification of raw material was performed twice. The first time the tobacco was classified according to the current Rules on standards for qualitative and quantitative assessment of raw tobacco leaf (Official gazette of the Republic of Macedonia No 16/2007, No 144/2010 and No 20/2011). The second time according to the Official Standard Grades For Burley tobacco-foreign type 93.

The yield per stalk was determined when the total quantity of dry tobacco with 15% humidity was divided by the total number of stalk (g/stalk) and the yield by hectare was determined by establishing the number of stalk per hectare (22222 stalk x yield per stalk).The physical properties of the raw material were tested in the certified laboratory of the Scientific Tobacco Institute – Prilep, and the tasting properties were examined by the tasting committee of the JSC "Tutunski Kombinat" – Prilep. In these two examinations, a raw material from the middle priming range was used.

Results and discussion

Morphological properties

The character of tobacco's morphological properties is mostly influenced by genetic factors, agricultural and environmental conditions and applied agricultural technology during vegetation.

In different varieties of tobacco from the Burley type, morphological properties (the number of leaves and their dimensions, stem height, etc.) are different and that is why they are different from each other.

Our examinations covered the dimensions of the 5th, 10th and 15th leaf, as well as the average number of leaves and the stem height with flower. These data are shown in Table 1. From the data presented in Table 1, can be concluded that dimensions of leaves in the lower priming range (the 5th leaf) and middle priming range (the 10th and 15th leaf) are typical of the Burley type. Uzunoski (1985) describing the American variety B-21 mentioned that the length of the largest leaf from this variety ranged from 55–70 cm, and the width from 26 – 30 cm. Risteski (2006), performing three-years examinations with six Burley types in the region of Prilep came to a conclusion that with the largest length of the 5th leaf distinguished was the variety Podravac, and with the largest length of the 10th leaf (61 cm) and the 15th leaf (62 cm) distinguished was the variety B-2/93. Dyolgerski (2009), gave certain parameters and directions for creating good (ideal) varieties of the Burley type where he recommended no limit in the size of the robust variety of tobacco, and for type Burley he recommended length of leaves no lesser than 60-62 cm and width 30-32 cm.

Table 1. Results of morphological measuring – average values

Variety	5th leaf in cm		10th leaf in cm		15th leaf in cm		Number of leaves	Stalk height with flower, cm
	L	W	L	W	L	W		
Pelagonec CMS F1	46,80	31,00	68,10	38,90	65,00	31,60	33,60	177,60

From data for the number of leaves per stalk it can be seen that the average number of leaves in the Pelagonec variety in average was 32,6 leaves.
According to Beljo (1996), varieties with this number of leaves belong to the group of high-yield tobacco, and according to the height of the stalk with flower (177,6 cm) the Pelagonec variety belongs to the category of middle-height tobacco. Stoyanov and Apostolova (1999 and 2000), point out that stalk heights of the newly created Bulgarian Burley varieties B-1317 and B-1351 are 158 cm and 165 – 170 cm accordingly. From data of the analyzed morphological properties and available literary data it can be concluded that the Pelagonec variety has all the characteristics of a typical Burley variety.
Yield and quality
Tobacco yield as a measurable category together with the quality represent an illustrative indicator when assessing the economic value of a variety. These two indicators despite from being genetically controlled are largely depend on agricultural and environmental conditions and the agricultural technology applied during tobacco vegetation. Pelivanoska et.al. (2001), report that by implementing different versions of fertilization and irrigation, yields of the Burley type B-2/93 in the region of Ohrid and Struga could reach up to 6 000 kg/ha. Budin (1988), reports that yields of the Burley type in Zimbabwe in the period of 1980 – 1985 ranged in average from 1 202 to 1 760 kg/ha. Risteski (2006), reports that three-year yield average of the six Burley varieties cultivated in the Prilep production area from the variety picked – strung ranged in the borders of 2278 to 2910 kg/ha.
How the yield per stalk (g/stalk) and area (kg/ha) ranged in our researches, it can be seen from data in Table 2.

Table 2. Yield per stalk (g/stem) and area (kg/ha)

Pelagonec variety CMS F1	Number of picked Stalk	Total quantity of raw tobacco from the picked stems in g	Yield per stem g/stalk	Yield per hectare kg/ha (196,3 g x 22222 stalk)
	163,00	31960,00	196,30	4362,00

From data in Table 2 it can be concluded that yields given by the Pelagonec variety (196,3 g/stalk and 4362 kg/ha) are quite acceptable so that this variety can be freely included in the group of high-yielding varieties. These results are strongly influenced by dimensions and number of leaves per stalk. In areas that are typical for production of the Burley type, higher yields of the Pelagonec variety can also be expected.
The quality of produced tobacco raw material is also a measurable category. In the beginning, the quality of raw material is assessed visually – organoleptically according to the Measures for Purchase of Raw Leaf Tobacco where inertia, dimensions and color of the leaf, thickness and delicacy of the leaf blade, content of the rib, etc. are taken into consideration. If more accurate results are needed, physical and chemical analyses are made.
However as a final and definitive indicator of the tobacco quality, results from tasting of raw material are taken. All these indicators of quality are largely dependent on agricultural and environmental conditions, applied agricultural technology, proper harvesting, curing, etc. How the

quality of the produced raw material ranged assessed by the Measures for Quality Assessment of Raw Leaf Tobacco for the Burley type, it can be seen from data in Table 3.

Table 3. Raw material quality

Pelagonec variety CMS F1	Total cured tobacco, g	I class	II class	III class	IV class	V class	Participation I-III class	
		%	%	%	%	%	Weight, g	%
	31960	46	20	8	14	12	23660	74

From data in Table 3 it can be seen that out of the produced total of raw tobacco from 31960 g, 14774 g or 46% belong to class I, which is an evidence that leaves from the middle picking range with larger dimensions (over 40 cm), full of content, delicate and with color characteristic of the high-quality Burley type were dominant in the produced raw material. The second class is represented with 6242 g or 20%, and 2644 g or 8% fall into the third class. The fourth class participates with 4 564 g or 14%, and the fifth class where the lowest quality of tobacco from all harvests is being classified participates with 3736 g or 12%. Much clearer picture of tobacco raw material quality is presented by the percentage share of high classes (I, II and III) in the total yield. From results shown it can be seen that from the total quantity of dry tobacco 23660 g or 74% fall into these three classes, which is an indicator that this variety gives high quality raw material.

Raw material quality

According to the classification (Official Standard Grades for Burley tobacco, Foreign type 93, U.S. Department of Agriculture, Washington D.C. 1990) of dry leaves, in the Pelagonec CMS F1 variety, a high percentage of classes with excellent use value were determined. In Table 4 presented are the values of the qualitative assessment of dry leaves from the examined material.

The insertion C – cutters, accounted for 42,9% of the total examined material of 30 000g. Within this insertion, the first class (C1F) accounted for 16,4% or 4920 g the second class (C2F) accounted for 15,6% or 4680 g and the third class (C3F) accounted for 7,8% or 2340g. The total value of the first, second and third class was 11940 g or 38,9%.

The insertion B – leaf, accounted for 31,2% or 9360 g. The percentage of participation of the first class (B1F) added up to 10,9%, the second class (B2F) added up to 8,6% and the third class (B3F) added up to 9,4% . The insertions C – cutters and B – leaf, cover the middle range of the plant habitus, leaves are very similar to each other and have a high use value in fabrication. Because of this, the total value of these 2 insertions, which added up to 74,1% or 22230 g of the total examined material, was a clear indicator that this variety is characterized by a high use value.

Class composition of leaves from the first insertion X – flyings, included 19,5% from the total examined material or 5850 g. The first class (X1L) added up to 2 340 g or 7,8%, the second class (X2L) up to 1410 g or 4,7%, and the third class (X3L) added up to 1 170 g or 3,9%. The total presented value of the three classes added up to 4920 g or 16,4% of the total examined material.

During classification of dry leaves from the T – tips insertion, it was determined that it was characterized by a low percentage of participation in the examined material that added up to 6,4% or 1930 g. The first class (T1F) accounted for 1,6% or 480 g. The (T2F) class accounted for 1,8% or

540 g and the third class (T3F) accounted for 1,6% or 480 g. The total values of the three classes added up to 5% of the total examined material or 1500 g.

Table 4. Classification of materials by Official Standard Grades, Burley tobacco foreign type 93

Insertion X	Total dry tobacco in g	1L	2L	3L	4L	5L	Participation 1-3 class	
		%	%	%	%	%	g	%
	5 850	7,8	4,7	3,9	3,1	/	4920	16,4
Insertion C	Total dry tobacco in g	1F	2F	3F	4F	5F	Participation 1-3 class	
		%	%	%	%	%	g	%
	12870	16,4	15,6	7,8	3,1	/	11940	39,8
Insertion B	Total dry tobacco in g	1F	2F	3F	4F	5F	Participation 1-3 class	
		%	%	%	%	%	g	%
	9360	10,9	8,6	9,4	2,3	/	8670	28,9
Insertion T	Total dry tobacco in g	1F	2F	3F	4F	5F	Participation 1-3 class	
		%	%	%	%	%	g	%
	1920	1,6	1,8	1,6	1,4	/	1500	5,0

Physical properties of raw material

Physical properties as part of the properties of tobacco raw material represent an objective indicator of its quality therefore they are implemented as a segment in the current classification systems, according to which the tobacco assessment is made. These properties are in co dependence with environmental conditions, the applied agricultural technology during vegetation, insertion, maturity of leaves when picked, time spent in yellowing, water quantity in picked leaves, way of harvesting and curing, etc. From physical properties, studied were the main rib content and leaf's thickness and materiality. According to Darkis (loc. cit. Uzunoski, 1985), the main rib content in the total leaf weight in the Burley type amounted to approximately 30%. Perovič and Prpič (1983), examining some physical properties of the Burley type in Jastrebarsko (Croatia) came to a conclusion that the main rib content in middle harvests was 27,78%. Arangelovič et al. (1973), examining the Burley varieties in eight regions in Serbia came to a conclusion that the main rib content ranged up to 29,40% and mentioned that in the Burley raw material produced in the USA (N. Carolina) this number was 35,48%. Smokvoski (1999), came to a conclusion that the leaf blade of the Burley type cultivated in Prilep production area ranged from 57,25 to 62,63 µm. Risteski (2006) reported that the average values of leaf thickness from three-year examinations in Prilep production area with Burley varieties ranged from 61,00 to 71,83 µm. In regards to materiality of the leaf, the same author mentioned that in average it ranged from 37,40 g/m^2 to 42,95 g/m^2. Pelivanoska (1999), came to a realization that the mutual influence of tobacco fertilization and irrigation during vegetation lowered the materiality of dry leaves. Which physical properties characterized the raw material in our examinations can be seen from data in Table 5.

Table 5. Physical properties of raw material

Pelagonec CMS F1	Rib %	Thickness of leaf tissue, μm	Materiality g/m^2
	31,45	83,25	35,91

From data presented in Table 5, it can be concluded that the main rib content in the leaf composition (31,46%) is within the boundaries typical for the Burley type, which is supported by the previously cited data by many authors and is within the expectations. The leaf thickness (83,25 μm) is also typical of the Burley type and corresponds with values from the cited literary data.

Regarding data of leaf materiality (35,91 g/m^2) it can be stated that it is somewhat lower than usual for the Burley type. But it is known that tobaccos with lower materiality produce a greater number of cigarettes. Taking into account the fact that today the Burley type participates with around 30% in cigarettes composition, lower materiality promises higher economic effects and vice versa.

Tasting properties of raw material

Unlike all other products that human consumes in solid or liquid state, tobacco is mostly consumed in the form of smoke. All products that are released in the process of pyrolysis, as a rule should give the consumer a pleasant feeling of taste, aroma, and relaxation that comes from the physiological influence of the nicotine on the nervous system.

These tobacco properties are very closely related to certain chemical components in the tobacco (soluble sugars, essential oils and resins, nicotine, proteins, etc.) and their mutual ratio. Although subjective, most authors consider the tasting method as the final and definitive indicator of tobacco quality. Nikolič et al. (1998), in 1994 and 1995 examined several lines of the Burley type in Serbia and concluded that when smoking this type of tobacco one should not expect some distinctive aroma, which will burn and irritate us, but to expect excellent flammability, white and compact ash.

Risteski (2006), stated that the raw material of all 6 Burley varieties examined in Prilep production area in the period of 1999-2001, by the tasting committee was rated as very strong. The author related this with the somewhat higher content of nicotine (over 2%). Which tasting properties characterized the raw material produced in our researches can be seen from data in Table 6.

Table 6. Tasting properties of raw material

Tasting components	Points
Irritation	17,80
Taste	17,70
Aroma	16,80
Intensity	13,00 (strong)
Flammability	4,00
Compactness	4,00
Total	73,30

The subject of assessment in Table 6 was a tobacco leaf mixture from the entire plant. According to tasters' opinion, the examined material was characterized by typical irritation with sugary taste with

good quality and intensity. Aromatic characteristics were representative of the typical Burley aroma with good quality. The physiological intensity was clearly defined and was consistent with the taste and aroma complex. The flammability and compactness fully met the standards of the Burley type. The opinion of the tasting committee at Cigarettes - LLC Prilep is presented in Table 6 and Table 7.
In the insertions, there was a clear definition of tasting properties. In the insertions C and B, the raw material was characterized by the typical Burley features with a rather more specified aroma (piquancy), sweetish and discreet refreshment. The physiological intensity was better expressed in comparison to X and T insertions. The material in all examined insertions was characterized by a good and solid compactness.
According to the values presented in Table 6. and Table 7. the highest points got the insertion C-cutters with 73,31 points, the second place got the tobacco mixture from the entire stem with 73,00 points, and the third place was for the insertion B-leaf with 73,21 points. The fourth and the fifth place were the insertions T - tips with 73,20 points and insertion X-flyings with 73,18 points.

Table 7. Tasting properties of tobacco row materials classified by Official Standard Grades, Burley tobacco foreign type 93

Tasting components	Insertions			
	X	C	B	T
Irritation	17,80	17,80	17,80	17,80
Taste	17,64	17,70	17,67	17,70
Aroma	16,74	16,81	16,80	16,70
Intensity	13,00 (strong)	13,00(strong)	13,00 (strong)	13,00
Flammability	4,00	4,00	4,00	4,00
Compactness	4,00	4,00	4,00	4,00
Total	73,18	73,31	73,27	73,20

Conclusions

Based on the above we come to the following conclusions:
With regards to morphological characteristics of the Pelagonec CMS F1 variety (height of stalk, number and dimensions of leaves) it can be stated that it is closely related to some eminent foreign varieties. The average yield per hectare (4 362 kg) and the average of the upper classes I-III (74%) achieved in a region atypical for the Burley type (Prilep) guarantees enough that this is a variety with high potential. Indicators of physical properties of raw material, rib participation (31,46%), leaf thickness in micrometers (83,25) and leaf materiality (35,91 g/m^2) are within the range for the Burley type. Results from the tasting properties of raw material show that it is typically Burley and it can be freely included in the mix of blended cigarettes. All these indicators tell us that in the Scientific Tobacco Institute– Prilep, a Burley type (Pelagonec CMS F1) was created, which can be used to restart the production of the Burley type in the Republic of Macedonia to a general satisfaction of the primary producers and cigarette manufacturers.

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РЕЗУЛТАТИ ОД ИСПИТУВАЊАТА ОД БЕРЛЕЈСКАТА СОРТА ПЕЛАГОНЕЦ ЦМС F1

Жарко М. Христоски

Апстракт

Целта на овие истражувања е ставањето во мирување на производството на типот берлеј во Р. Македонија и испитување на можностите истото да се рестартира и да се избегне целосната зависност на македонската фабрикација со суровина од овој тип на тутун. Водени од вакви размислувања се одлучивме за претходни испитувања со некои берлејски сорти. Вниманието беше насочено кон македонската перспективна сорта Пелагонец ЦМС F1 со која беа извршени одредени испитувања во текот на 2008 год. Резултатите од испитувањата (морфолошки, приноси, квалитет физички својства и дегустација на суровината) ја потврдија високата стопанска вредност на оваа сорта.

Клучни зборови: тутун, берлеј, сорта, принос, квалитет.

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PLANTH GROWTH PROMOTION EFFECT AND SURVIVAL RATE OF AZOTOBACTER IN ACID SOIL

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Abstract
Azotobacter is a soil bacterium which, apart from fixing atmospheric nitrogen, produces growth substances (e.g. indole acetic acid, IAA). For that reason, it is used as a biofertilizer in plant production. Due to the need to apply biofertilizers in acid soils, too, research has been focusing on creating acid resistant strains of azotobacter. In this research, nine strains of azotobacter were isolated from halomorphic soil (pH 9). The production of IAA in all strains was determined by colorimetric method. Their survival rate in acid soil (pH 5) and their effect on the early growth of wheat were investigated. The experiment was conducted in controlled conditions, in pots. The strains of azotobacter were introduced into the soil. The control variants were not inoculated. The number of azotobacter, the height and the dry mass of the plant were determined thirty days later. IAA production ranged from 3.73 to 10.4μg ml^{-1}. The survival rate of the introduced azotobacter was low. Its number decreased from $10^6 g^{-1}$ to $10^3 g^{-1}$, but it was still larger than in the non-inoculated variant ($10^1 g^{-1}$). The applied azotobacter strains promoted the early growth of wheat. The length of the part above ground in the inoculated variants was 3% to 35% greater than in the control, whereas the dry mass was 0,6 to 58% greater. The increase in the length and dry mass was mostly in correlation with the amount of IAA.

Key words: azotobacter, acid soil, wheat.

Introduction

Many bacterial species are well known for their growth promotion effects on plants (Tilak et al., 2005; Egamberdiyeva, 2005). PGPR promote plant growth by production of metabolites, i.e., phytohormones or enhanced availability of nutrients (nitrogen, phosphorous). For example, about 80% of the naturally occurring bacteria in soil are capable of producing auxin which is considered as an important plant growth regulator (Patten and Glick, 1996). These bacteria utilize tryptophan secreted by plants as root exudates to synthesize auxin. The positive role of PGPR in stimulating the plant growth has also been confirmed by Barea et al. (1976), Dazzo et al. (2000), Djuric et al. (2011). Enhanced availability of nitrogen are capable diazotrophic microorganisms. There are known to provide fixed nitrogen in exchange of fixed carbon secreted by plant as root exudates (Glick, 1995). One of these microorganisms is azotobacter. Azotobacter is a soil bacterium which, apart from fixing atmospheric nitrogen, produces growth substances (e.g. indole acetic acid, IAA). For that reason, it is used as a biofertilizer in plant production (Mrkovacki et al., 2006., Mrkovacki and Bjelic (2011), Okon et al (1995), Jarak et al.(2011). Due to the need to apply biofertilizers in acid soils, too, research has been focusing on creating acid resistant strains of azotobacter.

Material and methods

In this research, nine strains of azotobacter were isolated from halomorphic soil (pH 9). IAA was assayd by colorimetric method. Development of pink color was assayed with spectrophotometer at 530 nm. Concentration of produced IAA was determined from a standard curve of IAA (1-50 μg ml^{-1}). Their survival rate in acid soil (pH 5) and their effect on the early growth of wheat were investigated. The experiment was conducted in controlled conditions, in pots. Azotobacter was grown on medium with manitol. $4x10^6$ g^{-1} of cells of each strain was introduced into the soil. The control variants were not inoculated. Twenty sterilized wheat seeds were planted in the pots. The number of azotobacter, the height and the dry mater mass of the plant were determined thirty days later.

Results and discussion

The survival rate of the introduced azotobacter 30 days after inoculation was low. Its numberdecreased from $4x10^6$ g^{-1} to 5.2 - $6.6x10^3$ g^{-1}, but it was still larger than in the non-inoculated variant ($2x10^1 g^{-1}$) (Table 1). IAA production ranged from 3.73 to 10.4 μg ml^{-1} (Table 1).

Table 1. The IAA production and survival of azotobacter in acid soil 30 days after inoculation

Strains of azotobacter	The number of azotobacter ($CFUg^{-1}$ soil)	IAA μg ml^{-1}
22	$5.2x10^3$	6.23
23	$5.2\ x10^3$	3.73
24-1	$6.1\ x10^3$	8.28
24-2	$6.6\ x10^3$	10.4
25-1	$5.5\ x10^3$	5.56
25-2	$5.5\ x10^3$	5.20
26	$5.4\ x10^3$	4.54
27-1	$6.2\ x10^3$	9.32
27-2	$5.3\ x10^3$	6.35
Control	$2.1x10^1$	-
The starting number	$4x10^6$	-

The number of azotobacter is very low in acidic soil (Jarak at al., 2005), moreover some results shown that there is no azotobacter in acid soil. Acid enwiromental have negatively influence on azotobacters growth and that azotobacter never produce pigment in acid soil.

However, if azotobacter is introduced into the soil, one part of the introduced cells adapts to acid environment and their number increases (Jarak et al., 2005; Čolo and Jarak, 2006). Miličić et al. (2006) stated that the survival of *Azotobacter* in pH-5.4 soil was satisfactory after 20 days, whereas after 40 days the number of *Azotobacter* decreased.

Several studies have shown that *Azotobacter* as soil inoculant is not only effective in N fixation but also has other properties such as production of growth hormones, like gibberellins, auxins and cytokinins (Rajaee et al., 2007), and the property to solubilize phosphate (Narula et al., 2000). In our investigations the applied azotobacter strains promoted the early growth of wheat. The length of the part above ground in the inoculated variants was 3.6% to 35.5% greater than in the control, whereas the dry mass was 0.6 % to 58% greater. The increase in the length and dry mass was mostly in correlation with the amount of IAA.

Many field trials have demonstrated that under certain enviromental conditions, inoculation with azotobacter has beneficial effects on plant yields (Emtiazi et al., 2004), due to the increase of fixed nitrogen centent in soil (Pandey et al., 1989). Several authors have shown the beneficial effects of *Azotobacter* on vegetative growth and yields of maize (Hajnal et al.2005, Jarak et al., 2012). Inoculation with *Azotobacter chroococcum* has a positive effect on the increase in yield, seed germination and early growth of maize plants, as well as on the length of the part above ground and root (Egamberdiyeva, 2007).

Table 2. The effect of azotobacter on the early growth of wheat plants

Strains of azotobacter	Hight of plant (cm)	Increase to control (%)	Dry mater mass of plant (g)	Increase to control (%)
22	28.47	17.2	1,98**	23
23	25.17	3.6	2,54**	58
24-1	29.13*	19.8	1,45	0.6
24-2	32.90**	35.4	2,01**	25
25-1	27.27	12.2	2,38**	48
25-2	26.40	8.6	2,02**	26
26	26.13	7.5	1,95**	21
27-1	29.37*	20.8	1,88*	17
27-2	28.50	17.3	2,17**	35
control	24.30		1,60	
LSD 5%	4.66		0.245	
1%	6.36		0.335	

*Significant effect at P>5%; ** sinificant effect at P> 1%

The growth promotive effects of azotobacter on sugar been plants have been reported in results Mrkovački et al. (2006), as well on potato plants in results Azcon and Barea (1975) and Najdenovska et al. (2005). Khalid et al.(2004) demonstrated increases in root elongation (up to 17.3%), root dry weight (up to 13.5%), shoot elongation (up to 37.7%) and shoot dry weight (up to 36.3%) of inoculated wheat seedlings with azotobacter. Jarak et al. (2006) and Kizikaya (2008) recorded a positive effect of inoculation with azotobacter on wheat yield.

Conclusions

The survival rate of the introduced azotobacter was low, but it was still larger than in the non-inoculated variant.

IAA production ranged from 3.73 to 10.4 μg ml^{-1}.
The length of the part above ground of wheat in the inoculated variants was 3.6% to 35.5% greater than in the control.
The dry mass of above ground of wheat was 0.6 % to 58% greater than in the control.
The increase in the length and dry mass was mostly in correlation with the amount of IAA.

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ПРОМОЦИЈА НА ЕФЕКТОТ НА ПОРАСТ НА РАСТЕНИЈАТА И ИЗДРЖЛИВОСТ НА АЗОТОБАКТЕРОТ ВО КИСЕЛА ПОЧВА

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Апстракт

Азотобактерот е почвена бактерија која, покрај фиксација на азотот од атмосферата, произведува и супстанци на пораст (пр. индол оцетната киселина - ИОК). Поради тоа, се користи као биоѓубриво во растителното призводство. Потребата да се користат биоѓубрива у кисели почви, е всушност и причината за ова истражување да се фокусира на создавањето отпорни на киселини соеви азотобактер. Во ова истражување се предмет девет соеви азотобактер, претходно изолирани и од халоморфна почва (pH 9). Произведувањето на ИОК кај сите соеви е одредено со колориметриската метода. Беа испитувани нивниот степен на преживување во кисела почва (pH 5) и нивното влијание врз раниот пораст на пченицата. Експериментот е изведуван во контролирани услови, во саксии. Во почвата беа внесени соеви од азотобактер, а контролните варијанти не беа инокулирани. По триесет дена беа одредени: бројот на азотобактер, висината на растенијата и сувата маса на растенијата. Производството на ИОК се движеше од 3,73 до 10,4 микрограма мл$^{-1}$. Степенот на преживување на инокулираниот азотобактер беше низок. Бројот се намали од 106 г$^{-1}$ до 103 г$^{-1}$, но сепак беше поголем одошто кај неинокулираните варијанти (101г$^{-1}$). Применетите соеви азотобактер промовираа ран пораст на пченицата. Должината на надземниот дел кај инокулираните варијанти беше од 3% до 35% поголем одошто кај контролата, додека сувата маса беше поголема од 0,6 до 58%. Зголемувањето на должината и сувата маса, главно беше во корелација со количеството ИОК.

Клучни зборови: азотобактер, кисела почва, пченица.

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RESPONSE OF BARLEY GENOTYPES TO LIMING AND FERTILIZATION ON PSEUDOGLEY SOIL

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Abstract

In this study evaluated the response of four barley genotypes (Rekord, Jagodinac, Kristal and Premijum) to three fertilization method (120 kg N ha^{-1}, 80 kg $P_2O_5ha^{-1}$, 53 kg K_2O; 120 kg N ha^{-1}, 160 kg $P_2O_5ha^{-1}$, 53 kg K_2O; 120 kg N ha^{-1}, 80 kg $P_2O_5ha^{-1}$, 53 kg K_2O + 5 t ha^{-1}"Njival Ca" ha^{-1} + 20 t manure ha^{-1}) on pseudogley soil. The results showed that the examined genotypes gave poor yields at low soil pH, under low phosphorus and low humus cotent. The use of NPK fertilizer with a higher content of phosphorus had a positive effect on the yield that was increased twice.The combined ameliorative use of lime, manure and NPK fertilizers led to a significant increase in grain yield, particularly in cv. Kristal. Barley productive traits were highly significantly and positively correlated with soil pH and P_2O_5 and CaO content, while correlations with Mn and Al soil content were significant, but negative.

Key words: barley, fertilizer, genotype, liming, pseudogley soil.

Introduction

Soil acidity influences many chemical and biological reactions that control plant nutrient availability and element toxicity (Sumner et al., 1991; Lavelle et al., 1995). Worldwide, soil acidification affects an estimated 30% of the total topsoil (Sumner and Noble, 2003). Furthermore, 75% of acid topsoils are also affected by subsoil acidity, and failure to address topsoil acidity may result in subsoil acidifi cation of even neutral to alkaline soils (Sumner and Noble, 2003). Pseudogley and other types of acid soils are widespread in the Republic of Serbia, accounting for over 60% of total arable land (Stevanović et al., 1995). The acidity of these soils, their high contents of H^+ ions and low contents of essential plant nutrients, primarily P and Ca, are constraints to high and stable wheat yields. Low calcium levels, phosphorus deficiency and aluminum toxicity affect root growth, the absorption of water and nutrient uptake by plants, generally causing crop yield reduction in acid soils (Pavan et al., 1982; Sumner, 2004). The effect of fertilization and liming on crop yield has been observed in many studies; the trials, however, show differences in the intensity of the effect. Crop yield is also significantly affected by soil conditions, climatic factors and weather conditions in a given year (Eduardo et al., 2005, Ito et al. 2009, Chimdi et al., 2012). A large effect on the grain yield of cereals has been reported at combined application of manure, lime and mineral fertilizers (Manna et al. 2005). The objective of the present study was to evaulate the effect of different fertilization methods and fertilizer types on grain yield and yield components in four winter barley genotypes (Rekord, Jagodinac, Kristal amd Premijum) on pseudogley soil.

Material and methods

The study was conducted at the experimental field of the Dr. Đorđe Radić Secondary School of Agriculture and Chemistry in Kraljevo, on pseudogley soil, over a period of three years (2008-2010). The trial included an untreated control (B_1) and three different fertilization methods: B_2 (120 kgNha^{-1} , 80 kgP_2O_5ha^{-1}, 53 kgK_2O ha^{-1}), B_3 (120 kgNha^{-1}, 160 kgP_2O_5 ha^{-1}, 53 kgK_2O ha^{-1}) and B_4 (120 kgNha^{-1}, 80 kgP_2O_5ha^{-1}, 53 kgK_2O ha^{-1}+5 t "Njival Ca" ha^{-1}+20 t manure ha^{-1}). Fertilization treatments were set up in a randomized block design in three replications. Plot size was 50 m^2. The fertilizers used included complex NPK fertilizer (8:24:16), superphosphate (17% P_2O_5) and ammonium nitrate (AN=17% N) used as a nitrogen fertilizer at the end of winter. Four different winter barley cultivars (Rekord- A_1, Jagodinac- A_2, Kristal- A_3 and Premijum- A_4) were grown at the trial field. Sowing was performed at optimum dates, at a seeding rate of 500 viable seeds per square meter, using a tractor-drawn seed drill. Conventional production technology was employed. The crop was harvested at full maturity, using a Sampo harvester. Barley yield was weighed and adjusted to 14% moisture. Harvest index was calculated as the ratio of grain yield to straw yield. Grain number per ear were determined. Soil sampling was carried out after the harvesting operation. The soil was analyzed by the following standard chemical methods: soil pH was determined in a 1:2.5 soil - 1 M KCl suspension after a half-hour equilibration period; the humus content was determined using the Kotzmann method, the content of available P_2O_5 and K_2O was assessed by the Al method of Egner-Riehm. A colorimetric method using the aluminon acetate buffer was employed to analyze the content of mobile Al. The obtained data were evaluated using analysis of variance and the significance between mean values was performed according to Mead (1996).

Results and discussion

The soil used in the trial was pseudogley, previously (Dugalić, 1998) characterized as having poor physical properties (a high level of compaction, a high proportion of powder and clay particles, low water permeability) and being extremely acid (pH< 4.5). The soil was low in both humus and readily available phosphorus (about 2.18% and 7.0-8.0 mg 100 g^{-1} soil, respectively), and had a moderate supplay of readily available potassium (13-18 mg 100 g^{-1} soil) and a satisfactory amount of total nitrogen (0.10-0.13%), but showed very low microbial activity (89.4-145.3x10^5 ammonifiers, 0.0x10^1 azotobacter and 31.9-41.1x10^3 fungi).

The average air temperature during 2007-2010 growing season was considerably higher than the long - termmean (LTM) (Table 1). Total rainfall during 2009/10 growing season was about 41% above the LMT and 34% and 39% above the values reported for 2008/09 and 2007/08, respectively.

One part of the 2008 and 2009 growing seson (April and May) was characterized by decreased rainfall and increased air temperatures relative to the LTM. Barley yields on pseudogley soil are low and constrained by a range of agronomic and climate factors, with low soil fertility being one of major limiting factors. Unfavorable chemical properties can be improved by soil ameliorative operations (liming, phosphate fertilization and humification). In other words, the soil should be adapted to specific plant i.e. genotype requirements. The results obtained show that the effect of chemical soil amendment measures on barley grain yield on low-fertility soils was considerably higher than that of genotype (Table 2). The test winter barley genotypes exhibited different responses to the stress induced by low soil pH. The data clearly show that cv. Premijum (A_3) gave a much higher yield as compared to the other cultivars, and produced the highest maximum grain yield (4.78 t ha^{-1}). Yield differences among genotypes were also observed in the untreated control, with Premijum having the highest average grain yield (2.37 t ha^{-1}).

Table 1. Weather characteristics

Rainfall (R mm) and mean air temperatures (^{0}C) for period 2007-2010 and long- term means- LTM (1961-1990)										
Period	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	∑x
2007/08 R mm	117	116	39	33	22	72	63	40	73	576
2007/08 t ^{0}C	10.6	3.2	0.2	1.6	4.5	8.0	12.4	17.2	21.1	8.7
2008/09 R mm	40	48	41	47	55	72	23	36	194	557
2008/09 t ^{0}C	12.8	8.0	4.4	0.4	2.3	6.6	13.4	18.1	20.1	9.6
2009/10 R mm	138	63	98	34	82	39	100	84	136	774
2009/10 t ^{0}C	11.3	8.2	3.8	1.1	2.7	7.2	12.1	16.6	20.2	9.2
LTM R mm	58	89	50	42	38	48	54	86	83	548
LTM t ^{0}C	11.1	4.2	1.2	-0.2	1.7	6.8	11.5	16.8	19.6	8.1

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One part of the 2008 and 2009 growing seson (April and May) was characterized by decreased rainfall and increased air temperatures relative to the LTM. Barley yields on pseudogley soil are low and constrained by a range of agronomic and climate factors, with low soil fertility being one of major limiting factors. Unfavorable chemical properties can be improved by soil ameliorative operations (liming, phosphate fertilization and humification). In other words, the soil should be adapted to specific plant i.e. genotype requirements. The results obtained show that the effect of chemical soil amendment measures on barley grain yield on low-fertility soils was considerably higher than that of genotype (Table 2). The test winter barley genotypes exhibited different responses to the stress induced by low soil pH. The data clearly show that cv. Premijum (A_3) gave a much higher yield as compared to the other cultivars, and produced the highest maximum grain yield (4.78 t ha^{-1}). Yield differences among genotypes were also observed in the untreated control, with Premijum having the highest average grain yield (2.37 t ha^{-1}).
The combined use of lime, manure and NPK fertilizer had a significant effect on grain yield (Table 2). NPK fertilization (B_2) induced a significant (90%) increase in grain yield as compared to the control. Fertilization with NPK having high phosphorus levels (B_3) led to a significant yield increase in the test genotypes as compared to the other treatments. Therefore, the use of integrated nutrient management is very important and best approach to maintain and improve soil fertility (Lander et al., 1998) thereby to increase crop productivity in an efficient and environmentally benign manner, without sacrificing soil productivity of future generations. Grain yield of winter barley exhibited significant variations across years, being highest in 2009/10 which was marked by the highest amount of rainfall and the most favorable distribution during the growing period. The results obtained are consistent with those reported in our previous studies (Jelić et al., 2007; Jelić et

al., 2009). Furthermore, the pronounced effect of the treatment with NPK that had an increased phosphorus level was the result of a low content of available phosphorus in the soil due to its low pH value.

Table 2. Average values of grain yield of winter wheat cultivars (t ha^{-1}) (A- cultivar, B- fertilization variant, C- years, AB-, AC-, BC-, ABC- interaction)

Cultivar	Years	Fertilization variants (B_1- control, B_2- NP_1K, B_3- NP_2K, B_4- NP_1K + $CaCO_3$ + manure				Average for years	Average for cultivars
		B_1	B_2	B_3	B_4		
Rekord	2007/08	1.38	3.26	3.59	4.28	3.13	3.09
	2008/09	1.09	2.73	2.80	2.58	2.30	
	2009/10	2.28	4.33	4.43	4.38	3.85	
Jagodinac	2007/08	1.20	3.18	3.47	4.29	3.03	3.01
	2008/09	1.66	1.92	2.54	3.16	2.32	
	2009/10	2.34	4.01	4.23	4.20	3.69	
Kristal	2007/08	1.46	3.36	3.66	4.26	3.18	3.14
	2008/09	1.89	2.56	2.27	3.08	2.48	
	2009/10	1.95	4.09	4.30	4.68	3.75	
Premijum	2007/08	1.57	3.40	3.82	4.52	3.33	3.22
	2008/09	1.54	2.03	2.28	2.96	2.20	
	2009/10	2.37	4.63	4.78	4.75	4.13	
Average		1.73	3.29	3.51	3.93	3.11	
LSD	A	B	AB	C	AC	BC	ABC
0.05 0.01	0.039 0.051	0.039 0.051	0.078 0.103	0.034 0.044	0.067 0.089	0.067 0.089	0.135 0.178

The positive effect of increased phosphorus application rates on grain yield in winter barley grown on acid soils was also previously observed (Soon, 1992; Kulhanek et al., 2007). Coefficients of correlation between soil chemical properties and wheat yield parameters were also calculated (Tab. 3). The average grain yield in fertilized treatments was significantly positively correlated with pH value ($r=0.96^{**}$), P_2O_5 in the soil ($r=1.00^{**}$) and CaO in the soil ($r=0.91^{**}$). However, grain yield, harvest index and grai mass per head were negatively correlated with Al and Mg soil content. Correlation coefficients were lower ($r=-0.91^{**}$, $r=-0.80^{**}$ and $r=-0.79^{*}$) for Mg content and measured parameters, but higher ($r=-0.99^{**}$ i $r=-0.94^{**}$) for Al content and measured parameters. Ameliorative application of lime caused decreasing of soil content of mobile Al and content of active Mg, because of antagonistic action of increased Ca content. Decreased Al mobility at soil influenced efficiency of utilization of some biogenic elements, especially phosphorus, causing increasing of yield of tested winter barley genotypes.

Additionally, available phosphorus in the soil had a significant effect on grain harvest indeks and grain weight per ear (0.79^{**} and 0.95^{**}, respectively). A significant positive correlation was also observed between soil pH and grain harvest index ($r=0.82^{**}$), as well as between soil pH and grain weight per ear ($r=0.89^{**}$).

Table 3. Coefficients of correlation between different soil chemical characteristics and productivity parameters of the barley for the fertilized treatments

Soil characteristics	Productivity parameters			
	Yield (t ha^{-1})	Grain harvest index	Grain number/ear	Grain weight/ear (g)
$pH_{(KCl)}$	0.96^{**}	0.82^{**}	ns	0.89^{**}
Humus	Ns	ns	-0.81^{**}	ns
P_2O_5	1.00^{**}	0.79^{**}	ns	0.95^{**}
K_2O	Ns	ns	-0.84^{**}	ns
CaO	0.91^{**}	0.82^{**}	ns	0.82^{**}
Mg	-0.91^{**}	-0.80^{**}	ns	-0.79^{**}
Al	-0.99^{**}	-0.99^{**}	ns	-0.94^{**}

ns- there is no statistical significance; **statistically significant on the probability level of 0.01; *statistically significant on the probability level of 0.05

Table 4. Coefficients of correlation between soil chemical characteristics and grain yield of winter barley genotypes for the fertilized treatments

Soil characteristics	Genotypes			
	A_1	A_2	A_3	A_4
pH	0.88^{**}	0.92^{**}	1.00^{***}	0.95^{***}
Humus	ns	ns	ns	ns
P_2O_5	0.96^{**}	0.98^{***}	0.99^{**}	0.99^{**}
K_2O	ns	ns	ns	ns
CaO	0.81^{**}	0.86^{**}	0.98^{**}	0.89^{**}
Mg	-0.84^{**}	-0.89^{**}	-0.90^{**}	-0.90^{**}
Al	-0.95^{**}	-0.98^{**}	-0.98^{**}	-0.99^{**}

ns- there is no statistical significance; **statistically significant on the probability level of 0.01; *statistically significant on the probability level of 0.05

No significant correlation was found between humus content and soil chemical properties, except grain number per head, whose correlation was significant and negative ($r=-0.81^{**}$). Obtained results are in accordance with earlier results (Bashirov, 2009; Brown et al., 2008). A high positive correlation was observed (Tab. 4) between pH, P_2O_5 and CaO content in the soil with grain yield all genotype ($r=0.84^{**}$ to $r=1.00^{**}$). Takođe, svi testirani genotipovi pokazali su jaku negativnu korelaciju sa sadržajem Mn i Al u zemljištu ($r=-0.84^{**}$ to $r=-0.99^{**}$). Expressed interrelationships of grain yield of tested barley and some soil traits are results of improvement of soil fertility caused by application of NPK and liming. So, plant growth and grain yield of studied barley genotypes were improved, in conditions of decreased soil acidity and content of mobile Al, as well as increased P_2O_5 and CaO content (Haynes and Mokolobode, 2001; Wildey, 2003; Bashirov, 2009). The response of barley genotypes to the other soil chemical properties analyzed was not observed.

Conclusions

The increased soil acidity and the low content of available phosphorus and humus in pseudogley soil are constraints to grain yield and productivity parameters in winter barley. As compared to the control, application of NPK fertilizer with increased phosphorus content, like as ameliorative application of lime and manure with NPK fertilizer, induced a significant increase in grain yield (2.27-fold increase), as well as grain number per spike and grain weight per spike in the genotypes studied, particulary in 2009/10. year. The obtained correlation coefficients suggest that the highest yield response in barley genotypes, was produced by low pH, P_2O_5, CaO and Al content in the soil. Among the soil properties analyzed, the increase in P_2O_5 and CaO, and decrease of Al content in the soil led to a significant increase in grain yield in all genotypes tested.

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РЕАКЦИЈА НА ГЕНОТИПОВИТЕ ЈАЧМЕН НА ВАРОВНИК ИЃУБРЕЊЕ КАЈ ПСЕВДОГЛЕЈНА ПОЧВА

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Апстракт

Во оваа студија е прикажана реакцијата на четири генотипови јачмен (Rekord, Jagodinac, Kristal и Premijum) со три методи на ѓубрење (120 kg N ha^{-1}, 80 kg P_2O_5 ha^{-1}, 53 kg K_2O; 120 kg N ha^{-1}, 160 kg $P_2O_5ha^{-1}$, 53 kg K_2O; 120 kg N ha^{-1}, 80 kg $P_2O_5ha^{-1}$, 53 kg K_2O + 5 t ha^{-1}"Njival Ca" ha^{-1} + 20 t ѓубриво $ха^{-1}$) на псеудоглејна почва. Резултатите покажаа дека испитаните генотипови дадоа сиромашни приноси при ниска pH вредност на почвата и при ниска содржина на фосфор и хумус. Употребата на NPK ѓубриво со повисока содржина на фосфор имаше позитивен ефект врз приносот кој беше двојно зголемен. Комбинација од мелиоративни употреба на вар, ѓубриво и NPK ѓубрива доведе до значително зголемување на приносот, особено сортата Kristal. Продуктивните карактеристики на јачменот беа значајни и во позитивна корелација со pH и P_2O_5 на почвата и содржината на CaO, додека корелациите во однос на содржината на Mn и Al во почвата беа значајни, но негативни.

Клучни зборови: јачмен, ѓубриво, генотип, ѓубрење со варовник, псеудоглејна почва.

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DYNAMICS OF GRAIN DRY MATTER CONTENT IN SOME TRITICALE VARIETIES

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Abstract
The dynamics of dry matter content in the grain was followed in 8 triticale varieties (*Malesh, Triglav, Agrounija, Odisej, Novisadsko triticale, Triumph* and *KG - 20*) during 2009 and 2010. During the test period the varieties showed a difference in grain dry matter content increasement. Earlier triticale cultivars (*Malesh, Odisej*) show faster rate of accumulation of dry matter in the grain, while the later varieties (*Agrounija, Triglav, Triumph* and the *KG-20*) show slower rate of accumulation of dry matter. The average increase rate of early varieties was 87.6% (*Malesh*) and 91.2% (*Odisej*). For the later varieties the average increase rate was 84.7% (*Agrounija*) and 85.7% (*Triglav*). The obtained results gave the information on the dinamics of dry matter increasment in triticale grain, the effect of environmental factors on this trait and the variability of grain yield in triticale. The data will be used in selection of varieties for production and future breeding of triticale.
Key words: dry matter content, grain filling, *Triticosecale sp*.

Introduction

The dynamics of dry matter content in triticale grain during grain formation and filling as a physiological process depends on the genetic characteristics of varieties and growing conditions. This growth stage, in the climatic and soil conditions in Macedonia, occures during the second decade of May, June, and the first decade of July. Because of the genetic constitution of triticale (inherited traits from wheat and rye), it has longer reproductive period in comparison with wheat and other grain crops. In heksaploid triticale (2n = 6k = 42), amfidiploid between durum and rye, the period of grain formation starts 10-16 days after flowering stage (*Milovanovic et al*., 1998). According to the same author, the development of the endosperm starts from 14 to 27 days after flowering stage. The first 7-10 days after flowering, wheat grain is formed with all its dimensions (width and length) (*Jevtic*, 1981). The same period for triticale occures 10 to 16 days after flowering. At the beginning of its development, the triticale grain has low intensity of increasment of the dry matter. The intensity increases until the end of milk ripening, and then declines over the mealy ripening. At the end of this phase the grain filling ends and the full maturity stage begins. The aim of this work was to study the dinamics of dry matter increasment in triticale grain, and based on environmental factors in the grain filling and ripening period (May, June, July), to examine the variability of grain yield in triticale.

Material and methods

Dry matter content was followed in the grains from the main triticale spike in different growth stages, from heading to ripening, during 2009 and 2010 years. From the main spike of 8 triticale varieties, every seventh day the average samples were taken. Spikes were dried at room temperature (22-26°C) and then, the grains were separeted from the spike with labolatory trasher. For each testing period, the weight of 1000 grains was calculated. Based on average weight increasment of 1000 grains for each period, the percentage increase rates of dry matter in the grain were calculated.

Climatic conditions

Climatic factors (temperature and precipitation) during formation, filling and rippening of the grain are critical for optimal accumulation of dry matter content in the grain.

Table 1. Weather data for the region of Skopje

1.1. Average decade temperature (°C) for May, June and July

Decade	May			June			July		
	2009	2010	1967/90	2009	2010	1967/90	2009	2010	1967/90
I	16,5	8,3	16,6	21,6	20,0	19,0	23,2	24,4	21,8
II	18,9	16,1	17,0	29,8	16,1	21,0	23,9	25,6	24,2
III	19,5	19,0	18,0	18,7	18,7	22,2	25,2	23,5	23,0
Average	18,3	17,8	17,2	21,0	21,9	20,6	24,0	24,1	23,0

1.2. Average decade precipitation (mm) for May, June and July

Decade	May			June			July		
	2009	2010	1967/90	2009	2010	1967/90	2009	2010	1967/90
I	10,5	3,2	18,5	9,8	23,9	17,0	6,6	15,2	10,2
II	15,0	27,2	25,3	1,0	9,7	15,5	3,6	8,8	15,0
III	32,5	8,7	17,0	93,5	23,9	16,0	0,3	23,4	10,0
Total	57,5	39,0	60,8	104,3	57,4	48,5	10,2	47,0	35,2

The presented data (Table 1) show that the precipitation in June 2009 is almost two times higher than in 2010. In our climatic and soil conditions in different regions and years the reported temperatures above 30°C, followed by low soil moisture and low relative humidity, which stop rate of dry matter in the grain, and so-called "thermal shock" at the plants occurs. When such environmental factors forced grain ripens, it becomes wrinkled grain, which result with low overall yield per unit area.

Results and discussion

The dynamics of dry matter increasement in triticale goes through several stages. According to *Jevtic et al.* (1984), there are significant morphological, biological and other changes in the phase of formation and grain filling. In the conditions of Skopje, on average, the triticale grains are formed and filled during the second decade of May, June, and the first decade of July.

The weight of 1000 grains has been analyzed each year during the testing period, and obtained results are presented in Table 2.

Table 2. The dynamics of increase in 1000 grain weight (g)

2009						
Variety / period	22.V	29.V	6.VI	12.VI	26.VI	9.VII
Malesh	4,2	18,0	36,0	41,0	47,0	56,0
Triglav	4,5	13,5	34,0	38,5	49,0	58,0
Agrounija	4,1	13,1	21,5	33,2	43,3	53,0
Bt-04-002	7,7	21,0	30,0	42,5	46,0	52,5
Odisej	9,1	22,6	34,0	41,0	45,5	52,0
Novosadsko triticale	4,0	12,5	20,0	31,0	42,0	47,5
Triumph	4,4	9,9	24,0	33,5	40,0	49,5
KG-20	5,7	15,1	29,0	30,0	41,0	48,5
Average	5,5	15,7	28,6	36,3	44,2	52,1
2010						
Variety / period	20.V	27.V	4.VI	11.VI	24.VI	8.VII
Malesh	3,3	10,5	27,6	41,6	47,6	52,0
Triglav	1,7	4,3	14,9	36,1	46,8	53,0
Agrounija	1,2	3,4	12,5	30,1	42,7	48,0
Bt-04-002	3,3	12,6	24,0	38,1	46,0	51,0
Odisej	5,3	10,2	24,3	40,0	47,5	50,0
Novosadsko triticale	1,0	2,4	10,9	29,7	40,0	45,5
Triumph	1,3	4,5	16,0	30,7	42,0	47,0
KG-20	3,9	9,7	20,0	33,4	40,2	46,5
Average	2,6	7,2	18,8	35,0	44,1	49,1

From the presented data, in all analyzed varieties the values of dry matter are continuously increasing. The average weight of 1000 triticale grains (6.VI and 4.VI) was higher in 2009 (28.6 g) in comparison to 2010 (18.8 g) (Table 2).

After grain forming, the increase of dry matter in triticale grain has been intensified till the end of milky ripening stage, and then gradually decreases and is terminated in early mealy ripening stage (Table 3). *Milovanovic et al*. (1998) observed that due to a genetic trait inherited from parents, the triticale has longer reproductive development (from 7 to 10 days) than the wheat, and is later maturing (10-15 days) compared with soft wheat.

The tested triticale varieties extremly differ in terms of the dynamics of increase of dry matter in grain. The longest period of formation and grain filling has *Agrounija* variety, while *Odisej* variety has the shortest period (Table 4). This period duration is determined by genetic characteristics of the variety and environmental conditions. In our study, the average weight of 1000 grains at the end of June was found to be lower by 12.7% from the same average in the stage of full ripeness. In this period, minimum average weight of 1000 grains was found in *Agrounija* variety (84.7 %), and the highest was in *Odisej* variety (91.2%) of the total weight of 1000 grains at full maturity stage.

Table 3. Average dynamics of 1000 grain weight (g) for 2009/2010

Variety / period	20-22 V	27-29 V	3-6 VI	10-12 VI	24-26 VI	8-9 VII
Malesh	3,7	14,2	31,8	41,3	47,3	54,0
Triglav	3,1	8,9	24,4	37,3	47,6	55,5
Agrounija	2,6	8,2	17,0	31,6	42,6	50,5
Bt-04-002	5,5	16,8	27,0	40,3	46,0	51,7
Odisej	7,2	16,3	29,2	40,5	46,5	51,0
Novosadsko triticale	2,5	7,5	15,5	30,3	41,0	46,5
Triumph	2,8	7,2	20,0	32,1	41,0	48,2
KG-20	4,0	12,6	24,5	31,7	40,6	47,5
Average	3,9	11,5	23,7	35,6	44,1	50,6

Table 4. Average of increase rates of dry matter in grain (%)

Variety / period	20-22V	27-29V	3-6VI	10-12VI	24-26VI	8-9VII
Malesh	6,8	26,1	58,3	75,8	87,6	100
Triglav	5,4	15,7	43,2	66,0	85,7	100
Agrounija	5,3	16,7	34,7	64,5	84,7	100
Bt-04-002	10,3	31,5	50,7	75,7	90,0	100
Odisej	13,9	31,6	56,7	78,6	91,2	100
Novosadsko triticale	5,0	14,9	30,8	60,3	88,2	100
Triumph	5,8	14,3	41,5	66,6	85,1	100
KG-20	9,9	26,1	50,8	65,7	85,5	100
Average	7,8	22,1	45,8	69,2	87,3	100

In terms of Skopje, grain filling phase occurs in June and early July. If in this period the environmental conditions are favorable, it seems that more assimilates translocate from vegetative parts to the grain. During this period, the amount of yield per unit area could be determined. In our climatic and soil conditions in different regions and years the reported temperatures above 30°C, followed by low soil moisture and low relative humidity, which stop rate of dry matter in the grain, and so-called "thermal shock" at the plants occurs. When such environmental factors force grain ripening, it becomes wrinkled grain, which results with low overall yield per unit area.

Based on the obtained results (Table 3 and Table 4), when an unfavorable climatic conditions for grain filling occurs at the same phase, the later varieties (*Agrounija*, *Triglav*) will have less grain accumulation or lower weight on 1000 grains which contributes to lower yield per unit area.

From the results shown in Table 5 and Table 6, it is found that the highest average yield was obtained in 2009 (5.69 t/ha), while in 2010 the yield was 4.88 t/ha. The highest average yield gave *Agrounija* (5.5t/ha), followed by *Malesh* (5.9 t/ha) and *Bt-04-002* variety (5.8 t/ha), which were significantly higher than the standard variety *Triglav* (4.80 t/ha).

Table 5. Grain yield by variety and year (t / ha)

Variety/ year		2009	2010	Average
Malesh		6,3	5,5	5,9**
Triglav		4,6	5,0	4,8
Agrounija		6,0	5,0	5,5*
Bt-04-002		5,6	5,0	5,8**
Odisej		6,0	4,8	5,4
Novosadsko triticale		5,8	4,6	5,2
Triumph		5,8	4,5	5,1
KG-20		5,4	4,6	5,0
Average		5,69	4,88	5,34
LSD	0,05*	0,63	0,75	0,69
	0,01**	0,85	1,03	0,94

The favorable weather conditions during the examination period contributed to higher average grain yield in 2009 (5.69 t/ha) compared with 2010 (4.88 t/ha) (Table 5).
Data in Table 6, show an average values of weight of the grains in different growing periods.

Table 6. Average grain weight per growing period (kg/ha)

Variety / period	20-22 V	27-29 V	3-6 VI	10-12 VI	24-26 VI	8-9 VII
Malesh	401	1540	3440	4472	5168	5900
Triglav	290	753	2073	3168	4113	4800
Agrounija	297	863	2376	3630	4713	5500
Bt-04-002	597	1827	2941	4391	5220	5800
Odisej	751	1706	3062	4244	4925	5400
Novosadsko triticale	260	775	1602	3135	4586	5200
Triumph	296	729	2116	3397	4340	5100
KG-20	495	1305	2540	3285	4275	5000
Average	421	1187	2518	3715	4667	5960

Conclusions

Based on the results obtained in this study, the following conclusions can be drawn:
The dynamics of increase rate of the dry matter content in the grain differs between the examined triticale varieties.
In terms of the Skopje region, grain formation takes place during the second decade of May, while grain filling occures during the third decade of May, June and the first decade of July. The duration of this period depends on environmental conditions in the area of cultivation.
The accumulation of the dry matter content in the grain starts with less intensity at the begining, gradual intensification, and then decreasing in the mealy ripening stage (end of June) and at the end (the first decade of July) it completely finishes when grain is fully mature.
Earlier triticale cultivars (*Malesh, Odisej*) show faster rate of accumulation of dry matter in the grain, while the later varieties (*Agrounija, Triglav, Triumph* and the *KG-20*) show slower rate of accumulation of dry matter, but it lasts longer compared to earlier varieties.

In average, maximum difference in dynamic of dry matter increase in grain (%) is observed at the end of the third decade of June. The average increase rate of early varieties was 87.6% (*Malesh*) and 91.2% (*Odisej*).

For the later varieties the average increase rate was 84.7% (*Agrounija*) and 85.7% (*Triglav*). That is why the earlier varieties (*Malesh* and *Odisej*) are biologicaly more adaptable to different environmental conditions, and at the same time with more stable average grain yield per unit area.

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ДИНАМИКА НА ПРИРАСТОТ НА СУВАТА МАСА ВО ЗРНОТО КАЈ НЕКОИ СОРТИ ТРИТИКАЛЕ

Кабранова Ромина, Иваноски Милисав, Спирковска Маријана

Апстракт

Динамиката на содржината на сува материја се следеше кај 8 сорти на тритикале (*малеш, триглав, агроунија, одисеј, новосадско тритикале, триумф* и *КГ-20*) во текот на 2009 и 2010 година. Испитуваните сорти тритикале покажаа разлика во прирастот на сува маса во зрното во текот на испитуваниот период. Резултатите покажаа дека пораните сортите (*малеш*, *одисеј*) покажуваат побрза акумулација на сува материја во зрното, а подоцните сорти (*агроунија*, *триглав, триумф и КГ-20*) покажуваат побавна акумулација на сува материја. Просечниот пораст на сува маса изнесува 87,6% (*малеш*) и 91,2% (*одисеј*). За покасните сорти, просечниот пораст насува маса изнесуваше 84,7% (*агроунија*) и 85,7% (*триглав*). Добиените резултати дадоа информација за динамиката на прираст на сува материја во зрното на тритикале, ефектот од влијанието на еколошките фактори врз оваа особина и варијабилноста на приносот на тритикале. Добиените податоци ќе се користат во изборот на сорти за производство и понатамошна селекција на тритикале.

Клучни зборови: прираст на сува маса, налевање на зрното, *Triticosecale sp.*

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DRY TOBACCO YIELD IN SOME PRILEP TOBACCO VARIETIES

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Abstract
Tobacco is industrial culture grown for its leaf mass. Dry tobacco yield is one of the most important quantitative properties, because in normal conditions of growing and suitable agro techniques it reflects the biological potential of each tobacco variety. Investigations of this character were carried out in 2009 and 2010 on the Experimental field of Tobacco Institute-Prilep with six oriental tobacco varieties of the type Prilep: P-23 (Ø) P12-2/1, NS-72, P-79-94, P-66-9/7 and Prilep Basma 82. Determination was made on dry tobacco yields per stalk (in grams) and per unit area (kg/ha). According to the results of the two-year investigations, the highest yield was achieved in P-66-9/7 (21,88 g/stalk, i.e. 3297,45 kg/ha), and the lowest in P-12-2/1 (14,35 g/stalk i.e. 2164,90 kg/ha). The yield of the standard variety P-23 was 18,07 g/stalk i.e. 2717,75 kg/ha. Statistical processing of the results has shown significant differences in yields, which denotes that each of the investigated varieties has a different biological potential, which is undoubtedly governed by its own genotype.
Key words: dry tobacco yield, type Prilep, varieties, genotype.

Introduction

Republic of Macedonia is a well-known producer of high quality oriental aromatic tobaccos which are constituent part of the best quality cigarette brands. Tobacco takes an important place in the economy of the country and it is one of its main export products on world market. In recent years, the dry tobacco production in the country has ranged between 20 and 25 million kilograms, with a tendency to increase. The most represented types are Prilep, Yaka, Jebel and Basmak, but predominant type is Prilep, with about 70% share in the total production. When creating new varieties, geneticists and breeders pay great attention not only to tobacco quality but also to yield - a major quantitative trait which affects the effectiveness of work and farmer's gains. This trait was a subject of investigation to many authors in different tobacco varieties (Gornik, 1973; Uzunoski, 1985; Karajankov, 1995; Korubin - Aleksoska and Mitreski, 2005; Dimitrieski and Miceska, 2011). The aim of our research was to estimate the dry yield of Prilep tobacco cultivated under the same conditions in the Experimental field of Tobacco Institute-Prilep, expressed in g/stalk and kg/ha, which will reveal the biological potential of the investigated varieties.

Material and methods

Six Prilep tobacco varieties were used as material for the investigation: Prilep P-23 - Ø (control); Prilep, P 12-2/1; Prilep, NS-72; Prilep, P-66-9/7; Prilep P-79-94 and Prilep Basma-82.

These varieties have marked certain period in the past and present and dictated the structure of production of Prilep type tobacco in Macedonia. They also show the direction in which selection of this type has moved in the last two decades, aiming to meet the requirements of tobacco industry. These varieties present an important genetic basis for creation of new genotypes with improved yield and quality.

- Prilep P-23 - created through hybridization and selection in Tobacco Institute - Prilep by Nikoloski Kostadin and Mitreski Milan; recognized (approved) by the Ministry of Agriculture, Forestry and Water Management of the Republic of Macedonia in 1995. Characterized by elliptical – conical habitus, with 50-55 leaves densely arranged on stem.
- Prilep P 12-2/1 - created in Tobacco Institute - Prilep, in the 30ies of the 20th century by Gornik Rudolf, the founder of tobacco science in Macedonia and former Yugoslavia; obtained by individual selection from local variety Jumai-Bale from Bulgaria. Characterized by cup-like habitus, with small number of leaves (30 to 35), with characteristic lanceolate form. Of all tobacco varieties in the trial, it is the shortest in size and achieves the lowest yield.
- Prilep NS-72 - created through hybridization and selection by Boceski Dushko and Karayankov Simeon; recognized in 1984 in former Yugoslavia, as the first variety of the type Prilep obtained by crossing. Cylindrical-elliptical habitus with approximately 50 sessile leaves, elliptical in shape.
- Prilep P-66-9/7 - created through hybridization and selection in Tobacco Institute - Prilep, by Dimitrieski Miroslav and Miceska Gordana; recognized by the Ministry of Agriculture, Forestry and Water Management of R. Macedonia in 2004. Elliptical-conical habitus, with 54 - 60 ovate leaves, sessile and evenly distributed on the stem. The most represented tobacco variety in our country in recent years.
- Prilep P-79-94 - created in Tobacco Institute - Prilep through crossbreeding and selection by Bogdanceski Milan; recognized by the Ministry of Agriculture, Forestry and Water Management of R. Macedonia in 2001. Cylindrical-elliptical habitus with 56 – 60 sessile leaves densely distributed, especially in the upper part of stem.
- Prilep Basma-82 - created through hybridization and selection in Tobacco Institute - Prilep, by Boceski Dushko; recognized by the Ministry of Agriculture, Forestry and Water Management of R. Macedonia in 2010. Cylindrical habitus with a slight narrowing in the upper part. This is the highest variety, with the highest leaf number (80 - 90) among all investigated Prilep tobacco varieties. Leaves are sessile, elliptical in shape.

Field trials were set up in Tobacco Institute - Prilep in 2009 and 2010 on diluvial-colluvial soil, arranged in randomized block system with four replications.

Data on climatic conditions during the investigation were obtained by the Meteorological station located in the Experimental field of Tobacco Institute-Prilep.

One deep autumn plowing (35 cm depth) and three spring plowings were applied on the trial surface. Fertilization was made prior to the second spring plowing, with 300 kg/ha complex fertilizer NPK 10:30:20, in compliance with agrochemical properties of soil and the requirements of tobacco plants.

Tobacco seedlings were produced in the field of Tobacco Institute, in seedbeds covered with polyethylene. The period for seedling production lasted 50 days in 2009 and 52 days in 2010. Transplanting was performed manually, on 3 June 2009 and 11 June 2010, with 40 cm spacing between rows and 12 cm between stalks, on a soil previously treated with herbicide Treflan EC (a.s. Trifluralin 48 %) agains weeds. The area of each plot was 12 m^2, with six rows of tobacco and 42 stalks in the row. The first digging was done in June (fifteen days after transplanting), and the second followed ten days after, in order to obtain normal growth and development of plants. During this period, preventive protection of tobacco was made with the fungicide Ridomil MZ 72 (a.s. Metalaksil+Makonzeb) and insecticide Confidor SL-200 (a.s. Imidachorpirid).

During the growing season, sprinkler irrigations were applied three times in 2009 and twice in 2010, with irrigation norm of 250 m^3 water per hectare. Each irrigation was followed by harrowing of the soil in order to improve its water-air regime. In both years of investigation, fertilization of tobacco was made after the third priming, with nitrogen fertilizer (calcium ammonium nitrate, CAN), with 60 kg N / ha (27% N).

Tobacco harvesting was performed by insertions, in the technical maturity of leaves from each variety. Four rows were picked from each plot, while the other two rows served for monitoring and protection. Tobacco leaves were strung manually and sun-cured in traditional way, on scaffolds covered with polyethylene.

On the basis of measurements and grading, dry tobacco yield was calculated in grams per stalk (g/stalk) and kilograms per hectare (kg/ha), using standard forms and formulas for corrected yield.

The data obtained in the investigation were processed by Method of analysis of variance and LSD-test (Najcevska, 2002).

Climate characteristics

Tobacco belongs to the group of plants which are highly affected by climatic factors, giving maximum yield and highest quality at optimal temperatures, precipitations and relative air humidity. With regard to the temperature in the period of investigation (2009 and 2010), it can be concluded that it meets the requirements for obtaining a good quality raw material (Table 1).

The amount of precipitations from May to September ranged 196 l/ m² in 2009 and up to 298 l/ m² in 2010, but in both years their distribution was uneven and unfavorable for tobacco growth, especially in July and August. For this reason, additional irrigations were applied - three in 2009 and two in 2010. With regard to mean monthly relative humidity of the air, in both years it ranged within the optimum, except for July 2009 (42%).

Table1. Mean monthly air temperatures in 2009 and 2010

Meteorological factor	Year	Months					$\bar{x}$
		V	VI	VII	VIII	IX	
Mean monthly air temperatures, ºC	2009	15,8	18,5	21,9	21,4	17,1	18,9
	2010	15,3	18,8	21,3	23,1	15,9	18,9
Precipitations, mm	2009	55,0	75,0	8,0	43,0	15,0	**Σ** 196,0
	2010	64,0	87,0	55,0	45,0	47,0	298,0
Mean monthly relative air humidity, %	2009	58,0	57,0	42,0	50,0	54,0	52,2
	2010	57,0	59,0	53,0	50,0	61,0	56.0

Results and discussion

Tobacco is an industrial crop grown for its dry leaf mass. The amount of yield is a type and variety characteristic which largely depends on agri-environmental conditions and applied cultural practices during the growing season. The selected varieties were cultivated under the same conditions in order to investigate their genetic potential.

In our investigations measurements were made on dry tobacco yield per stalk in grams and estimations of yield in kilograms per hectare.
The results in 2009 showed the highest yield per stalk in P-66-9/7 (21,55 g), the check variety P-23 gave 16,07 g/stalk and the lowest yield of 13,36 g/stalk was obtained in P 12-2/1 (Table 2).

Table 2. Dry tobacco yield, g/stalk (2009)

No.	Variety	Replications				Average	Index
		I	II	III	IV		
1.	Prilep P-23 (Ø)	15,60	17,88	15,17	15,64	16,07	100,00
2.	Prilep P 12-2/1	13,69	12,32	13,81	13,63	13,36	83,14
3.	Prilep NS -72	16,38	14,77	13,79	18,54	15,87	98,76
4.	Prilep P-66-9/7	21,12	22,80	17,91	24,38	21,55***	134,10
5.	Prilep P-79-94	14,74	16,51	15,20	14,93	15,35	95,52
6.	Prilep Basma-82	19,93	21,42	18,96	20,94	20,31***	126,38
Average		16,91	17,62	15,81	18,01	17,08	106,28

LSD 0,05 = 2,15 g; LSD 0,01 = 2,97 g; LSD 0,001 = 4,11 g

Statistical processing of the data for 2009 showed highly significant differences resulting from the genetic potentials of the varieties (leaf number, leaf size, substantiality, etc.).
All investigated varieties in 2010 show higher average yields per stalk due to the favorable climatic conditions, but differences among the varieties are identical to those in 2009.
The highest average yield of dry tobacco was recorded in Prilep Basma-82 (23,09 g/stalk), P 66-9/7 (22,22 g/stalk) and in the check variety P-23 (20,07 g/stalk), while the lowest yield (15,34 g/stalk) was observed in P 12-2/1 (Table 3).

Table 3. Dry tobacco yield, g/stalk (2010)

No.	Variety	Replications				Average	Index
		I	II	III	IV		
1.	Prilep P-23 (Ø)	16,58	23,27	18,51	21,92	20,07	100,00
2.	Prilep P 12-2/1	16,32	15,33	12,98	16,73	15,34	76,43
3.	Prilep NS -72	17,57	19,53	15,47	19,93	18,13	90,33
4.	Prilep P-66-9/7	20,74	23,80	20,87	23,45	22,22*	110,71
5.	Prilep P-79-94	18,31	20,81	15,60	19,39	18,53	92,33
6.	Prilep Basma-82	21,60	25,31	20,60	24,83	23,09**	115,05
Average		18,52	21,34	17,34	21,04	19,56	97,46

LSD 0,05 = 1,78 g; LSD 0,01 = 2,46 g; LSD 0,001 = 3,40 g

Data presented in this Table also reveal significant differences between the varieties investigated, which is confirmation of heritability of this trait.
The highest average values for dry tobacco yield during the two-year investigations were obtained in variety P-66-9/7 (21,88 g/stalk), and the lowest values were reported in P 12-2/1 (14,35 g/stalk). The yield of the check variety P-23 was 18,07 g/stalk (Table 4).

Table 4. Average yield of dry tobacco, g/stalk

No.	Variety	Year		Average	Index
		2009	2010		
1.	Prilep P-23 (Ø)	16,07	20,07	18,07	100,00
2.	Prilep P 12-2/1	13,36	15,34	14,35	79,41
3.	Prilep NS -72	15,87	18,13	17,00	94,08
4.	Prilep P-66-9/7	21,55	22,22	21,88	121,08
5.	Prilep P-79-94	15,35	18,53	16,94	93,75
6.	Prilep Basma-82	20,31	23,09	21,70	120,09
Average		17,08	19,56	18,32	101,38

The yield of dry tobacco per stalk has been a subject of investigation by many research workers and tobacco professionals. Dimitrieski (1995), based on his three-year investigations, reported an average yield of 14,25 g/stalk in the variety P 12-2/1. Karajankov (1995), obtained relatively high yields in the variety NS-72, ranging from 14 - 15 g/stalk on hilly and mountainous terrains to over 30 g/stalk in plains and fertile soils. Dimitrieski et al. (2001), in investigation of several Prilep tobacco varieties in conditions of irrigation, reported the following results for this trait: P 12-2/1 - 14,12 g/stalk, P-23 - 16,18 g/stalk and NS 72 - 14,70 g/stalk. Korubin-Aleksoska (2004-a), in a dialel of four oriental and two semi-oriental varieties, reported a yield of 26,4 g/stalk in P-23. Mitreski (2005), studying the inheritance of some morpho-bilogical traits in tobacco, reported a yield of 19,98 g/stalk in the variety P-23.

The dry tobacco yield per unit area (ha), in the first year of investigation (2009) ranged from 2020,2 kg/ha in P 12-2/1 to 3266,2 kg/ha in P-66-9/7. Lower yields, compared to the check P-23 (2426,6 kg/ha), were observed in P 12-2/1, NS-72 and P-79-94, while higher yield was obtained in Prilep Basma-82 and P-66-9/7 (Table 5).

Table 5. Dry tobacco yield, kg/ha (2009)

No.	Variety	Replications				Average	Index
		I	II	III	IV		
1.	Prilep P-23 (Ø)	2340,0	2690,6	2297,7	2378,0	2426,6	100,00
2.	Prilep P 12-2/1	2060,4	1874,0	2082,0	2064,4	2020,2	83,25
3.	Prilep NS -72	2490,0	2230,0	2082,0	2800,0	2400,5	98,92
4.	Prilep P-66-9/7	3210,0	3454,2	2694,7	3706,0	3266,2 ***	134,60
5.	Prilep P-79-94	2240,0	2501,8	2295,0	2262,4	2324,8	95,80
6.	Prilep Basma-82	3018,9	3201,7	2832,5	3151,2	3051,1 **	125,74
Average		2559,9	2658,7	2380,6	2727,0	2581,6	106,39

LSD 0,05 = 328,8 kg/ha; LSD 0,01 = 454,7 kg/ha; LSD 0,001 = 628,4 kg/ha

Statistical analysis of the data (Table 5) for determination of comparative differences between varieties confirms that they are highly significant.

The results of the trials carried out in 2010 revealed again the existence of differences among the investigated tobacco varieties which result from their genetic structure. The average yield in the control variety P-23 was 3008,9 kg/ha. The lowest yield was recorded in P 12-2/1 (2309,6 kg/ha) and the highest in P-66-9/7 (3328,7 kg/ha) and Prilep Basma-82 (3452,5 kg / ha) (Table 6).

Table 6. Dry tobacco yield, kg/ha (2010)

No.	Variety	Replications				Average	Index
		I	II	III	IV		
1.	Prilep P-23 (Ø)	2470,0	3488,4	2767,4	3310,0	3008,9	100,00
2.	Prilep P 12-2/1	2420,5	2323,0	1960,0	2535,1	2309,6	76,76
3.	Prilep NS -72	2670,0	2959,3	2343,2	2979,5	2738,0	91,00
4.	Prilep P-66-9/7	3090,0	3615,8	3141,1	3468,0	3328,7*	110,63
5.	Prilep P-79-94	2737,1	3110,8	2340,0	2898,7	2771,6	92,11
6.	Prilep Basma-82	3203,3	3794,4	3100,7	3711,7	3452,5**	114,74
Average		2765,1	3215,3	2608,7	3150,5	2934,9	97,54

LSD 0,05 = 259,10 kg/ha; LSD 0,01 = 358,31 kg/ha; LSD 0,001 = 495,22 kg/ha

Here again, the statistical processing of the results showed that the existing differences among the investigated tobacco varieties are statistically significant. The average two-year results (Table 7) show that the highest dry tobacco yield was obtained in P-66-9/7 (3297,45 kg/ha) and the lowest in P 12-2/1 (2164,90 kg/ha). The check P-23 is on the third place with 2717,75 kg/ha.

The yield of dry tobacco per unit area is of great interest both to farmers and buyers – manufacturers and therefore it has been a subject of investigation by many research workers and tobacco professionals. Korubin-Aleksoska (2004-b) reported that dry yield mass in P 12-2/1 approximated 1500 kg/ha, and in P-23 it ranged from 2000 to 2500 kg/ha.

Table 7. Average dry tobacco yield, kg/ha

No.	Variety	Year		Average	Index
		2009	2010		
1.	Prilep P-23 (Ø)	2426,6	3008,9	2717,75	100,00
2.	Prilep P 12-2/1	2020,2	2309,6	2164,90	79,66
3.	Prilep NS -72	2400,5	2738,0	2569,25	94,53
4.	Prilep P-66-9/7	3266,2	3328,7	3297,45	121,33
5.	Prilep P-79-94	2324,8	2771,6	2548,20	93,76
6.	Prilep Basma-82	3051,1	3452,5	3251,80	119,65
Average		2581,6	2934,9	2758,25	101,49

In P-79-94 variety the yield was somewhat higher, ranging from 500 to 3000 kg/ha. Pelivanoska (2009), in her investigation on the impact of fertilization and irrigation found that the highest yield of 3988 kg/ha was achieved in the variety P-66-9/7, with NPK variant 40-80-100 and soil moisture content remaining at 55% of field capacity. According to Dimitrieski and Miceska (2011), dry tobacco yield in P-66-9/7 ranged from 2000 to 3600 kg/ha, depending on the conditions of growing and cultural practices applied. The results of our research are in correlation with the data reported by the above authors.

Conclusions

Comparative investigations were made during 2009 and 2010 on dry yield in different varieties of the oriental tobacco Prilep (P-23 (Ø), P 12-2/1, Prilep NS-72, P-66-9/7, P-79-94 and Prilep Basma-82) grown under same conditions. The following conclusions can be drawn:

The highest yield of 21,88 g/stalk was recorded in P-66-9/7 and the lowest - 14,35 g/stalk in P 12-2/1. The yield obtained in the check variety P-23 was 18,07 g/stalk.

The highest yield per unit area was recorded in P-66-9/7 (3297,45 kg/ha) and the lowest again in P 12-2/1 (2164,90 kg/ha). The values obtained for the other varieties are as follows: Prilep Basma 82 - 3251,80 kg/ha, the check variety P-23 - 2717,75 kg/ha, NS-72 - 2569,25 kg/ha and P-79-94 - 2548,20 kg/ha.

Statistical procession of the results showed significant differences in the yield, which indicates that each of the investigated varieties has different biological potential, undoubtedly governed by its own genotype.

According to the results obtained in the study, the investigated tobacco varieties are a huge source for breeders in creation of new more productive and high quality tobacco genotypes which will find their place in mass production.

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ПРИНОС НА СУВ ТУТУН КАЈ НЕКОИ СОРТИ ОД ТИПОТ ПРИЛЕП

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Апстракт

Тутунот е индустриска култура која се одгледува заради неговата лисна маса. Приносот на сув тутун е едно од најважните квантитативни својства, кое во нормални услови и адекватна агротехника го рефлектира биолошкиот потенцијал на секоја сорта. Испитувањата беа извршени во 2009 и 2010 година на Опитното поле при Научниот институт за тутун - Прилеп, со шест ориенталски тутунски сорти од типот прилеп: П-23(Ø), П12-2/1, НС-72, П-79-94, П-66-9/7 и Прилеп Басма 82. Беше одреден приносот на сува маса по страк (g) и по единица површина (kg/ha). Според резултатите од двегодишните истражувања, највисок принос беше регистриран кај П-66-9/7 (21,88 g/страк, т.е. 3297,45 kg/ha), а најнизок кај П-12-2/1 (14,35 g/страк, т.е. 2164,9 kg/ha), Приносот кај стандардната сорта П-23 беше 18,07 g/страк, т.е. 2717,75 kg/ha. Статистичката обработка на резултатите покажа сигнификантни разлики во приносот, што укажува на фактот дека проучуваните сорти имаат различен биолошки потенцијал како резултат на нивниот генотип.

Клучни зборови: принос на сув тутун, тип прилеп, сорти, генотип.

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Review paper

COTTON PRODUCTION IN BULGARIA AND MACEDONIA THROUGH THE YEARS

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Abstract
Bulgaria and Macedonia are situated in the northern part of the favorable for cotton growing climatic belt. Cotton has been introduced into Bulgarian-Macedonian territories still in Roman Empire; it was cultivated during medieval centuries and during the Ottoman rule on the Balkans. The American varieties *G. hirsutum L.* type were spread over in 19th century. A historical review of the last 50 years of the cotton production, harvested area, export, yield and domestic consumption in Bulgaria and Macedonia, as registered by the US Department of Agriculture, is presented. An interruption of cotton production Macedonia is observed from 2006 to 2012. Bulgarian growing varieties are of the type *Gossypium hirsutum L.* and cross lines of *Gossypium hirsutum L.* × *Gossypium barbadense L.*, while Macedonian ones are only of *Gossypium hirsutum L.* type. The advantage of the varieties, grown in our countries is their early maturing. Cotton breeding in Bulgaria is done in Field Crops Institute near the town of Chirpan. Presently One variety is in the EU Catalogue – Rumi, and six varieties more are pretending to be also in - Beli Izvor, Ogosta, Chirpan 539, Chirpan 603, Avangard 264, and Perla 267. A brown-fiber variety "Isabell" has been recently recognized. For Bulgarian moderate-continental and continental-Mediterranean climate conditions, the needed irrigation application number in dry and medium dry years is 2-3 with an application depth of 400-600 m^3/ha. Cotton response to irrigation is by yield increase of around 40-60%. Specific water saving irrigation scheduling is recommended - just one application before flowering. Thus, by saving 57% irrigational water, a 30% yield reduction is tolerated. For Macedonian transitional-Mediterranean climate conditions, the number of irrigation applications in a medium dry year varies from 5 to 6, with total irrigation amount for the vegetation period - from 3000 to 3500 m^3/ha, while in a medium year only 2-3 applications of 600 m^3/ha per application are enough for proper crop production. Manure fertilization with 10000 kg/ha has proved to be efficient. New cultivation practices with a yield increase of 15% are being developed - 80-cm inter-row spacing instead of the traditional 60-cm and a plant density of 180000 plants per hectare. Common Agricultural Policy, starting from 2014, will fix for Bulgaria a quota of sawn area - 3340 ha and a subsidy of 2690000 EUR yearly.

Key words: cotton, harvested area, yield, subsidies, agricultural practices.

Introduction

Cotton is one of the most valuable agricultural crops. Cotton area in the world takes around 3% of the arable lands and is classified of 6th rank after wheat, rice, maize, barley and sorghum. Net income is one of the highest. The main world producers are China (24%), USA (20%) and India (14%). In EU, the maximum cultivated area is 45060 ha (2%), but cotton has regional significance for the member-states, in which it is cultivated - mainly Greece and Spain. Portugal no longer produces cotton.

Around 76% of the total production in EU comes from Greece. Bulgaria has a small share in the European cotton production – from 10327 in 2007 (Regulation (EC), 2007) base area decreased to 3342 ha after 2009 (Regulation (EC), 2009). Only 400-700 ha have been sawn recently (Agrostatistics, MZH).

Cotton is a warm-climate and photophilic crop. Therefore it is often called "Sun child". Bulgaria and Macedonia are situated in the northern part of the favorable for cotton growing climatic belt. The conditions of both countries – minimum 3600^{o}C temperature totals and 2000 h sunshine duration – ensure a vegetation period of 120 days). Cotton is sown at the end of April, when the mean air temperature is favorable for emergence - minimum 16^{o}C, optimum 25-30^{o}C. The necessary seasonal water for cotton growing in our territories is 300-350 mm, but it is not ensured by the atmospheric rainfalls (Nikolov et al., 2001; Stoilova, 2012a). High and steady yields are obtained only by irrigation.

Bulgarian soils, on which cotton is grown are deep and fertile - chenozems, smalnitsa, alluvial and cinnamonic soils (Nikolov et al., 2001; Saldzhiev et al., 2007). The best soils for growing cotton in Macedonia, according to its thermal regime, are deep clayey–sandy or light sandy–loamy alluvial sediments, which do not suffer from high groundwater's and have medium water capacity.

Figure 1. Situation of Uzundzhovo village and a photo of the caravan-saray gate, built with the donation of Sinan Pasha

Beginnings of cotton cultivation in Bulgaria and Macedonia

Cotton was introduced into the Balkan territories during the time of Roman Empire. Later on, historical documents show that in has been grown in Bulgaria in 9th century in the period of First Bulgarian Kingdom. It was imported as a processed or semi-processed material, or as seeds from Asia Minor, Egypt or Cyprus. Cotton has been grown actively over Bulgarian-Macedonian territories during the Ottoman rule on the Balkans. In 18th century the famous Uzundzhovo Trade Fair played a key role in distribution of cotton seeds (Cotton in Bulgaria, 1983). The Fair was founded by Sinan Pasha in 1593 who donated 30000 Turkish Grosz for a caravan-saray, a mosque, a hospice and a bath to be built in the village of Uzundzhovo and ordered a 40-day market fair to take place yearly. The village of Uzundzhovo is situated near the Bulgarian-Turkish border (haskovo-online.com) (Fig. 1). Later on, in 19th century the Anatolian variety *G. herbaceum* was replaced by the American one – Upland type *G hirsutum,* introduced from Istanbul. In 1836 the new American varieties were sawn on an area of 800 ha and cotton production started slowly developing. It prospered from the beginning of 20th century.

Figure 2. A Bulgarian post stamp with an image of a cotton plant

During World War II (1941-1945) around 23000 ha were sawn and 2180 kg fiber yield was obtained yearly. The greatest progress of cotton production in Bulgaria occurred in the '50-ies of 20th century, when 143000 ha were sawn and 66700 t unginned cotton was obtained per year (Fig. 2). Since then cotton areas in North Bulgaria were liquidated and till 1980 gradually reduced to 16000 ha and 5370 t fiber yield (Cotton in Bulgaria, 1983). After 1980, cotton import expanded - mostly from Central Asia. Since 1990, cotton manufacturing in Bulgaria strongly fell off and the sawn area was reduced. A 55% drop of cotton acreage was reported since 2005 (Sekliziotis, 2009). In 2008 only 700 ha were sawn and the raw cotton obtained was around 750 t. In 2011 952 ha were sawn, but 414 ha was harvested in Southern Bulgaria. The technology is mainly rain-fed. The average yield of raw cotton is 990 kg/ha (Agrostatistics, 2012).

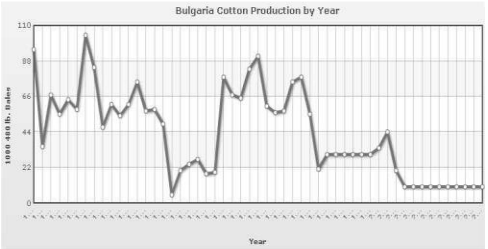
Cotton was intensively grown in Macedonia in the period of World War II and a long time after. An area of 16419 ha was sawn in 1948, which is 3 times more compared to 1939, with production of 6200 t raw cotton. In the late '60-ies and early '70-ies of 20th century, the area under cotton occupied almost 10000 ha from which the raw cotton production was 7700 t. Average yield has increased from 380 to 1000 kg/ha of raw cotton i.e. from 75 to 237 kg/ha pure fiber. In the region of Strumica and Gevgelija (south part of the country) a yield of 260 kg/ha has been registered. In 1959 in Agricultural cooperative in Bogdanci applying measure of planting of cotton plants, 460 kg/ha raw cotton has been achieved (Gjorgevski, 1964). From period after '70-ies areas under cotton rapidly start to decrease. This industrial crop was last recorded in a public register in 1997, when only 6 ha were planted. After a break of 15 years, the crop was planted again this year (2012) on area of 15 ha in the region of Stip, with a tendency of around 50 ha to be sawn in 2013.

The history of cotton production - harvested area, export, yield, and domestic consumption of cotton in Bulgaria and Macedonia has been reviewed by the US Department of Agriculture. All the indices have decreasing tendencies through the years – from 1962 to 2012 for Bulgaria and from 1992 to 2012 for Macedonia. The flourishing period of Bulgarian cotton production is 1982-1994, when the indices' values are at the maximum. Later on, the total area under cotton decreases due to low farm-gate prices and highly competitive imports of long-fiber cotton. The average yield fluctuates widely through the years as irrigation for the biggest part of the sawn area is missing (Index Mundi) (Figs 3 and 4).

According to the 'Agro-statistics' of Bulgarian Ministry of Agriculture and Forestry, the area under cotton in 2001 is 14700 ha; in 2002 - 6300 ha, and in 2003 - 2000 ha only. The yields of unginned cotton are low - 740 kg/ha in 2000 and 690 kg/ha in 2001. The total output in 2000 is 7000 t, in 2002 - 10000 t but in 2003 - 2000 t only (Agrostatistics, MZH).

The environmental potential for cotton production in Bulgaria includes 60000 ha favorable areas, 30000 ha of them have exclusively favorable soils and climatic conditions for cotton growing. These areas are situated mainly in South and South-Eastern Bulgaria (Thracian Valley and Burgas Lowland) and less in Central North Bulgaria. Most suitable soil and climatic conditions for cotton growing can be found in Haskovo, Stara Zagora, Blagoevgrad and par of Plovdiv regions (Fig. 5). There are suitable conditions also in Burgas, Yambol, Sliven and regions and some parts of Vratsa, Pleven, Veliko Tarnovo, Ruse and Silistra regions (Cotton in Bulgaria, 1983; Nikolov et al., 2001; Saldzhiev et al., 2007). They are equipped with irrigation networks for surface and pressurized irrigation (CONF BG 43/01). The variety Beli Izvor which has great adaptability and high fiber quality has been grown from 1980 to 1999. It was substituted by Chirpan 603 and Chirpan 539. At present, mainly the following Bulgarian varieties are grown: Chirpan 539, Chirpan 603, Avangard 264, Perla 267, Beli Lom, Beli Iskar, and Vega. Chirpan 539 is a standard for early ripening and Avangard 264 – for fiber quality. Avangard 264 has 3 mm longer fiber than Beli Izvor (Stoilova, 2012a).

The strongest aspects of the fiber crop production and processing in the country has been that the textile industry was well developed in the past. Unfortunately, Bulgarian potential cotton production was enough to supply only 50% of the capacity of Bulgarian cotton industry. Because of a strongly developed textile industry and comparatively low actual production of cotton fiber in the country, Bulgaria imported about 90% of cotton fiber. In Bulgaria there were 5 enterprises for primary manufacturing of raw cotton which had the potential to early processing of 100000 t. The main ones were “Trakia Cotton” Ltd. - Stara Zagora, and “Textile fibres” Ltd – Haskovo, still functioning. The sector provided yearly permanent employment for 10000 workers and temporary seasonal employment for 3000 workers. An Association of the Cotton Growers and Users for defending the rights of the cotton producers and users has been founded in Bulgaria.



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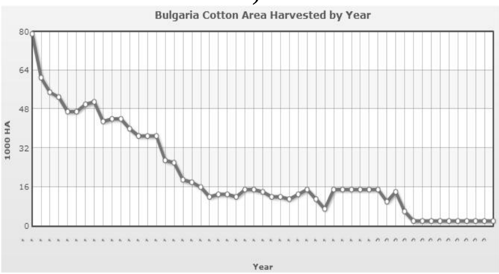

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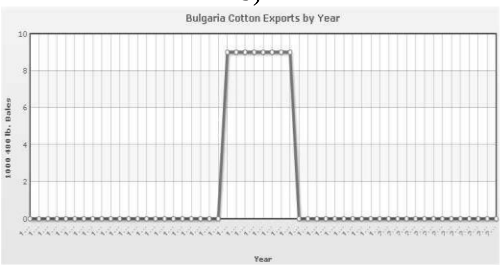

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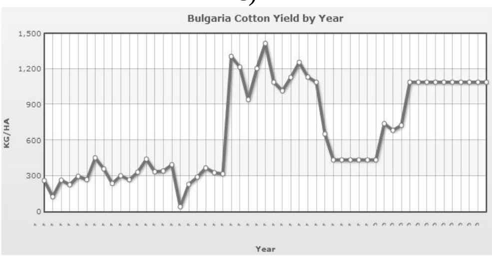

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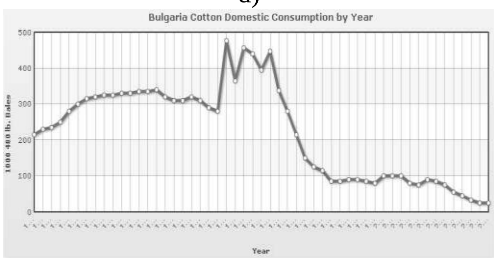

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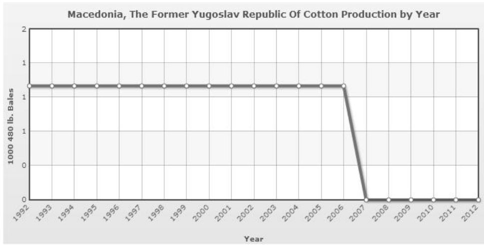
Figure 3. Cotton production (a), cotton area harvested (b), cotton export (c), cotton yield (d), and cotton domestic consumption (e) by year in Bulgaria (Source: Index Mundi)



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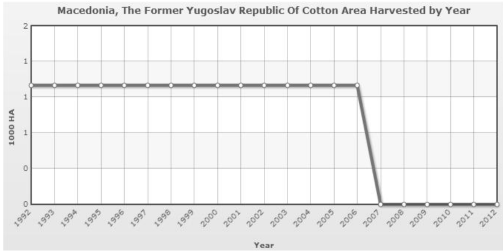

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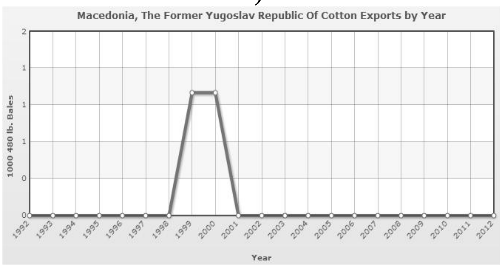

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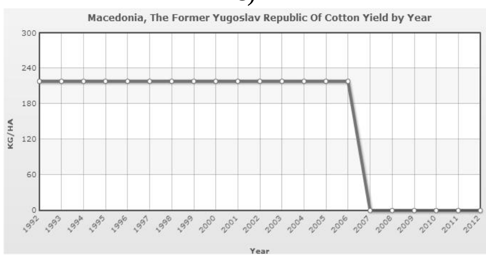

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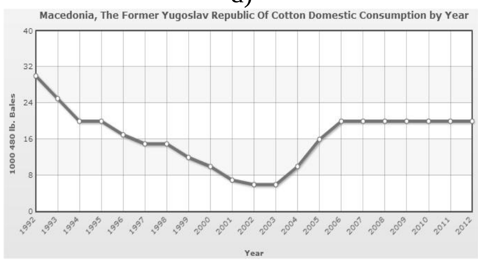

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Figure 4. Cotton production (a), cotton area harvested (b) cotton export (c), cotton yield (d), and cotton domestic consumption (e) by year in Macedonia (Source: Index Mundi)

The potential districts, where cotton can be grown in Macedonia, are along the Valley of Vardar River, south-west of the city of Strumica, and around in Stip and Kochani region, where the textile industry is pretty developed. The regions where cotton was cultivated in the past were Strumica, Stip, Bogdanci, Valandovo and Veles and in smaller scale Kumanovo and Skopje (Egumenovski et al., 1998) (Figure 6).

Figure 5. Cotton growing regions in Bulgaria

Figure 6. Cotton growing regions in Macedonia

Benefits of cotton growing in Bulgaria

For many economic reasons, EU subsidies for the agricultural production in Bulgaria are low (Fig. 7).

The initial regime of subsidizing cotton manufacturing by EU was based on a "deficiency payment" to cotton processors who paid a minimum price to the farmers that supplied them with unginned cotton. This regime stimulated cotton sector in EU.

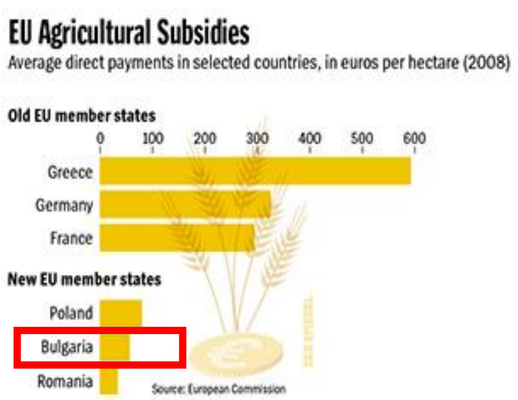

Figure 7. EU Agricultural Subsidies in 2008 (Source: EC).

Common Agricultural Policy of EU (CAP) from 2009 on fixes a quota for Bulgarian sawn area of 3342 ha, basic yield - 120 kg/ha and a subsidy of 671.33 EUR/ton (=804.91 EUR/ha; =2690978 EUR/year) (Regulation (EC) № 73/2009). The tendency of subsidizing cotton production in 2016 is 660 EUR/ha. The state aid in 2012 is a subsidy "*deminimis*", which completes 290 EUR/ha but maximum 7500 EUR for the period 2010-2012 per producer (Instructions…, 2012). The national subsidy in 2014 will be maximum 556523 EUR, and in 2015 – 295687 EUR (Novinar, 2011).

Cotton breeding and the investigations on agro-technologies for cotton production in Bulgaria are done at the Field Crops Institute (former Cotton and Durum Wheat Research Institute), situated in Central South Bulgaria near the town of Chirpan (Fig. 8). The Institute has long traditions, since it has been founded in 1925. Breeding is oriented to early maturing, high productivity and high fiber quality. Individual traditional selection methods are being practiced - intraspecific and interspecific hybridization; experimental mutagenesis; in vitro techniques; study of resistant to biotic and abiotic stress factors; genotype-environment interaction and phenotype stability; creation of ecological cotton forms with naturally colored fiber; early leaf-fall and naked seeds; and keeping, evaluation and use of cotton genetic resources.

The following elements of cotton growing technologies are being improved: crop rotation; fertilization; sowing density; irrigation; development of pest, weed and disease control; growth regulators; low-input technologies; and economic efficiency of production. The Institute offers certificated sawing material of cotton, as well as stock production of cotton (http://www.iptp-chirpan.org/).

Figure 8. The building (left) and Logo (right) of Field Crops Institute, 6200 Chirpan, Bulgaria, http://www.iptp-chirpan.org/

The specific soil and climatic conditions in Bulgaria are good for growing varieties of *Gossypium hirsutum L.* type and, to some extent, of *Gossypium barbadense L.* type. The cotton fibers are 29-33 mm long; have moderate fineness, good strength and good fiber uniformity. The advantage of Bulgarian varieties is their early maturing. The selection is being done in two directions – 1) of early maturing varieties with great genetic potential for yield and 2) of varieties with improved fiber quality. The following breeding methods for early maturing with high genetic potential varieties are used: intraspecific hybridization within *hirsutum* variety and experimental mutagenesis, i.e. local and foreign varieties are crossed (Stoilova, 2012b). Best of them in the country are: Beli Izvor, Garant, Ogosta, also – Chirpan 539 (standard), Chirpan 603, Beli Iskar and Beli Lom. A basic breeding method for the second direction is interspecific hybridization between the chromosome varieties *G. hirsutum L.* and *G. barbadense L.*, as well as *G. hirsutum* and bred lines of *G. hirsutum* L. × *G. barbadense L.* origin. On the basis of this method the following varieties have been obtained: Avangard 264 (standard), Perla 267, Vega (Stoilova, 2012ab). In 2007 and 2008 the varieties Kolorit, Darmi, Natalia and Dorina were certificated. Trakia, Helius, allied to the first breeding direction, were lately certificated too. Kolorit and Darmi are good for mechanized harvesting, and Natalia's fiber is of very high quality. Darmi and Natalia have the best combination of productivity and fiber quality (Stoilova, 2011; Stoilova 2012a). The newest varieties are Rumi and Plovdiv, recognized in 2011 (Stoilova, 2012b). Currently variety Rumi is included (EU

Catalogue…, 2011) Six varieties more, given in Table 1, are pretending to be in the EU Catalogue (CONF BG 43/01).

Table 1. Bulgarian cotton varieties presently pretending to be in the EU Catalogue (Nikolov et al. 2001; Saldzhiev et al., 2007; Stoilova, 2012a)

Variety	Vegetation Period, days	1000-seed Weight, g	Ball Weight, g	Fiber length, mm	Yield (pure fiber), kg/ha	Lint percentage, %
Beli Izvor	115-120	110-112	5,7	29-31	330	35-36
Ogosta	110-117	110-116	5,1-5,4	28-30	NA	36-37
Chirpan 539	109-116	105-112	5,2-5,8	29-31	170-250	37
Chirpan 603	110-117	110-115	5,3-5,8	29-32	NA	37-38
Avangard 264	115-122	105-112	5,0-5,7	31-34	170-240	34
Perla-267	115-120	NA	NA	31-34	170	35-37

A new variety “Isabell” with light brown fibers has been recognized in 2010. Its quality is equal to the foreign ones of USA, Turkey and Brazil. “Isabell” has high productivity, early ripening, and suitability for mechanized harvesting. Its fiber is short, moderately fine, with good elasticity and strength, but as a whole is of lower quality compared to the commercial varieties (Fig. 9). Bulgarian breeders have also obtained varieties of dark brown and green color (Stoilova 2012ab).

Figure 9. Yarn from Bulgarian colored cotton

Strong dependence of yield and fiber length on July-August rainfall totals (mostly from 11th July to 10th/20th August) and on July-August air temperature (especially 21st Jul to 10th August) has been established hence one of the goals of cotton breeding in Bulgaria is genesis of drought resistant and high temperature tolerable varieties (Stoilova 2012a).

The most popular varieties of *Gossypium hirsitum* grown during the intensively cotton growing period in Macedonia were: No 3279, No 996, No 4521, Makedonija and Strumica 105. The first three varieties are Bulgarian (Cotton in Bulgaria, 1983), while the last two are domestic varieties, created by the former Cotton Institute in Strumica (Gjorgevski, 1964; Spasova, Dimov, 2003).

Despite of the objection of the public, GMO Act/1.06.2005 in Bulgaria allowed cotton GMO varieties to be grown in the country with a buffer zone of 400 m. GMO cotton is still not grown in Bulgaria, because there is no approbation from EU (GMO Act, 2005).

Irrigation and fertilization of cotton

The practice of irrigation is definitely necessary in Bulgarian and Macedonian conditions. Potential evapotranspiration (ETP) of cotton in Bulgaria, estimated in lysimeters is 550 mm, while the maximum one (ETM) in water unlimited field conditions varies from 380 to 430 mm, dependent on the occurrence of the meteorological factors (Nikolov, 1980; Nikolov et al., 2001). A small part of it - 5% is established in the initial stage, 11% - in the vegetative stage, 24% - in the podding-flowering stage and the rest 60% - in flowering-maturing stage. Daily evapotranspiration varies from 1.1-1.6 mm/d at the initial stage to 3.7-4.8 mm/d at flowering. For a short time, maximum daily evapotranspiration can reach 6.0 -6.5 mm/d (Nikolov et al., 2001) (Fig. 10). Autumn-winter soil moisture usually shares 41-42% of ETM, rainfalls – 34-35%, but irrigation – 23-25%. Cotton consumes irrigational water mainly during flowering (40-42% of the total ETM). Irrigational water is mainly needed in the period from podding to ball formation. Generally, irrigation must be cancelled on 5th August (Bozhinov et al., 1988; Bozhinov et al., 1995; Nikolov et al., 2001). ETM is best managed at a refill point of 70% of field capacity (FC) in the to 50 cm soil layer. Thus, in a medium dry year, 3 irrigation applications are given.

Water saving irrigation scheduling can be managed by one application before flowering. The application depth depends on the maximum allowed water depletion in soil and is 40, 60 or 80 mm. Thus 57% irrigational water is saved; the yield increase vs. rain-fed yield is 42-44%; the relative yield is 69-72% of the maximum yield at full irrigation; and water use efficiency (WUE) is 1 kg/m^2. This irrigation scheduling ensures on-time ripening. When optimal irrigation scheduling is applied, the yield obtained is 220-300 kg/ha raw cotton vs. 120-130 kg/ha under rain-fed conditions (Bozhinov et al., 1995).

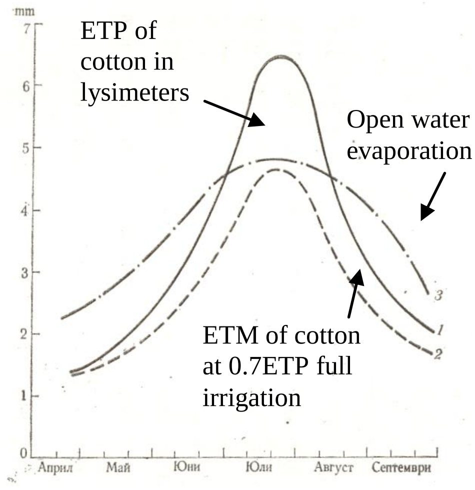

Figure 10. Daily evapotranspiration of cotton (Nikolov, G., 1980)

Cotton in Bulgaria can be irrigated by sprinkling or gravitationally, or by drip irrigation. If surface irrigation is applied, it is recommended the every-other-furrow technique (Nikolov et al., 2001). Sprinkling vs. surface irrigation ensures 11-22% higher yields (September yield). Reel rain traveler and side-roll wheel line can be used. For small areas medium and low pressure sprinklers are recommended. Surface irrigation is not quite recommended, because the soils, on which cotton is grown, make cracks at the moisture level of 85% of FC. Further, long furrows are risky for over-moisturizing. It is difficult to dosage the water and often the irrigational water is 1.5-2.0 times greater than crop needs. WUE at surface irrigation is very low. For uniform distribution of water it is good to use flexible plastic pipes, equipped with irrigation siphons and irrigation narrow pipes. Drip irrigation contributes for 9-13% yield increase and 9-20% increase in WUE (Technology for cotton production, 1997; Nikolov et al., 2001).

Depending on soil nutrient supply, fertilization of cotton under rain-fed conditions is recommended as 100-120 kg N/ha, 80-100 kg P_2O_5/ha and 60-70 kg K_2O/ha. When irrigated, the fertilizer efficiency is higher hence the quantities are smaller – 140-160 kg N/ha, partially given before sowing and during the stage of flowering-ball formation. Manure fertilization with around 10000 kg/ha has proved to be efficient (Technology for cotton production, 1997).

New cultivation practices are being developed. Wide inter-row spacing 80 cm instead of the traditional 60 cm is being introduced. When combining 80-cm inter-row spacing with plant density of 180000 plants/ha, the yield is 15% higher. Cotton crop rotation, soil tillage systems, physical and chemical properties of soil are in the focus of cotton-growing science, as well as the fertilizing practices and their impact on soil fertility. Science pays attention to overcoming weeds, cotton diseases and pests (Stoilova, 2012).

According to the Macedonian literature (Iljovski, Cukaliev, 1994), the total water consumption during the vegetation is as follows: from initial to podding stage 8-10%; from podding to flowering stage 18-20%; from flowering to beginning of the ripening stage 50-60%; and in the ripening stage 14-20%. The total irrigational amount for the vegetation period and the number of applications depend on the meteorological peculiarities of the year. In a medium dry year, the irrigation application number vary from 5 to 6, with a total irrigation amount for the vegetation period - from 3000 to 3500 m^3/ha. In a medium year, only 2-3 applications with 600 m^3/ha per application are enough for proper crop production. The yield of raw cotton can be 250-300 kg/ha when optimal irrigation scheduling is applied. The most applied techniques for irrigation in cotton crop production are furrow and sprinkler irrigation. In last two decades, the drip irrigation technique is usually used in cotton crop production in the world. According to the results for better efficient use of water and fertilizers, as well as quality and higher yield production (Janat et al., 2002); the drip fertigation is recommended in further cotton production in both countries.

Lastly, cotton has an age-old tradition over Balkan lands. It follows the cultural traditions of the people inhabiting these lands. It has always been important for the livelihood of the population. Nowadays cotton breeding and agrotechnologies note original achievements and useful practical results. The most important of them is creating early maturing varieties, also varieties with longer and of highest quality fiber and ecological varieties with natural coloration. The scientific collaboration between Bulgaria and Macedonia in study of cotton is a good basis for further developing of its production in the region, for meeting the people needs in cotton textiles, for reviving and prosperity of the textile industry of the two countries, for taking the rightful place in cotton production in Europe and in the world.

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ПРОИЗВОДСТВОТО НА ПАМУК ВО БУГАРИЈА И МАКЕДОНИЈА НИЗ ГОДИНИТЕ

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Апстракт

Бугарија и Македонија се наоѓаат во северниот дел на поволниот климатски појас за одгледување на памук. Памукот беше воведен во Бугаријс и Македонија уште за време на римската империја, беше одгледуван и во текот на средниот век и за време на османлиското владеење на Балканот. Американската сорта памук, тип Gossypium hirsutum L., започнува да се шири во текот на 19 век. Од страна на американското Министерство за земјоделство е претставен историски преглед за последните 50 години од производството на памук, и се регистрирани ожнеаните површини, извозот, приносот и домашната потрошувачка во Бугарија и Македонија. Прекин на производството на памук во Македонија е забележано 2006-2012. Бугарското производство расте со сорти од типот Gossypium hirsutum L. и крстоските на Gossypium hirsutum L. × Gossypium barbadense L, додека македонските се само од типот Gossypium hirsutum L.. Предноста на овие сорти е нивното рано зреење. Одгледувањето памук во Бугарија е од страна на Институтот за поледелски култури во близина на градот Чирпан. Во моментов една сорта е регистрирана во Каталогот на ЕУ - Rumi, а шест варијанти претендираат исто така да бидат на листата: Beli Izvor, Ogosta, Chirpan 539, Chirpan 603, Avangard 264, и Perla 267. Сортата "ISABELL" , со кафеаво влакно е призната неодамна. За бугарските услови на одгледување во умерено-континентална и континентално-медитеранска клима, потребно е наводнување во суви и средно сушни години со апликација од 400-600 m^3/ha. Памукот го зголемува приносот како одговор на наводнувањето за околу 40-60%. Се препорачува специфичен распоред за наводнување за заштеда на вода - само една апликација пред цветање. За правилно производство на памук во македонски услови на одгледување во преодна-медитеранска клима, бројот на наводнувања во средно сува година варира од 5 до 6, со вкупен износ на наводнување за периодот на вегетација 3000-3500 m^3/ha, додека во средно сушна година доволни се само 2-3 апликации од по 600 m^3/ha. Како ефикасно се покажа ѓубрењето со арско ѓубре во количество од 10 т/ха. Се развиваат нови практики на одгледување, со зголемување на приносот од 15% - при 80 цм внатредово растојание, наместо традиционалните 60 см. и склоп од 180.000 растенија по хектар. Заедничката земјоделска политика (CAP), почнувајќи од 2014 година, за Бугарија ќе овозможи квота за посеана површина од 3340 ха и субвенции од 2.690.000 евра годишно.

Клучни зборови: памук, ожнеана површина, принос, субвенции, земјоделски практики.

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EFFECT OF BIOPRODUCTS ON DURUM WHEAT (TRITICUM DURUM *DESF.)* UNDER CONDITIONS OF ORGANIC FARMING IN SOUTHERN BULGARIA

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Abstract
The purpose of this investigation was to establish the efficiency of the bioproducts Biohumax and Humustim on the development, yield and quality on the Bulgarian durum wheat cultivar Progress, grown organically at the certificated field of the Field Crops Institute, Chirpan, Bulgaria on soil type of Eutric Vertisols in the period 2008-2010. The influence of bioproducts in dozes of 1 and 1.5 $l.ha^{-1}$ was tested as spring foliar application. The grain yield, test weight (kg), 1000 kernel weight (g), glassiness (%), crude protein and gluten (%) and grain N, P, K concentrations were determined on harvested grain. The results showed that the bioproducts affected the durum wheat growth, productivity and grain quality. The grain yield surpassed the unfertilized with 8.6-14.1 % and reached 3.43 $t.ha^{-1}$ at double spring foliar feeding in rate 1.5 $l.ha^{-1}$. No significant differences in the efficiency of the two products were seen and their action was one-sided. The grain yield was mostly influenced to the highest extent by the yearly conditions and by the applied rates, while the fertilizer type made an insignificant influence. The plant height increased with 11.5 to 18.5 %, content of protein – with 2.4-4.7 %, wet gluten – to 1.2 %. The experiment demonstrated that organic farming can produce high quality grain of durum wheat.
Keywords: organic farming, durum wheat, biofertilizers.

Introduction
Obtaining ecologically clean plant products intended for food for people and preserving the environment are connected to using organic based products. Limiting the negative influence of chemical fertilizers and eliminating their consequences is important for modern agriculture.
Organic agriculture is an integrated system of management and production of food and other products, which includes a combination of good agricultural practices, high level of biodiversity, preservation of natural resources and use of natural substances (Diver, 2001; Manojlovic et al., 2010). The organic production insists on an exclusive use of organic and microbial fertilizers, while taking special care of mutual interactions between soil, plants, animals and humans (Manojlovic et al., 2010; Oxouzi and Papanagiotou, 2010).
The initiation and development of biological farming in Bulgaria is part of the European strategy for ecological integration and sustainable development within the frame of the Common Agricultural Policy whose reforms encourage the market orientation in the production of biological products.

The organic farming is an optimal choice for the future development of the farming sector as it preserves the natural resources and the environment, meets the needs of the increasing number of consumers and uses safe methods of production. The organic products market is sustainable, constantly increasing, efficient and has good prospects. The expansion of the EU creates a large home market in regard to the purchasing power, which opens broad range of opportunities before the organic farming.

The conventional farming varieties are not always suitable for organic growing, because they are bred for high yield and quality at growing on high soil fertility, with high doses of synthetic fertilizers and pesticides. Maintaining the biodiversity is an important principle in organic farming, and in this regard steps should be taken for the farmers who are to be provided with a number of varieties, including in local companies adapted for growing at organic farms.

The farmers occupied with organic farming don't have the necessary qualification in the area of seed production and at this stage they are not capable of managing by themselves the growing of biological seeds, and even less with a targeted breeding.

So far there is no research related to selection of varieties suitable for biological growing and development of production technologies for organic seeds from field crops. The production of organic seeds is more difficult as compared to conventional farming seed production. The problems depend on the specific plant, but they can be summed up to the following: growing healthy vital seed; reaching the seed quality standards, defined for the conventional seed production – disease, pest and weed control with no use of pesticides and a special attention should be paid to the seed-transmitted diseases; big production expenses. At this stage of conventional farming cereal crops are the main crop rotation unit, produced by the Bulgarian farmers. Its growing in organic farming, especially in rural areas with available work hands would contribute to stimulating the production for gaining additional income for the population. where the durum wheat is the main crop and the grain is used to make flour and pasta as food for the people.

The conventional and low-input farming practices (effect of organic and mineral fertilizers, manure and crop rotation) were studied at the Field Crops Institute - Chirpan to document changes in soil fertility properties, nutrient storage and productivity of durum wheat. Two farming systems which differed in crop rotation and the use of external inputs were established on land that had been previously conventionally managed.

The low-input system was managed using a long-term manure and cover crops. The application of 30 $t.ha^{-1}$ manure lead to better results toward fertilization with $N_{60}P_{48}$ and was equal to N_{120}. Inputs of C, P, K, Ca, and Mg were higher in the organic and low-input systems as a result of manure applications and crop incorporations. After 4 yr of production, soils in the organic and low-input systems had higher soil organic C, soluble P, exchangeable K. Organic and low-input farming systems indicated small but important increases in soil organic C and larger pools of stored nutrients which are critical for long-term fertility maintenance. The reduction of the negative effect of chemical fertilizers on the soil properties or eliminating their consequences is an issue of pressing interest for the modern agriculture; it is related to protecting the environment by obtaining ecologically clean plant products.

Some consumers purchase organic food because they perceive the products to have superior quality attributes over conventional foods (Yiridoe et all., 2005). Despite perceived benefits of consuming organic foods, organic certification is based on the process used to produce the good, not on the product itself. This suggests that organic products may not be superior to conventional ones (Brandt and Molgaard, 2007). Research into nutritional differences of organic and conventional products has not yielded consistent results (Bourn and Prescott, 2002). Soil, climate, crop type and cultivar, management practices and post-harvest factors can all affect the nutritional quality of crops.

In the last years the biological and ecological production of plant products has been one of the fastest developing branches in Europe. According to data of the International federation of organic agriculture the annual increase in a large number of European countries has been 20-25 %.

Recently further attention has been paid to the foliar corrective nutrition. The use of foliar fertilizers creates an opportunity to increase the effect of fertilization, to reduce the environment pollution by reducing the fertilizer type and norms and their use to the best advantage. It provides better efficiency of the applied products as the nutrient and biologically active substances are fully absorbed by the plants without the soil mediation where secondary processes of nutrient immobilization might occur or it might be washed out of the root development soil layer. The foliar fertilizers may help overcome quicker the plants' functional diseases when a certain nutrient is missing. Foliar fertilizer treatment was applied during the cultures' vegetation, doses were applied in accordance with the plant needs in the particular stage.

Subject of research for different cultures are the humat formulations created in the last years such as extracts of organic sludge, coal, peat, kinds of manure, as well as products from red Californian worm. The results published in the last years show that they have a stimulating effect on the development and productivity of a number of cultures (Delfine et al., 2005, Gramatikov, 2005; Gramatikov and Koteva, 2004; Nankova et al., 2004; Nenov et al., 2004; Sengalevich et al., 2004).

Our objectives were to determine the efficiency of the bioproducts Humustim and Biohumax on the development, yield and quality of the Bulgarian durum wheat (*Triticum durum Desf.*) cultivar Progress, grown organically on Eutric Vertisols at the certificated field of the Field Crops Institute, Chirpan, Bulgaria.

Material and methods

The investigation was carried out in the period 2008-2010 on the certificated bio-field of the Field Crops Institute, Chirpan, situated in a major durum wheat-growing region of Bulgaria. The durum wheat cultivar Progress was grown under non-irrigated conditions after cotton. Randomized block design with four replications was used. The net plot size of individual trial plots was 10 m^2.

The bio-fertilizers were applied two times as foliar feeding at the beginning of the spring vegetation (tillering) and at early boot stage in dozes 1 and 1.5 l/ha with 300 l water/ha. The results were compared with untreated (water control).

The bioproducts “Biohumax” and “Humustim” (potassium humate), according to information by the producers, is ecologically clean, highly concentrated humic natural product, which contains a number of humic acids and fulvoacids, vitamins, phytohormones, microelements, enzymes and others, which are quickly and directly included in the metabolism and stimulates the cultures' growth, development and productivity as well as the micro organisms' development.

The durum wheat was cultivated after a technology approved for the region of Central South Bulgaria. (Yanev et al., 2005), but without application of synthetic fertilizers and pesticides. The seeds were sown on October 25-30. The sowing rate was about 500 germinated seeds per m^2. The harvest with plot combine was carried out in the period July10-15.

The grain yield (kg/ha), test weight (kg/hl), 1000 kernel weight (g), virtuousness (%), crude protein and gluten (%) were determined on the harvested grain. The test weight was determined by hectoliter, 1000 kernel weight – by weighing two samples of 500 kernels, total virtuousness – by cutting with pharinotom of Heinsdorf, the content of crude protein - by Kjeldahl standard method and derived according to: Protein, % = N (% DM).5.83. N, P, K concentration (%) in plants was analyzed in phases of development.

The data was statistically analysed according to the method of variance analysis (ANOVA) and LSD test for evaluation of significant differences.

Agrochemical characteristic of the Eutric Vertisols at Biofield was made by conventional methods for determination of mineral nitrogen (by Kjeldahl), available P_2O_5 and K_2O (acetate-lactate method).

Table 1. Meteorological conditions during vegetation period of durum wheat 2008-2010

Period	Temperature sum, ^oC			Rainfall, mm/m^2		
	X-II	III-VI	X-VI	X-II	III-VI	X-VI
2008	734	1744	2478	322	210	532
2009	1011	1783	2794	137	95	232
2010	879	1734	2613	311	206	517
1928-2008	705	1670	2375	238	203	442

In regard with the meteorological conditions the studied years were characterized by higher temperatures in the autumn-winter period, unevenly distributed precipitation and they were not particularly favorable to the optimal growth, development and productivity of the durum wheat (Table 1). Temperature sums total for the vegetation period of durum wheat (X-VI) in 2008, 2009 and 2010 exceeded the average amount (2375^{o}C) with 103, 419 and 238^{o}C, respectively. With respect to rainfall for the vegetation period in 2008 and 2010 the amount of rainfall was respectively 90 and 75 mm/m^2 more, and in 2009 with 210 mm/m^2 less than average (442 mm/m^2).

Results and discussion

The soil in the field of organic farming was Eutric Vertisols (FAO). It was clay, with high humidity capacity and small water-permeability, defined by the sand-clay composition. The test field was with bulk weight of the plough soil layer - 1.2 g/m^3 and specific gravity - 2.45. The sorbcium capacity was 35-50 mequ/100 g soil.

As the focus is on organic soil, it is very important to maintain and increase soil fertility. The analysis results before the experiments in the 0-60 cm soil layer indicated slightly acid to neutral soil reaction (Table 2). The values of $pH_{(KCl)}$ were within the favourable scope for growing cereal crops. In the 0-20 cm layer the soil had slightly acid reaction, and in the deeper soil layers (20-60 cm) the acidity decreased and the values ranged within 5.8-6.5. Acorging to the total humus content (1.54-2.40 %) the soil had from low to middle supply of organic matter. The content of mineral nitrogen as a sum of NH_4-N + NO_3-N varied significantly, it changed dynamically under the influence of the meteorological conditions and the grown crops had low values, reaching a maximum of 25 mg/kg soil. As for the available phosphates supply, it was established that in the 0-60 cm soil layer the phosphates supply was low - 0.3-3.2 mg/100 g soil. The phosphates regime was unfavourable for the durum wheat development. The leached smolnitzha in the field was well provided with available potassium. Its content ranged within 15-38.0 mg/100 g soil with its highest values being for the plough layer.

The combination of temperature and rainfall was the main regulatory factor for the phonological development of durum wheat plants (Table 3). During the period of research an insignificant delay was observed in the culture development – the tillering occurred in February, the stem elongation – at the beginning of April. Temperatures below -14^{o}C in February 2010 caused partial freezing of the crops and lower grain yield.

The highest temperatures and draught in May 2010 hindered the obtaining of record yield.

The abundant rainfall in June 2008 led to lodging of the durum wheat and deteriorated the grain appearance. Year 2010 was favorable for the durum wheat development and obtaining a good yield, but it was very unfavorable to the grain quality due to the July rainfalls (114.4 mm/m^2). Overall durum wheat riping was reported in the period July 5-13.

There were no pathogens and pests above the threshold of harm during the durum wheat vegetation period in the three years of cultivation.

Table 2. Agrochemical properties of the Eutric Vertisols, 0-60 cm

Depth, cm	pH $_{(KCl)}$	Humus, %	Mineral N (NH_4+NO_3), mg/kg soil	Available forms, mg/100 g	
				P_20_5	K_20
0 -10	5.5 - 5.8	2.05 - 2.20	15 - 18	0.3 - 0.5	32-38
10-20	5.5 - 5.8	2.10 - 2.40	20 - 25	0.5 - 1.4	25-35
20-40	5.8 - 6.5	1.95 - 2.25	23 - 25	2.5 - 3.0	19-28
40-60	6.0 - 6.5	1.54 - 1.70	20 - 22	2.0 - 3.2	15-26
Average	5.5 - 6.5	1.54 - 2.40	15 - 25	0.5 - 3.2	15-38

Table 3. Phenological stages in durum wheat development, 2008-2010

Stage	2008	2009	2010
Emergence	10. XI	15. XII	25. X
Tillering	25. XII	25. II	10. II
Stem elongation	01. IV	03. IV	22. IV
Ear emergence	15. V	18. V	12. V
Flowering	22. V	28. V	24. V
Maturity	10. VII	05. VII	13. VII

Acording to the results the bioproducts Humustim and Biohumax affected the durum wheat growth and productivity. Foliar treatment with Humustim at doses 1 и 1.5 l.ha^{-1} increased the productiviy by 9.1 and 13.7 % respectively, and at the same doses of Biohumax - by 8.6 and 14.1 % (Table 4). The grain yield reached 3.43 t.ha^{-1} at twofold spring feeding with Biohumax in rate 1.5 l.ha^{-1}.

The net profit increased to a higher degree at 1.5 l.ha^{-1} biofertilizer – 82.0-85.2 lv/ha. Twofold spring foliar feeding in rate 1.5 l.ha^{-1} was an effective activity. No significant differences in the efficiency of the two products were seen and their action was one-sided. The data showed that the grain yield was influenced to the highest extent by the yearly conditions and by the applied rates (LSD = 0.001), while the fertilizer type had an insignificant influence.

Table 4. Grain yield of durum wheat cultivar Progress and effect of bio-fertilizers, 2008-2010, kg.ha^{-1}

Variant	Grain yield					Net profit, lv/ha
	2008	2009	2010	Average		
				kg.ha^{-1}	%	
Water check	2870	3452	2698	3007	100.0	-
Humustim - 1 l.ha^{-1}	3098	3696	3046	3280	109.1	54.2
Humustim - 1.5 l.ha^{-1}	3187	3942	3127	3419	113.7	82.0
Biohumax - 1 l.ha^{-1}	3126	3689	2985	3266	108.6	50.8
Biohumax - 1.5 l.ha^{-1}	3223	3870	3202	3432	114.1	85.2
LSD 0.05	285	347	296	324	7.75	
LSD 0.01	312	397	362	340	13.07	
LSD 0.001	348	468	509	358	19.06	

Delchev (2000) also reported that the foliar feeding increased yield and it was the highest at complex foliar fertilizers treatment during stem elongation stage. The foliar treatments during ear emergence and milk development stages had a weak effect on the yield, but increased grain quality (Delchev, 2000).

The results showed that decisive influence for increasing the grain yield had higher levels of structural elements. The spike length, number of spikelets in spike, number of kernels, formed in a spike and the weight of kernel in spike increased to a greater extent at a higher doze biofertilizers (Table 5). A tendency was seen for Biohumax to be more effective than Humustim. The structural analysis of the yield showed that the foliar feeding additionally stimulated the formation and growth of the durum wheat grain.

The application of foliar fertilizers stimulated the durum wheat growth processes. The height of the plants at the end of vegetation increased by 11.5 to 18.5 % over the water control (78.2 cm) and reached higher values (90.4-92.7 cm) under tested doses 1.5 l.ha^{-1}. In 2010 the plants was characterized by better height in maturity – average 90.3 cm, while in 2008 the average height was 82.5 cm. (Figure 1).

Table 5. Structural elements of durum wheat yield, average for 2008-2010

Variant	Length of the spike, cm	Number of spikelets in spike	Number of kernel in a spike	Weight of kernel in spike, g
Check	5.5	16.1	25.6	1.4
Humustim - 1 l.ha^{-1}	5.6	16.8	28.4	1.5
Humustim - 1.5 l.ha^{-1}	5.8	18.1	29.0	1.6
Biohumax - 1 l.ha^{-1}	5.7	17.1	28.9	1.5
Biohumax - 1.5 l.ha^{-1}	5.8	18.9	29.5	1.5

The test weight is an indirect classification parameter, normally in direct correlation with flour output**,** criterion for the health state of durum wheat. It is desirable that the test weight is over 78 kg.hl^{-1}. In western Canada, grain samples of top grade (No. 1) Canada Western Amber Durum wheat must contain at least 80 % hard vitreous kernels and have a test weight of 80 kg.hl^{-1} or higher

(May et al., 2008). From the physical properties in organic conditions the test weight meant that the 3-year period was good – from 78.2 to 80.3 kg.hl^{-1} (Table 6). The test weight values were lower in 2008 and 2010 (78.2-79.1 kg). They were characterized by high moisture supply, while in 2009 under the influence of the favourable combination of temperature and precipitation the values were higher – 79.4-80.3 kg. There were no significant differences established in regards with test weight of grain under foliar application.

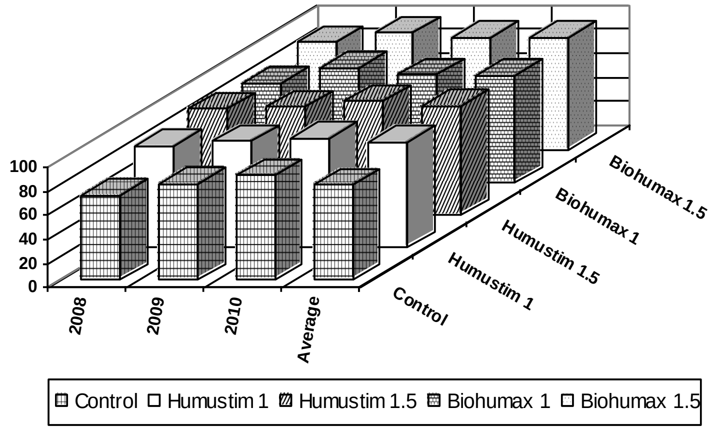

Figure 1. Influence of bio-fertilizers on the height of durum wheat plants in maturity, 2008-2010

Table 6. Influence of bio-fertilizers on the test weight of durum wheat grain, 2008-2010, kg.hl^{-1}

Treatment	Year			Average	
	2008	2009	2010	kg.hl^{-1}	%
Water check	79.1	79.8	78.2	79.0	100.0
Humustim -1 l.ha^{-1}	79.0	80.2	78.6	79.3	100.3
Humustim-1.5 l.ha^{-1}	79.1	80.3	79.1	79.5	100.6
Biohumax -1 l.ha^{-1}	79.1	79.7	78.5	79.1	100.1
Biohumax-1.5 l.ha^{-1}	79.2	79.4	78.3	79.0	100.0
Average	79.1	79.9	78.5	79.2	-
LSD 0.05	0.84	0.97	1.07	0.92	

Average for the period, the 1000 kernel weight value was high - 51 to 63 g (Table 7). The values were highest in 2009 – 61 to 63.4 g. The meteorological conditions strongly influenced the 1000 kernel weight. Without fertilization the grain was formed in average weight of 56.2 g. The double foliar fertilization with Humustim in dose 1.5 l/h increased the 1000 kernel weight the most. The total vitreousness in organic production meant that the period was low - 53.7%, varying from 44.2 to 58.6%. An exceptionally low vitreousness was formed in 2010 – average of 48.5 % (44.2-54.0 %), when during the maturity stage the weather conditions were mainly dry, with temperatures higher than average. Positive changes were found in all the years in the period, regardless whether they are wet or dry. The bio-fertilization with 1.0 and 1.5 l.ha^{-1} increased the vitreousness respectively with 5.1-6.2 and 11.1-13.4% compared to the unfertilized. The protein and gluten content are important indexes for the grain quality intended for pasta products. The genetic potential of the Progress varieties is good, enough for the Bulgarian and international standarts. Average for the period the protein content, wet and dry gluten for the grain of check were respectively 12.6 %, 25.4% and 9.6 % (Table 8). There has been a trend towards lower protein content in cereal grains produced organically. The fertilization with liquid bio-fertilizers was an additional factor for stabilizing the technological properties of durum wheat grain. The content of crude protein increased with 7.7-11.2% at biofertilization, the wet gluten – to 5.9 %, and dry gluten – from 6.2 to 9.4 % over the check.

Table 7. Influence of bio-fertilizers on the 1000 kernel weight and vitreousness of durum wheat grain, 2008-2010

Variant	1000 kernel weight, g					Vitreousness, %				
	2008	2009	2010	Average		2008	2009	2010	Average	
				g	%				%	to C
Water check - C	56	61	51	56.2	100.0	53.2	53.0	44.2	50.1	100.0
Humustim -1 l/ha	57	62	52	57.1	101.5	56.2	55.6	46.2	52.7	105.1
Humustim-1.5 l/h	57	63	54	57.8	102.8	57.4	57.2	52.4	55.7	111.1
Biohumax -1 l/ha	56	61	53	56.7	100.9	57.5	56.6	45.5	53.2	106.2
Biohumax-1.5 l/h	57	61	54	57.3	102.0	57.8	58.6	54.0	56.8	113.4
Average	57	62	53	57.0	-	56.4	56.2	48.5	53.7	-
LSD 0.05; 0.01; 0.001 = 1.12; 1.48; 1.90						LSD 0.05; 0.01; 0.001 = 7.1; 9.7; 12.7				

Table 8. Technological properties of durum wheat grain, average for 2008-2010

Treatment	Crude protein		Gluten	
	%	% to check	Wet, %	Dry, %
Water check – C	12.62	100.0	25.4	9.6
Humustim -1 l/ha	13.64	108.1	26.4	10.3
Humustim-1.5 l/h	13.97	110.7	26.9	10.5
Biohumax -1 l/ha	13.59	107.7	26.2	10.2
Biohumax-1.5 l/h	14.04	111.2	26.8	10.5
Average	13.57	-	26.34	10.22
LSD 0.05	1.12	8.87	4.07	1.26
LSD 0.01	1.54	12.20	5.37	1.51
LSD 0.001	2.14	16.96	6.90	1.99

The increase of protein in the grain follows the application of increasing dozes of fertilizers. The application of 1.5 $l.ha^{-1}$ had a better positive effect on the protein and gluten content. As for the extensibility of gluten no differences were established under the influence of year conditions, type of fertilizer and level of fertilization.

The study confirms that fertilization is a factor that is crucial to the nitrogen content of the wheat plants. The average N concentration in the tillering stage was 2.63 %, in the stage of stem elongation – 2.34 %, while in flowering was reduced to 1.56 %, i.e. with the advance of vegetation, the percentage of N was reduced (Table 9). All levels of the nitrogen content in plants grew at increasing the fertilization.

Table 9. N, P_2O_5 and K_2O concentration in durum wheat plants, 2010

Dose /Stage	$N_0P_0K_0$	1.0 $l.ha^{-1}$	1.5 $l.ha^{-1}$	Average %
N, %				
Tillering	2.46	2.64	2.80	2.63
Stem elongation	2.16	2.35	2.52	2.34
Flowering	1.49	1.55	1.64	1.56
P_2O_5, %				
Tillering	0.38	0.40	0.39	0.39
Stem elongation	0.40	0.36	0.38	0.38
Flowering	0.40	0.38	0.36	0.38
K_2O, %				
Tillering	4.35	4.78	5.14	4.76
Stem elongation	3.41	4.21	4.24	3.95
Flowering	2.01	2.26	2.29	2.19

The influence of fertilization was manifested most in the tillering stage. The phosphorus concentration in wheat plants was lower than that of N and K. The P_2O_5 content insignificantly decreased with the development advancing - an average of 0.39 % during the tillering to 0.38% in stem elongation and flowering. Potassium concentration decreased with increasing vegetation – 4.76 % to 2.19 % at tillering to flowering. By increasing the nutrition rate, the K_2O content increased.

Conclusions

The results showed that the bioproducts affected the durum wheat growth, productivity and grain quality. The grain yield surpassed the unfertilized with 8.6-14.1 % and reached 3.43 $t.ha^{-1}$ at twofold spring foliar feeding in rate 1.5 $l.ha^{-1}$. No significant differences in the efficiency of the two products were seen and their action was one-sided. The grain yield was mostly influenced to the highest extent by the yearly conditions and by the applied rates, while the fertilizer type made an insignificant influence. The plant height increased with 11.5 to 18.5 %, content of protein – with 2.4-4.7 %, wet gluten – to 1.2 %. The experiment demonstrated that organic farming can produce high quality grain of durum wheat. From ecological point of view outcast the synthetic fertilizers, may be successfully applied feeding with organic fertilizers during vegetation of the durum wheat, whereat the productivity increases and the production economical indexes do not get worse.

Aknowledgement

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ЕФЕКТ НА БИОПРОДУКТИ КАЈ ТВРДА ПЧЕНИЦА (TRITICUM DURUM *DESF.*) ВО УСЛОВИ НА ОРГАНСКО ПРОИЗВОДСТВО ВО ЈУЖНА БУГАРИЈА

Галија Панајотова, Виолета Божанова, Светла Костадинова, Нели Валкова

Апстракт

Целта на ова истражување беше да се утврди ефикасноста на биопродуктите Biohumax и Humustim врз развојот, приносот и квалитетот на бугарската сорта тврда пченица Progress, органски одгледувана на сертифицираното поле, при Институтот за поледелски култури, Чирпан, Бугарија, на почвен тип промиена смолница, во периодот 2008-2010 година. Влијанието на биопродуктите во дози од 1 и 1,5 $l.ha^{-1}$ беше тестирано со пролетна фолијарна апликација. При тоа, беа определени: приносот (kg), апсолутната маса (g), стаклавоста на зрното (%), суровите протеини и глутенот (%) и концентрациите на N, P, K кај ожнеаното жито. Резултатите покажаа дека биопродуктите влијаеле на порастот, продуктивноста и квалитетот на житото кај тврдата пченица. Приносот на жито изненади кај неѓубрената варијанта за 8,6-14,1% и достигна 3,43 $t.ha^{-1}$ при двојното пролетно фолијарно ѓубрење со 1,5 $l.ha^{-1}$. Нема значајни разлики во ефикасноста на овие два производи, и нивното влијание е еднострано. Приносот на жито беше условен главно од влијанието на климатските услови и применетите апликации, додека типот на ѓубриво немаше значајно влијание. Височината на растенијата се зголеми од 11,5% на 18,5%, содржина на протеини со 2,4%-4,7%, влажниот глутен до 1,2%. Експериментот покажа дека органското земјоделство може да даде високо квалитетни зрна тврда пченица.

Клучни зборови: органско земјоделство, тврда пченица, биоѓубрива.

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Orginal scientific paper

THE EFFECTS OF POTASSIUM AND ZINC APPLICATION TO RATE OF PHOTOSYNTHESIS, FIBER YIELD AND QUALITY ON COTTON

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Abstract
Optimal quantities of mineral nutrients and using balanced macro and micro nutrient to growing crops plays important to improve yields and quality. Potassium and zinc involved in key many metabolic processes and enzyme activities in plants. The efficiency of such type of elements is improved when it is used in combination with other macro and micro elements. In this study was conducted to determine the effects of different potassium and zinc application to fiber yield and quality of Berke cotton varieties in experimental area of Dicle University Faculty of Agriculture in 2010. Photosynthesis rate, number of sympodial branches fiber properties of fiber length, fiber fineness and fiber strength were investigated. According to the results, for all traits studied doses of potassium × zinc application and interaction were significant. Effects of potassium and zinc applications were determined significant to properties of photosynthesis rate, number of sympodial branches, boll number, fiber length, fiber fineness, fiber strength.
Key words: cotton, potassium, zinc, yield, quality.

Introduction
Cotton maintains its place and importance in spite of synthetic fiber as a, raw materials used by the textile industry. Currently, 60% of the raw material used in the weaving technology was provided by cotton. As an industrial crop, cotton has been used by textile industry for its fibers; oil industry feed industry for its seeds. Cotton is also used by a wide range of industry for chemical, oil and artificial textile (Usta, 2003; Lukonge *et al.*, 2005; Zengin 2010).
To increase crop production, together with other measures, balanced and adequate amounts of nutrients are very important.
Supplying optimal quantities of mineral nutrients and using balanced macro- and micronutrient doses to growing crop plants is one way to improve crop yields (Zubillaga *et al.* 2002).
Potassium has a vital role in the plants in terms of plant metabolic, physiological and biochemical functions. Quantity and quality of the product increase as a result of the effect of these functions in plants. Potassium has also important role in terms of plant water relations and turgor pressure which is required for cell expansion, growth of new tissues, photosynthesis, water balance, carbohydrate and sugars needed quantity of transport, and plant metabolic enzymes (Rogalski, 1994; Narang *et al.*, 1997; Sangakkara *et al.* 2000; Coker *et. al.*, 2003).

Among the macro-nutrients, potassium nutrition program is known to be a key element in terms of high-efficiency and high-quality cotton production (Kaçar, 2004).

Potassium is involved in providing the turgor pressure for the fiber cells. During active fiber growth, deficiency of potash (K) resulted in reduction in the turgor pressure of the fiber resulting in less cell elongation and shorter fibers at maturity (Oosterhuis, 1994).

Between trace elements, zinc has an important role in terms of auxin content (growth hormone) that contains the functional parts of enzymes, carbohydrate metabolism, protein synthesis, and stem growth too (Oosterhuis *et al.* 1991; Rajput *et al*., 1995; Kaya *et al.*, 2005; Marschner, 1995).

Zinc is sufficient, although at very low doses, deficiency of this element can lead to significant problems. (Rajput *et al*., 1995; Çakmak, 1994; Kaya *et al*., 2005).

Zinc deficiency appears especially in dry and hot conditions, high level of pH, lime and clay content and lower organic matter and in case of excessive phosphorus application (Cakmak, 1994; Marschner, 1995). Zinc deficiency symptoms include, i.e. small leaves, shortened internodes giving the plant a stunted appearance, reduced boll set and small boll size (Oosterhuis *et al.* 1991). The most obvious view of zinc deficiency in plants is dwarf growth (Oren and Basal, 2006).

This study was carried out to determine the effects of different amount of potassium and zinc applications to the rate of photosynthesis, yield and fiber quality of the cotton plant cultivated in large areas in our country and aimed to help this kind of studies in the future.

Material and methods

The research was carried out at research areas of Faculty of Agriculture at Dicle University in 2010. The experiment was conducted as a randomized complete block design with factorial treatment structure with three replications. Berke cotton variety was used as material. Parcels were composed of rows in 12 m length. Row spacing was 70 x15 cm. Plots were consisted of 4 rows and during harvesting; two out of four rows in the middle were sampled. Fertilizer was applied as 7 kg pure N and 7 kg pure P, and 7 kg pure N with the first irrigation for per decare. Due to its clay content (49-67%), soil enlarges and swells in the winter, and shrinks in the summer with deep cracks. Soil pH was between 7.73-7.86. Hoeing was accomplished 3 times by tractor, 2 times by hand. During the research, irrigations were done 8 times, and the bolls were harvested in two different dates with hand. Soil samples were taken from different points of the field at 0 cm-30 cm depth before planting and analyzed in the Soil Analysis Laboratory of GAP Soil and Water Resources and Agricultural Research Institute. Results of soil sample analysis were presented Table 1.

Table 1. Some physical and chemical properties of the soil taken from the of experimental area

Org Subst (%)	P_2O_5	K_2O	PH	Salt (%)	Water Saturat. (%)	Soil Depth (cm)	$CaCo_3$	Cu (mg/l)	Mn (mg/l)	Fe (mg/l)	Zn (mg/l)	Sand (%)	Clay (mg/l)	Silt (%)	Soil Structure
1.45	1.83	105.8	7.49	0.045	79	0-30	10.2	1.31	13.71	7.50	0.34	14.8	66.48	18.72	Clay

GAP Soil and Water Resources and Agricultural Research Institute / Şanlıurfa

The province of Diyarbakir has Southeastern Anatolian steppe climate. The average annual rainfall is 490 mm falling 18% in autumn, 44% in winter, 37% in spring and 1% in summer months. Most of the rainfall obtained in the winter and the spring. The annual average temperature is 15.8 ^{o}C, the driest and hottest months are July and August. The meteorological data of the experimental site during the study period is presented in Figures 1, 2 and 3.

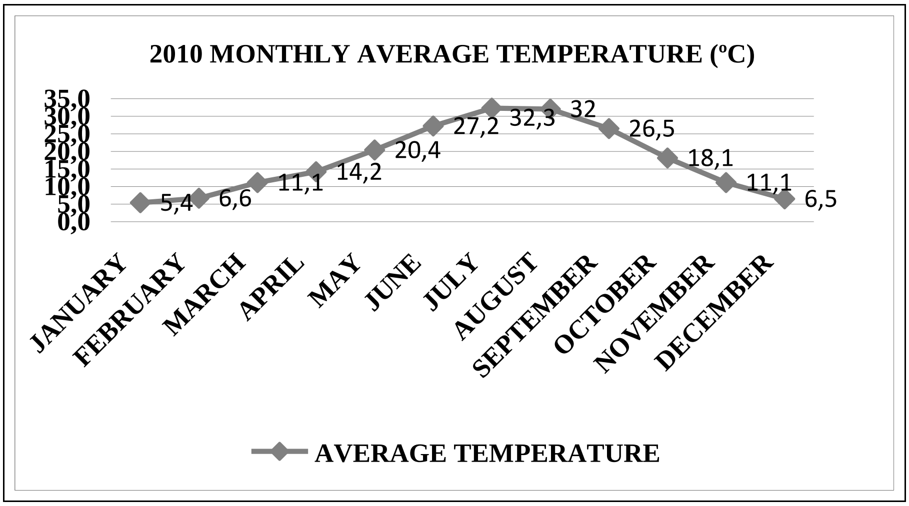

Figure 1. The monthly average temperature (°C) in the province of Diyarbakir in 2010

As seen Figure 1. in 2010, monthly average air temperature in the province of Diyarbakir 5.4ºC - 32.3ºC throughout the growing period ranged from 11.1° C to 32.3° C. According to the mean values of the year 2010, the average monthly rainfall in the province of Diyarbakir was 0 mm-55.6 mm. Rainfalls during the experimental period, ranged from 0 mm-21.6 mm (Figure 2). Monthly average moisture ranged from 17.5% - 80.9% in the province of Diyarbakir in 2010 but during the cotton growing period, monthly average moisture varied between 41.1% and 49.3% (Figure 3).

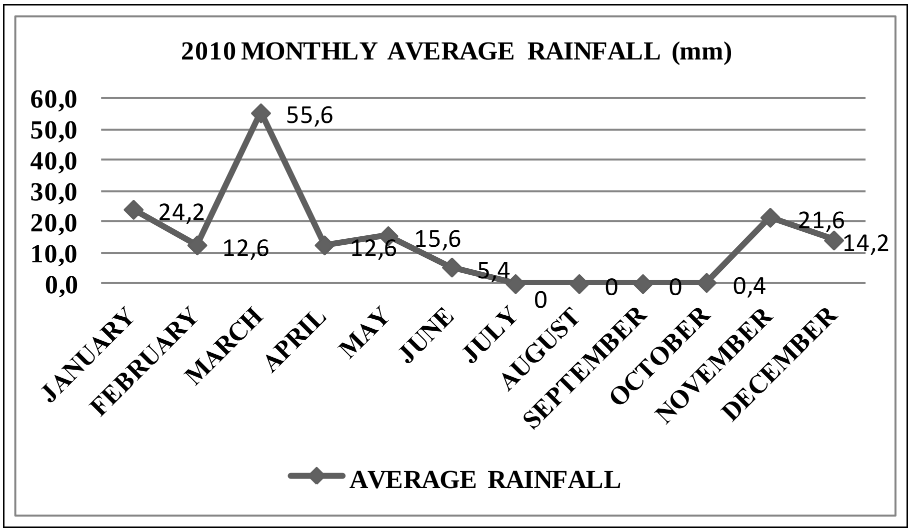

Figure 2. The monthly average rainfall (mm) in the province of Diyarbakir in 2010

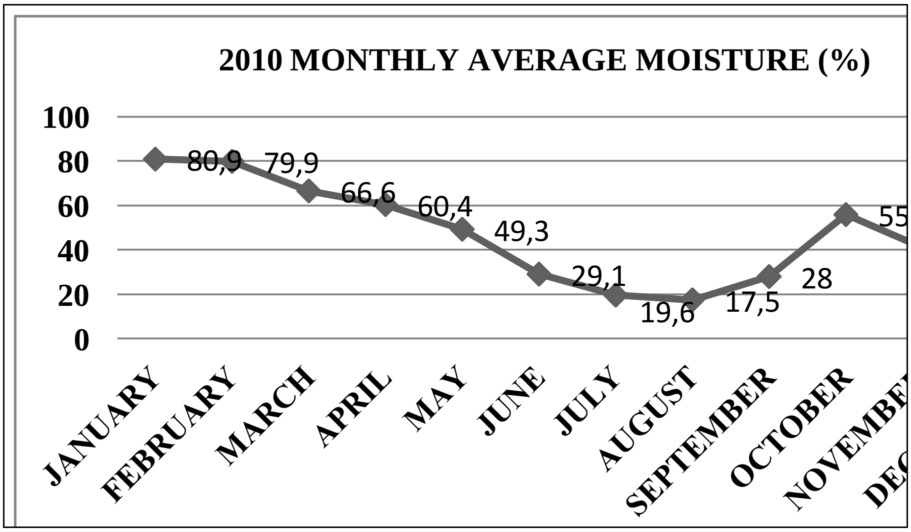

Figure 3. The monthly average amount of moisture (%)in the province of Diyarbakir in 2010

Applications of potassium doses were performed 2 times in the stages of blooming and top of flowering as 0 (without application); 300 g.da^{-1}; 500 g.da^{-1}; 700 g.da^{-1}. Zinc applications were also done 2 times, blooming and top of flowering as 0 (without application); 100 cc da^{-1}; 200 cc da^{-1}; 300 cc da^{-1}. Zinc and potash were applied to the plants as foliar spray in the form of EDTA chelated $ZnSO_4$ $7H_2O$ and K_2SO_4 respectively.

Parameters observed were photosynthesis rate (mg CO_2 cm^{-2} h^{-1}), number of sympodial branches (number plant^{-1}), number of bolls (number plant^{-1}) fiber length (mm), fiber fineness (mic.) and fiber strength (g tex^{-1}). Fiber properties were determined with the HVI 900 (High Volume lnstrument) device. Data obtained from research were evaluated with JMP 7.0 (Copyright © 2007, SAS Institute Inc.), statistical software package, averages (%) grouped according to LSD significance test.

Results and discussion

Interaction between potash and zinc was found significant in terms of all the investigated parameters. Applied doses of potassium and zinc, mean values of plant height, number of siypodial branches and number of bolls LSD groupings given in Table 2.

Photosynthesis rate varied between 37.00 (mgCO_2 cm^{-2} h^{-1}) and 48.33 (mg CO_2 cm^{-2} h^{-1}) by effect of applications and average photosynthesis rate was 42.24 (mgCO_2 cm^{-2} h^{-1}). The highest photosynthesis rate (48.33 mg CO_2 cm^{2} h^{-1}) was obtained from K500(g.da^{-1})+Zn200(cc.da^{-1}) dose while the lowest photosynthesis rate (37 mg Co_2 cm^{2} h^{-1}) was obtained from K0Zn0(control plot) and Zn.100(cc. da^{-1}) dose (Table 2). Findings in terms of photosynthesis rate similar those of Narang *et al.*, (1997); Sangakkara *et al.* (2000); Kacar, (2004) who reported that photosynthesis rate is affected potash and zinc application methods. Sympodial branches varied between 9.66 number. plant^{-1} and 15.00 by effect of applications and average number of sympodial branches was 11.71 number. plant^{-1}. The highest number of sympodial branches was obtained from K.500 (g. da^{-1})+Zn.300(cc. da^{-1}) dose while the lowest sympodial branches was obtained from Zn.200 (cc. da^{-1}) dose (Table 2). Findings are conformity with those of Oosterhuis *et al.* (1991); who reported zinc deficiency symptoms include, i.e. small leaves, shortened internodes, reduced boll set and small boll size.

Table 2. Average values of potassium and zinc applications of cotton plant and LSD groupings belong to photosynthesis rate, number of sympodial branches and number of bolls

Aplications	Photosynthesis Rate (mg CO_2 cm^{-2} h^{-1})		Aplications	Sympodial Branches (number $plant^{-1}$)		Aplications	Boll Number (number $plant^{-1}$)	
K500 Zn	48.33	A	K500 Zn300	15.00	A	K500	17.66	A
K300 Zn	47.00	AB	K500 Zn200	13.00	B	Zn 300	16.26	AB
K500	44.33	ABC	K500 Zn 100	13.00	B	K500	15.66	ABC
K700	44.33	ABC	K300	12.00	BC	K300 Zn	15.06	ABC
K500	43.66	BC	K700	12.00	BC	Zn200	15.00	ABCD
K700	43.66	BC	K300 Zn 200	12.00	BC	K700	15.00	ABCD
K500	43.33	BCD	K700 Zn 300	12.00	BC	K700	15.00	ABCD
K700	43.00	BCD	K500	12.00	BC	K500	14.83	BCD
K300	42.66	BCD	K700 Zn200	11.13	CD	Zn100	14.56	BCD
K 700	42.00	CD	K300 Zn 300	11.00	CD	K500	14.12	
K300	40.18	CDE	K700 Zn100	11.00	CD	K300	14.00	
K300	40.00	CDE	K300 Zn 100	11.00	CD	K700	13.83	
Zn200	40.00	CDE	Zn100	11.00	CD	K700	13.33	
Zn300	39.00	DE	K0 Zn0	10.88	CD	K300	12.30	
K0 Zn0	37.33	E	Zn300	10.66	CD	K0 Zn0	11.66	
Zn 100	37.00	E	Zn 200	9.66	D	K300	11.66	
Ortalama	42.24		1.71			14.37		
EGF $_{0.05}$	4.36		1.62			2.72		

Number of bolls varied between 11.66 and 17.66 number. $plant^{-1}$ by effect of applications and average number of bolls were 14.37 number. $plant^{-1}$. The highest number of bolls were obtained from K.500(g. da^{-1}) +Zn.300(cc. da^{-1}) dose while the lowest number was obtained from K.300 (g. da^{-1}) and K0 Zn0 dose (Table 2). These results are in the conformity with those of Knowles *et al.* (1999) who reported that zinc practices that increase the fruit of cotton similarly Haliloğlu *et al.* (2006), also reported that foliar spray of macro and micro nutrient increased the number of cotton bolls.

Dose applications of potassium and zinc, mean values of fiber length, fiber strength and fiber fineness and according to the test groups of EGF given in Table 3.

Fiber length varied between 25.03 mm and 27.98 mm by effect of applications and average fiber length was 26.86 mm. The highest fiber length was obtained from K500(g, da^{-1})+Zn300(cc da^{-1}) dose while the lowest fiber length was obtained from Zn100(cc da^{-1}) dose (Table 3). These findings are in the conformity with those of Oosterhuis 1994; Anac, 2010 who reported that zinc and potassium deficiency have reduced the quality of fiber. Fiber fineness varied between 3.69 mic and 5.54 mic. by effect of applications and average fiber fineness was 4.49 mic. The highest fiber fineness was obtained from K500(g, da^{-1})+Zn300(cc da^{-1}) dose while the lowest fiber fineness was obtained from K700(g da^{-1})+Zn,200(cc da^{-1}) dose (Table 3). Findings are similar with those of Sawan (2008)who reported that cotton productivity and quality due to the application of potash and zinc. Fiber strength varied between 26.03 g tex^{-1} and 31.30 g tex^{-1} by effect of applications and average fiber strength was 28.94 g, tex^{-1} The highest fiber strength was obtained from K700(g da^{-1})+Zn200(cc da^{-1}) dose while the lowest fiber fineness was obtained from K700(g da^{-1})+Zn100(cc da^{-1}) doses (Table 3). Results are conformity with those of Sawan (2008) who reported that potash and zinc applications play important role on cotton productivity and quality.

Table 3. Potassium and Zinc Applications of Cotton Plant Average Values and groups belong to fiber length, fiber strength and fiber fineness

Aplications	Fiber Length (mm)		Aplications	Fiber Strength (g tex^{-1})		Aplications	Fiber Fineness (mic)	
K500	27.98	A	K700 Zn200	31.30	A	K0 Zn0	5.54	A
K300Zn300	27.78	AB	K300 Zn300	31.19	AB	Zn100	5.42	AB
K300	27.65	ABC	K700 Zn300	30.76	ABC	K300	5.06	ABC
K500	27.46	ABCD	K500 Zn200	30.23	ABCD	Zn200	4.88	ABCD
K700	27.14	BCD	K500 Zn300	29.90	BCDE	K500	4.73	BCDE
K700	27.09	BCD	K700 Zn100	29.66	CDEF	Zn300	4.60	CDE
K700	27.03	CDE	K300 Zn200	29.60	CDEF	K700	4.43	CDEF
K500	27.01	CDE	K500 Zn100	29.24	DEFG	K300	4.43	CDEF
K300	26.88		K700	28.80	EFG	K500	4.42	
K700	26.82		K500	28.43		K300Zn100	4.42	
K500	26.81		Zn300	28.40		K700	4.27	
K300	26.38		K300 Zn100	27.96		K300	4.18	
Zn300	26.28		Zn200	27.36		K500Zn100	4.14	
Zn200	26.13		K0 Zn0	27.23		K700	3.88	
K0 Zn0	26.13		K300	26.93		K700	3.74	
Zn100	25.13		Zn100	26.03		K500	3.69	
Ortalama	26,86			28,94			4,49	
EGF $_{0,05}$	0,70			1,39			0,70	

Conclusions

This study was carried out to determine the effect of different amount of potassium and zinc applications the increased K and Zn doses led to more photosynthetic capacity and more yield and quality per plant. K500g da^{-1} Zn300cc da^{-1} dose was higer than the other aplications in terms of photosynthesis rate, sympodial branches, number of bolls, fiber length, fiber fineness. Applicatin of Zn and K together gave better results in terms of yield and quality properties.

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ЕФЕКТИ ОД ПРИМЕНАТА НА КАЛИУМ И ЦИНК ВРЗ СТЕПЕНОТ НА ФОТОСИНТЕЗА ВРЗ КВАЛИТЕТОТ НА ВЛАКНОТО И ПРИНОСОТ НА ПАМУК

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Апстракт

Оптималното количество на минерални материи и избалансирано користење на хранливи макро и микро елементи за одгледување на културата, игра важна за подобрување на приносот и квалитот. Калиумот и цинкот учествуваат во многу важни метаболички процеси и ензиматски активности во растенијата. Ефикасноста на таков тип на елементи е подобрена кога се користи во комбинација со други макро и микро елементи. Ова истражување беше спроведено за да се утврдат ефектите од апликација на различни дози калиум и цинк врз приносот и квалитетот на влакното кај Berke - сорти на памук во експерименталното поле на Дикле универзитетот на Земјоделскиот факултет, во 2010 година. Беа испитани степенот на фотосинтеза, бројот на симоподијални гранки и својствата на влакната по должина, финост и јачина на влакното. Резултатите од испитуваните дози на апликација на калиум × цинк и интеракција, покажаа значајни разлики во однос на сите карактеристики. Беа утврдени значајни ефекти од апликацијата на калиум и цинк за: степенот на фотосинтеза, бројот на симоподијални гранки, бројот на чушки, својство на влакната по должина, финост и јачина на влакното.

Клучни зборови: памук, калиум, цинк, принос, квалитет.

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YIELD AND TECHNOLOGICAL QUALITY IN SOME MACEDONIAN WHEAT VARIETIES

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Abstract

Common wheat (*Triticum aestivum L.*) is one of the most important cereal food crops. Breeding for high yielding what varieties is curtail role but no less is importance of breeding high quality wheat varieties that is essential for bread making industry. Wheat quality is assessed on the basis of physical, chemical, rheological and baking tests. For this reason at cereals industry has been a long history of using descriptive empirical measurements of rheological properties to predict bread-making quality. In this paper, grain yield and technological quality of five wheat varieties (Radika, Milenka, Bistra, Treska and Altana) from the breeding program at Institute of Agriculture-Skopje, Macedonia, were examined in two years (2007/2008 and 2008/2009). Bistra has shown significantly the highest yield among wheat varieties over two years of study carried out. Altana has shown the highest protein content, sedimentation value, dough energy, extensograph extensibility and ratio (resistance/extensibility).According to technological quality among varieties, Altana has shown the best quality and belongs to A1-A2 quality class, following Treska and Milenka (A2-B1) and Radika and Bistra (B1).

Key words: wheat, variety, yield, technological quality.

Introduction

Wheat (*Triticum aestivum* L.) is an important cereal crop used as staple food in Macedonia. Wheat is grown in almost every part of the country. In the period 2006-2011, the average sown area with wheat was 49,4% out of the average sown area with cereals (176666 ha). The average wheat production in the same period was 262246 t, or in average 3048,7 kg/ha (Statistical yearbook of the Republic of Macedonia, 2012). It is a principal source of carbohydrates for human beings while its straw can be used as an integral part of livestock feed. Compared with other cereals, it provides food for human with more calories and proteins in the daily diet. In many common wheat varieties grain contains carbohydrates 60-80%, protein 8-15 %, fat 1.5-2.0%, inorganic ions 1.5-2.0% and vitamins such as B complex and E (Schellenberger, 1996). Despite to higher yield potential, average yield, of different varieties, in Macedonia is much less than the most countries of the world. To meet the increasing demand of food grains, it is desired to have higher yield per unit area. A number of factors including, time of sowing, land preparation, seed bed preparation, fertilizer application, weed management, and irrigation scheduling are responsible for the variation in yield of wheat, but all these factors are agronomic and greatly influenced by temperature, rainfall and humidity. The vital factor for harvesting suitable environment into grain yield is the genetic potential of the wheat variety. Its suitability and superiority in breadmaking with viscoelastic dough properties has been well known and documented (Branlard *et al*., 2011). The developments of high grain yield potential with good breadmaking quality and tolerance to biotic and/or abiotic stress factors and which respond to improved agricultural practices are the main achievements for bread wheat breeding programmes. It is known that the baking quality of wheat is under genetic as well as environmental control. It is genetically controlled but may vary widely depending upon the variety, climatic conditions, location, soil fertility, etc and the complex interactions between these factors. In general, high protein flours give rise to better results since they have a high loaf volume potential with higher water absorption. Genotype-by-environment (G x E) interactions and the negative correlation between grain yield and grain protein content of wheat had been established in different studies (Feil, 1997, Qury and Godin, 2007). If a genotype has a high stability and shows low interactions with the environment is desirable in plant breeding. Generally, wheat quality is defined by: physical properties (hectoliter weight, thousand kernels weight, grain hardness), protein-linked properties (total protein and gluten contents, gluten index, sedimentation volume, protein and amino-acid composition), rheological properties (farinograph test, alveograph value, extensograph test), enzymatic properties (hagberg falling number, amilograph test) and other properties (test backing, micotoxin content, residues of pesticides and insecticides). Nutrition value and bread-making quality in winter wheat depends on: starch from the endosperm, fats from the embryo and aleuronic layer, mineral substances in pericarp, vitamins in tegument and pericarp, and protein content (Bunta and Bucurean, 2011). The rheological properties of wheat-flour dough, among other parameters, include the extensibility and resistance to extension, which influence the processing behaviour very strongly, and are thus important factors of the wheat varieties' bread-making quality (Ma *et al*., 2005). The present study was, therefore, designed to determine the yield potential and quality of some Macedonian varieties namely, Radika, Milenka, Bistra, Treska and Altana.

Material and methods

Five Macedonian wheat varieties (Radika, Milenka, Bistra, Treska and Altana) were used to study yield and technological quality. The field experiment was carried out in Skopje in 2007/2008 and 2008/2009. The experiment was designed as a completely randomized block with three replicates. The plots consisted of 5 m^2, spaced at a distance of 12,5 cm. The harvested grain from three replicates was subjected to yield and quality analyses. Determination of hectolitre weight was determined by standard methods. Grain protein content was determined by Kjeldahl method (ICC standard method No.105, 2001). The preparation of test flour from wheat samples for sedimentation test was performed according to ICC standard method No.118 (ICC, 2001) and determination of Zeleny sedimentation value according to standard methods described in ICC (ICC standard method No.116, 2001). Determination of water absorption of flours, dough stability and quality number was performed by Brabender farinograph according to ICC standard method No.115 (ICC, 2001). Determination of rheological properties of wheat flour dough (energy, resistance and extensibility) was done by Brabender extensograph according to ICC standard method No.115 (ICC, 2001). Wheat yield and quality parameters are agronomic and greatly influenced by temperature, rainfall and humidity. The average temperature and total rainfall prevailing in Skopje region is given in Table 1.

SPSS software was used for statistical analysis. Mean values were tested by ANOVA, whereas differences among individual mean values were determined by Tukey test at significance level of 0,05.

Table 1. Weather data for Skopje region

Climatic parameters	Years	Months									
		X	XI	XII	I	II	III	IV	V	VI	
Average temperature (ºC)	2007/08	12,7	4,3	1,0	1,4	5,6	9,6	13,7	18,0	22,4	
	2008/09	14,2	8,5	5,0	1,0	3,3	7,1	13,4	18,0	21,0	
	1951-90	12,4	5,9	1,3	0,0	3,1	7,5	12,2	17,2	20,6	
											Sum
Total rainfall (mm)	2007/08	140,0	69,4	14,6	7,7	0,5	29,8	18,7	40,7	46,9	368,3
	2008/09	27,3	37,5	68,3	72,8	12,2	68,6	65,3	70,2	104,3	526,5
	1951-90	41,0	51,0	50,0	36,0	36,0	37,0	40,0	61,0	48,0	400,0

Results and discussion

Wheat grain yield is influenced by genotype, environment, planting date, crop rotation, seeding rate, fertilization, biotic-abiotic stresses, etc and their interactions. Year-to year variations in climate gave rise to considerable variations in grain yield in the study. The distribution of rainfall over wheat growing seasons is of great importance. And also daily high temperatures and water stress in spring time shorten the grain filling period, resulting in earlier maturity of the grain, which result in lower grain yield with higher protein content. Grain yield is a polygenic trait and is a product of expressions of many genes (number of tillers/plant, 1000-grain weight, spike length, numbers of grains per spike and spikelet etc.). Several research studies have been carried out on relationship of various yield component and also climatic factors with grain yield and its related traits (Kneževic *et al*., 2008, Yousaf *et al*., 2008). There is large gap between yield potential of our modern wheat varieties and yield production which indicated that crop yield can be improved through better crop husbandry.

From the results in this study over two years the average grain yield was 6,11 t/ha (Table 2). The average grain yield in 2009 (6,40 t/ha) was 10% higher compared to 2008 (5,82 t/ha) due to the total rainfall and distribution of rainfall (Table 1). In 2008 variety Bistra had significantly higher yield (6,30 t/ha) among varieties used in this study, except to variety Treska (6,10 t/ha) where significant differences were not found. In 2009, also Bistra (7,20 t/ha) has shown the highest grain yield significantly higher compared to other varieties. In both sessions the highest average grain yield was obtained from Bistra (6,75 t/ha).

Table 2. Grain yield of the varieties investigated over two years

	Year	Varieties					Average
		Radika	Milenka	Bistra	Treska	Altana	
Grain yield (t/ha)	2008	5,40 a	5,70 abc	6,30 c	6,10 bc	5,58 ab	5,82
	2009	6,40 b	6,50 b	7,20 c	5,70 a	6,20 ab	6,40
	Average	5,90 a	6,10 a	6,75 b	5,90 a	5,89 a	6,11

Note:Values with the same letter in one row are not significantly different from each other

Hectolitre mass or test weight, usually expressed as kilograms per hectolitre (kg hl^{-1}), is a measure of volume grain per unit and it is an important wheat grading factor (Donelson *et al*., 2002). Well-filled, plump kernels result in higher hectolitre mass, because they pack more uniformly compared to small, longer kernels which exhibit lower hectolitre mass because they pack more randomly.

Although some cultivars might have the ability to always have higher hectolitre mass than others grown under similar conditions, hectolitre mass is affected by growing conditions as well as genetic factors (Bordes *et al*., 2008). A hectolitre mass of 74.00 kg hl^{-1} is required for bread making purposes (Nel *et al*., 1998), but Koekemoer (2003) reported a hectolitre mass of 76.00 kg hl^{-1} and higher to be preferable. Posner and Hibbs (1997) stated that hectolitre mass can be an indication of expected flour yield to millers.

The hectoliter mass was in the range of 73,0 kg hl^{-1} to 80,3 kg hl^{-1} in wheat varieties over two years of experiment. In average, the hectoliter mass had higher value among wheat varieties in 2009 (78,9 kg hl^{-1}) compared to 2008 (75,7 kg hl^{-1}). Altana had shown significantly the highest hectoliter mass among varieties used in this study in 2008 (79,3 kg hl^{-1}). Although Altana (80,3 kg hl^{-1}) had a highest hectoliter mass in 2009, the differences were not significant to Milenka (79.4 kg hl^{-1}) and Treska (80,1 kg hl^{-1}), except for Radika (76,5 kg hl^{-1}) and Bistra (78,4 kg hl^{-1}).

Protein content (quantity) as well as protein quality (composition) determines wheat flour quality. Stable flour composition and quality are desired traits in wheat quality despite the environmental influence (DuPont *et al*., 2007). According to their solubility, four protein-types, namely albumins, globulins, prolamins and glutelins were originally classified by Osborne (1907). Gluten, the storage protein in wheat, mainly located in the endosperm and known for having an influence on functional properties of wheat as determined on a mixograph, farinograph, alveograph, SDS-sedimentation volumes and loaf volumes (Finney *et al*., 1987, Branlard *et al*., 2001; Rakszegi *et al*., 2005) can vary within and between genotypes regarding their proportions, structures and properties. Protein content is strongly affected by environment and less affected by genotype. Depending on environmental conditions, wheat grain protein content can vary between 6% and 25% as affected by nitrogen availability. Total protein content as well as the amount of each different protein is mainly determined by genotype.

Flour protein content between wheat varieties was between 12,7% to 15,5% over two sessions of study. The average protein content among varieties in 2008 and 2009 was 14,1%.

The flour protein content was significantly higher in Altana in both sessions (15,1 % and 15,5%, respectively). While in 2008 no significant differences were found among Radika, Milenka Bistra and Treska, in 2009 there were significant differences among these varieties. The lowest protein content was obtained in Radika (12,7%) in 2009.

The obtained results for grain yield and protein content confirm the negative correlation with grain yield and protein content. The high yielding variety Bistra was among lowest wheat varieties containing 13,9% protein content in 2008 and had a moderate protein content (13,5%) among varieties in 2009.

Sedimentation test is a good indicator of end-use quality, especially where wheat contains a low to medium protein content. SDS-sedimentation volume is effective in differentiating between different wheat quality-types. In addition, the sedimentation volume is independent of whether whole meal or white flour is used, but a disadvantage is the ineffectiveness of this test to distinguish between medium to strong quality flour samples when protein content is higher than 13% (Carter *et al*., 1999). Higher SDS-sedimentation volumes usually indicate stronger gluten and better quality (Eckert *et al*., 1993, Carter *et al*., 1999). Fowler and De la Roche reported (1975) that SDS-sedimentation volume reflects protein quantity and dough development time, both being important basic quality characteristics. Wheat breeding programmes utilise this test to get an indication of differences in protein content as well as gluten quality, where both these characteristics are of great importance regarding end-use quality.

Table 3. Quality characteristics of the varieties investigated over two years

Quality parameters	Year	Varieties					
		Radika	Milenka	Bistra	Treska	Altana	Average
HLM (kg hl^{-1})	2008	73,0 a	74,3 a	75,8 b	76,3 b	79,3 c	75,7
	2009	76,5 a	79,4 bc	78,4 b	80,1 c	80,3 c	78,9
FPC (%)	2008	14,0 a	13,8 a	13,9 a	13,9 a	15,1 b	14,1
	2009	12,7 a	14,4 c	13,5 b	14,4 c	15,5 d	14,1
S (mL)	2008	32,0 a	42,0 c	32,0 a	37,0 b	53,0 d	39,2
	2009	34,0 a	46,0 c	38,0 b	46,0 c	64,0 d	45,6
FARINOGRAPH							
FABS (%)	2008	57,0 c	58,0 d	56,0 b	53,0 a	58,0 d	56,4
	2009	62,0 b	62,0 b	63,0 c	63,0 c	61,0 a	62,2
DS (min)	2008	1,0 a	3,0 d	1,5 b	2,5 c	4,0 e	2,4
	2009	2,5 a	6,5 d	3,5 b	5,0 c	6,5 d	4,8
QN	2008	55,2 a	67,8 c	55,6 a	66,7 b	83,5 d	65,8
	2009	71,0 a	75,6 c	74,5 b	76,5 d	88,5 e	77,2
Quality level		B1	A2/B1	B1	A2/B1	A1/A2	
EXTENSIOGRAPH							
En (cm^2)	2008	37,0 a	77,0 c	40,0 b	78,0 d	85,0 e	63,4
	2009	44,0 b	86,0 d	43,0 a	82,0 c	102,0 e	71,4
R (BU)	2008	230,0 a	310,0 e	270,0 b	290,0 d	280,0 c	276,0
	2009	260,0 c	290,0 d	240,0 a	250,0 b	340,0 e	276,0
Ex (mm)	2008	150,0 b	157,0 d	125,0 a	155,0 c	157,0 d	148,8
	2009	150,0 a	160,0 c	155,0 b	170,0 d	180,0 e	163,0
Ratio (R/Ex)	2008	1,73 c	1,81 d	1,55 b	1,47 a	1,90 e	1,7
	2009	1,53 a	1,97 d	2,16 e	1,87 c	1,78 b	1,9

HLM=Hectolitre mass, FPC=flour protein content, S=Sedimentation value, FABS=Farinograph water absorption,
DS=Dough stability, QN=Quality number, En=Energy, R=Resistance (BU=Brabender Units), Ex=Extensibility
* Values with the same letter in one row are not significantly different from each other.

Results obtained from the sedimentation test had significant differences among varieties in both sessions. The sedimenatation value of the varieties had a range of 32,0 mL to 64,0 mL. The sedimentation value was highest in Altana and significant to other varieties used in this study in both years (53,0 mL and 64 mL, respectively). The lowest sedimentation value was Obtained in Radika in both sessions (32,0 mL and 34,0 mL, respectively).
Farinograph dough stability time is important index for classifying wheat, and it often indicates the most appropriate end use for the wheat cultivars (Tian *et al*., 2007). Water-absorption gives an indication of the potential of the protein molecules to absorb the added water, and therefore is an indicator of baking quality (MacRitchie, 1984). Van Lill and Smith (1997) reported that grain with higher protein content tended to be harder and give higher ash-content flour, which then results in higher water-absorption.

Stability is an indication of the flour tolerance to mixing and stronger flour tends to be more stable (Miralbés, 2004). Miralbés (2004) also reported a linear relationship between stability and protein content. There is positive correlation between the globulin protein fraction and dough development time. Gliadin and glutenin are significantly correlated with flour protein content, dough development time, stability, and water-absorption as well as loaf volume. There exist several rheological tests to evaluate dough characteristics during mixing and fermentation processes. Among them, water absorption capacity of the flour is important to obtain acceptable dough consistency during the mixing time. In general, waterabsorption increases as protein content increases, although water-absorption is a function of protein quantity and protein quality (Finney *et al*., 1987). Zounis and Quail (1997) reported significant correlations between farinograph water-absorption (FABS) and mixogram peak height as well as between FABS and maximum mixograph bandwidth.

Comparison of some rheological parameters of examined wheat varieties is presented in Table 3. According to the presented values, farinograph water absorption was significant among varieties in both years of study. In 2008, Milenka (58,0%) and Altana (58,0%) were with slightly significant differences in comparison with Radika (57,0%), Bistra (56,0%) and Treska (53,0%). In 2009, Bistra (63,0%) and Treska (63,0%) have the the highest water absorption capacity. Dough stability time was highest in Altana in both years (4,0 min and 6,5 min, respectively). Treska has shown the same dough development time with Altana in 2009. From the values presented in Table 3, it is remarkable that the average value for dough stability in 2009 (4,8 min) was two times higher in comparison to 2008 (2,4 min). According to farinograf results the highest quality class has Altana (A1/A2), following Treska and Milenka (A2/B1) and Radika and Bistra (B1). The extensograph determines the resistance and extensibility of a dough by measuring the force required to stretch the dough with a hook until it breaks. Extensograph results include resistance to extension, extensibility, and area under the curve. Resistance to extension is a measure of dough strength. A higher resistance to extension requires more force to stretch the dough. Extensibility indicates the amount of elasticity in the dough and its ability to stretch without breaking. Extensograph is employed to predict the dough characteristics during the fermentation process. Flours with high protein contents and high gluten strength result in doughs with a nearly perfect gluten matrix. The breads made of such doughs could benefit from near to perfect texture and bread volume (Bloksma and Bushuk, 1988). Therefore, accurate prediction of dough rheology could provide many benefits to the baking industry for satisfying consumer demands.

The results from extensograph evaluation showed that the high protein content variety Altana (85 cm^2 and 102 cm^2) possessed highest dough energy, significant among varieties in both years (Table 3). The extensogrph resistance and extensibility were significantly different among varieties in both years. Treska (290,0) owned significantly higher dough resistance in 2008, but not in the 2009 (250,0), having with Bistra (240,0) the lowest dough resistance. Dough extensibility was significantly higher in Altana (157,0 mm and 180,0 mm) in two years of study, except to Milenka (157,0 mm) in 2008 where no significant difference was found.

Conclusions

Presented two-year trial showed that differential results were obtained for grain yield and quality of the bread wheat varieties evaluated. It can be concluded that wheat variety Bistra performed significant high grain yield over two years of study carried out. Obtained results for grain yield demonstrate strong influence from the environment and climate conditions showing increased grain yield of 10% in 2009 due to the total rainfall and distribution of rainfall.

Since there are, generally, negative correlations between yield and protein content in wheat, the typical negative correlations between grain yield and protein content was found in this experiment in high yielding variety Bistra. Beside high yield obtained, variety Bistra is ranked among varieties with lowest to moderate protein content.

Sedimentation values of flour above 36 mL are characterized as very good and also there is positive correlation between sedimentation value and baking. The sedimentation values of the varieties had a range of 32,0 – 64,0 mL which was included in very good category, except variety Radika (32,0 mL and 34,0 mL) owning low sedimentation value in both sessions. Wheat variety Bistra (32,0 mL) although has sedimentation value under the range in 2008, but not in 2009 (38,0 mL) which is influenced from the climatic conditions.

The high flour protein content variety Altana, also possessed high hectoliter mass, sedimentation value, water absorption capacity, dough stability time, dough energy, dough resistance and dough extensibility, that in general are positively correlated parameters with high protein content and mainly with protein structure. Most rheological properties obtained from farinograph curves in accordance to extensograph dough properties were also affected by climatic conditions. In accordance to farinograph and extensograph parameters Altana is wheat variety with good technological properties having quality level A1/A2 depending of the year of study. It can be concluded that wheat grain yield and technological quality are strongly influenced by the environment and climatic condition. It may be concluded that wheat variety Bistra is high yielding variety and Altana is variety whit good quality (A1/A2 quality level) preferable for bread-making industry.

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ПРИНОС И ТЕХНОЛОШКИ КВАЛИТЕТ КАЈ НЕКОИ МАКЕДОНСКИ СОРТИ МЕКА ПЧЕНИЦА

Маријана Спирковска, Љупчо Јанкуловски, Милисав Иваноски, Даниела Димовска

Апстракт
Пченицата (*Triticum aestivum L.*) претставува најважното лебно жито. Освен одгледување на високопродуктивни сорти, многу е значајно и одгледувањето на високо квалитетни сорти пченица, особено за потребите на пекарската индустрија и производството на леб. Квалитетот на пченицата се оценува врз основа на физички, хемиски и тестови за технолошкиот квалитет. Преку емпириски испитувања од ваков вид, се овозможува предвидување на квалитетот на лебот. За да се следи стабилноста на квалитетот на некои сорти пченица, испитуван е технолошкиот квалитет на пчениците од производните 2007/08 и 2008/09 год. кај сортите *Миленка, Радика,Бистра,Треска и Алтана*, селекции на Земјоделски институт, Скопје.Сортата *Бистра* покажа статистички највисок принос на семе во однос на останатите сорти, текот на двегодишното истражување.Сортата *Алтана* се одликува со највисока содржина на протеини, седиментациона вредност, енергија на тестото, отпорност на растегливост и растегливост. Според технолошкиот квалитет, сортата *Алтана* покажа највисок квалитет и припаѓа на А1-А2 класа на квалитет, потоа следат сортите *Треска и Миленка* (А2-Б1) и сортите *Радика и Бистра* (Б1).

Клучни зборови: пченица, сорта, принос, технолошкиот квалитет.

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Original scientific paper

THE INFLUENCE OF MINERAL NUTRITION ON THE GRAIN HARVEST INDEX OF THE WINTER WHEAT

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Abstract
Examinations were held at stationary field experiment with fertilizing during period of three years (2004/2005, 2005/2006 and 2006/2007) the property of Center for small grains in Kragujevac.The experimental examinations, beside control, included six fertilizing variants: 1) N_0 P_0 K_0; 2) $N_{80,\ 120}$ P_0 K_0; 3) $N_{80,\ 120}$ P_{60} K_{60}; 4) $N_{80,\ 120}$ P_{100} K_{60}; 5) $N_{80,\ 120}$ P_{60} K_0; 6) $N_{80,\ 120}$ P_{100} K_0; 7) $N_{80,\ 120}$ P_0 K_{60}. During experiment individual fertilizings were implemented as follows: KAN (as nitrogen fertilizing), superphosphate (as phosphate fertilizing) and 60% of potassium salts (as potassium fertilizing). In the experiment were included seven cultivars of winter wheat: Takovčanka, Ana Morava, KG 100, Lazarica, KG 56S, KG 4 and KG 5. The aim of this work was to examine the effect of various dosages and relation of mineral fertilizers on grain harvest index of different winter wheat cultivars. The usage of fertilization increased grain harvest index. The highest value of harvest index was reached by applying nitrogene phosphorus and only nitrogene (ferilizers). Depending on cultivars, the highest grain harvest index was obtained at cultivar Lazarica (46%), and the lowest at cultivar KG 4 (41%). The highest grain harvest index of winter wheat in period of triennial examination, obtained cultivar Lazarica (48%) at NP_2 variant of fertilizing, at higher nitrogene dosage.
Key words: wheat, fertilizing variants, grain harvest index, cultivars.

Introduction

From the aspect of achieving of high grain yield of desired technological quality, the most efficient, but at the same time the most expensive agrotechnical measure in production of small grains is fertilizing (Djokić et al., 1998). In the last decades of 20 th century, their excessive utilization in planting system of small grains became economic unjustified. Because of this, genotypes of small grains which are characterized by better absorbtion of nutrition, above all nitrogen from ground resources and applied fertilizers and their efficient exploitation in the plant for producing assimilats for pouring of grain and formation of yield and protein synthesis, the aim of modern selection and improvement of small grains.

Such a strategy demands implementation of new methods and parameters in sense of criteria, that is, active inclusing accomplishments from other sciences in the process of improvement of wheat, as the most important cultivar of small grains (Fisher, 1981; Baker et al., 2004; Flawers et. al., 2004).

Since the indexes of effectivness of wheat plant are in positive correlation to level and quality of grain yield, it is supossed that those physiological parameterscould be significant in obtaining desired results in wheat improvement (Djokić, 1996).

Harvest index of grain represents agronomucal part of biological yield, that is, it represents relation between agronomical (wheat grain yield and biological (grain yield and straw yield). Many authors recommend grain harvest index as the criteria in selection and improvement of wheat, for higher wheat yield (Sharma et al., 1987), because most investigations confirmed positive correlation between it's value and grain yield level.

Latest investigations demonstrate that the range of this parameter is 36-58%. Borojević (1983) states two methods for increasing grain yield by increasing grain harvest index above 50% with keeping biomass at the same level or with keeping value of grain harvest index at 50% with increasing biomass.

The aim of this word was to examine the effect various dosages and relation of mineral fertilizers on grain harvest index of different cultivars of winter wheat.

Material and methods

Examinations were performed at stationary field experiment with fertilizing that has been applied for many years (over 30), at the property of Center for small grains in Kragujevac. The experiments were performed in three years period (2004-2007). The experiment on which examinations have been performed includes also six variants of fertilizing: 1) N_0 P_0 K_0; 2) $N_{80,\ 120}$ P_0 K_0; 3) $N_{80,\ 120}$ P_{60} K_{60}; 4) $N_{80,\ 120}$ P_{100} K_{60}; 5) $N_{80,\ 120}$ P_{60} K_0; 6) $N_{80,\ 120}$ P_{100} K_0; 7) $N_{80,\ 120}$ P_0 K_{60}. Individual fertilizers were used: KAN as the nitrogen fertilizer, superphosphate as the phosphate fertilizer, and as the potassium fertilizer it was used 60% potassium salt. Besides mentioned variants of mineral nutrition, in experiment it was included also seven different cultivars of winter wheat from the region of Kragujevac:,Takovčanka, Ana Morava, KG 100, Lazarica, KG 56 S, KG 4 and KG 5. The area of the basic experimental parcels is 100 m^2 for fertilizing with phosphor and potassium, and for fertilizing with two dosages of nitrogen of 80 and 120 kg ha^{-1}, basic parcel was divided in two parts of 50 m^2 each.

The experiment was set up at random block system in 5 repetitions. It was used standard agrotechnics. Plant samples for for analysis were taken in the phase of full maturity. After drying to the stage of dry mass, it was depined the mass of overground part of the plant (g). Besides it was separately defined grain mass (g) and straw mass (g). Grain harvest index was determined as the relation of grain yield to total biomass.

About average monthly temperatures and quantity of precipitations during our examinations, we can conclude that the weather conditions differed in each experimental year, table 1. The most favorable weather condition were in the first vegetation period, 2004/2005, when the highest total quantity of precipitations was registered, with the most favorable disposition through months. Also the temperatures were optimal for planting the wheat, especially during the most important phases of its growth.Vegetation period in the years 2006/2007 was also favorable for winter wheat growing, while the most unfavorable weather conditions for growth of winter wheat were in second year of experiment.

Table 1. Temperature and water in the course of the vegetation (2004-2007)

Month	Temperature t° C				Water lm^{-1}			
	Year			Average	Year			Average
	2004/ 2005	2005/ 2006	2006/ 2007	perennial 1961/99	2004/ 2005	2005/ 2006	2006/ 2007	perennial 1961/99
September	16,2	17,4	17,7	16,7	31,0	57,4	115,6	50,5
Oktober	14,7	11,5	13,3	11,3	50,1	16,7	49,0	42,8
November	6,8	5,6	7,6	6,5	90,7	13,7	54,8	46,4
December	3,0	3,3	3,5	1,1	170,0	51,9	47,1	46,8
January	1,5	- 1,7	6,1	- 1,8	36,6	45,3	27,9	38,3
February	- 1,5	1,5	6,3	3,0	66,9	32,1	38,1	35,7
March	4,5	5,6	9,1	6,5	178,7	62,9	116,1	40,4
April	11,6	12,7	12,1	11,3	72,3	3,6	29,6	53,1
May	16,4	16,4	18,2	16,3	70,2	118,4	86,3	66,7
Jun	19,2	19,7	22,8	19,0	39,1	25,3	84,8	80,3
Juli	21,6	23,0	24,8	21,1	86,2	10,1	22,4	70,6
(IX - VII)	10,6	10,6	12,9	10,4	891,8	437,4	671,7	571,6

Results and discussion

Wheat requires more or less fertile ground of optimum physical characteristics.The experimental field is of type vertisol in the process of degradation. It has A-Bt-C type of profile. Upper part of A horizon is of grey color, and due to ongoing rinse process it is significantly impoverished of alkalis and humus. Reaction of the upper part of A horizon is in range of very high acidity to normal acidity with the level of saturation with alkalis less than 70%. In deeper levels of this terrain Bt horizon has been formed, and it is very rich with clay and more watertight. During periods in the year with more humidity, under it surface water collects and that causes forming of rusty deposits of Fe-hydroxide as well as small granules of orstajn.

Besides heavy mechanical composition and rough and unstable structure, this terrain has not favorable condition of porosity, what additionally worsens unfavorable physical characteristics of this parcel. With the purpose of determining fertility of the parcel, before the beginning of experiment, analysis of basics fertility parameters of samples were made, according to fertilizing variants table 2.

The ground of the experimental parcel has very strong acid reaction (pH in KCl < 4.5). The highest acidity exchanging potency of the terrain is with NP and NK variants of fertilizing, while the content of humus is average. Fertilized variants had average higher percentage of humus comparing control. The highest content of humus was found with NP_1K and NP fertilizing variants.

The total content of nitrogen was average (according to Wohtmann's classification), there with fertilizing variants had higher content of total nitrogen comparing control. The content of easily accessible nitrogen is low (2,20-9,83 mg/100g of sample of ground), while the content of easily accessible kailium is in the range of average to high (17,40-27,47 mg/100g of sample). Grain harvest index is genetic characteristic and it mostly changes depending to cultivar as well as under the influence of applied mineral nutrition.

Table 2. Facts of ground fertility at experimental field

Fertilizing variant	Profound (cm)	Humus (%)	pH		N overall (%)	P_2O	K_2O
			H_2O	KCl		mg/100g ground	
O		2.13	5.85	4.37	0.12	2.60	18.67
N		2.10	5.83	4.26	0.14	2.20	17.60
NP_1K	20	2.39	5.58	4.27	0.15	8.17	27.47
NP_2K		2.25	5.72	4.28	0.14	9.83	24.00
NP		2.34	5.63	4.15	0.15	9.00	17.40
NK		2.24	5.73	4.22	0.16	2.83	23.53
						9.02.83	23.53

Table 3. Grain harvest index % of examined wheat cultivars

Variant fertilizing	Dosage N	Cultivars								
		1.	2.	3.	4.	5.	6.	7.	Average	
O		41	42	43	45	41	41	43	42	42
N	N_1	42	46	43	45	42	38	43	43	44
	N_2	43	45	44	47	44	42	44	44	
NP_1K	N_1	42	40	45	45	41	40	41	42	42
	N_2	42	45	44	43	42	41	42	42	
NP_2K	N_1	42	44	43	43	41	40	40	42	43
	N_2	44	45	46	47	43	42	41	44	
NP_1	N_1	43	46	44	46	44	39	42	43	44
	N_2	43	45	45	46	43	46	43	44	
NP_2	N_1	43	43	44	45	41	39	45	43	44
	N_2	47	44	46	48	43	41	42	44	
NK	N_1	44	44	44	46	42	39	38	42	43
	N_2	44	45	45	46	44	40	43	44	
Average	N_1	42	43	44	45	42	39	42	42	
	N_2	43	44	45	46	43	42	43	44	43
Average	N_1 / N_2	43	44	45	46	43	41	43	43	

LSD	A	B	AB	C	AC	BC	ABC
0.05	1.188	1.188	3.143	0.635	1.680	1.680	4.445
0.01	1.567	1.567	4.146	0.837	2.216	2.216	5.863

1. Takovčanka, 2. Ana Morava, 3. KG - 100, 4. Lazarica, 5. KG - 56S, 6. KG - 4, 7. KG - 5
A-variant fertilizing, B-cultivar, C-nitrogen fertilizer dosage, AB, AC, BC, ABC - interaction

Grain harvest index is indicator of efficiency of exploitation of dry matter of plant for grain pouring and syntesis of proteins. During triannual period, the lowest grain harvest index was found at control 42%, while fertilizing brought to increasing of grain harvest index table 3. The most important statistical increase of grain harvest index was accomplished with appling nitrogen-phosphorus and only nitrogen fertilizers (Savić Nadica, 2009). Between these fertilizing variants with NP and N there wasn't statisticaly significant differences. Earlier investigations have already shoued that in conditions of poor content of nutrition in ground, plants of small grain show better efficiency in absorbing them and exploting them for pouring of grain and protein synthesis (Djokić and Lomović, 1990). Complete plant nutrition in sense of adding all of three necessary elements (N, P and K) to crops, haven't influenced increase of grain harvest index. Applyng higher dose of nitrogene fertilizer brought to higher grain harvest index at all the fertilized variants, with exception of NP_1K. In triannual average grain harvest index showed significant verying depending on cultivar. The highest grain harvest index was achieved with cultivar Lazarica 46%, and the lowest with cultivar KG 4 41%. The highest grain harvest index in average obtained cultivar Lazarica 48% with NP_2 fertilizing variant, using higher nitrogen dosage

Conclusions

Based on results of examination, it can be concluded that the nutrition of wheat plant in form of adding certain fertilizers, has influence on value of grain harvest index, that is better exploitation of dry matter and nitrogen for grain pouring and protein sinthesis.

The most important statistical increase of grain harvest index was accomplished with appling nitrogen-phosphorus and only nitrogen fertilizers. Applyng higher dose of nitrogene fertilizer brought to higher grain harvest index at all the fertilized variants, with exception of NP_1K. In triannual average, grain harvest index showed significant varying depending on cultivar. The highest grain harvest index was achieved with cultivar Lazarica 46%, and the lowest with cultivar KG 4 41%. The highest grain harvest index in average obtained cultivar Lazarica 48% with NP_2 fertilizing variant, using higher nitrogen dosage.

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ВЛИЈАНИЕ НА МИНЕРАЛНАТА ИСХРАНА НА ЖЕТВЕНИОТ ИНДЕКС КАЈ ЗИМСКАТА ПЧЕНИЦА

Надица Тмушиќ, Катерина Николиќ, Миодраг Јелиќ, Славиша Стојковиќ

Апстракт

Испитувањata беа изведени на експерименталното поле во сопственост на Центарот за ситнозрнести култури во Крагуевац, со ѓубрење во текот на период од три години (2004/2005, 2005/2006 и 2006/2007). Во експерименталните испитувања, покрај контрола, беа опфатени и шест варијанти на ѓубрења: 1) N_0 P_0 K_0; 2) N_{80}, $_{120}$ P_0 K_0; 3) N_{80}, $_{120}$ P_{60} K_{60}; 4) N_{80}, 120 P_{100} K_{60}; 5) N_{80}, $_{120}$ P_{60} k_0; 6) N_{80}, $_{120}$ P_{100} K_0; 7) N_{80}, $_{120}$ P_0 K_{60}. Во текот на експериментот, беа имплементирани индивидуални ѓубрења, како што следува: КАН (како азотно ѓубре), суперфосфат (како фосфатно ѓубре) и 60 % на калиумови соли (како калиумово ѓубре). Во експериментот биле вклучени седум сорти на зимската пченица: Таковчанка, Ана Морава, KG 100, Лазарица, KG 56S, KG 4 и KG 5. Целта беше да се испита ефектот на различните дози и односот на минерални ѓубрива врз жетвениот индекс на различни сорти зимска пченица. Користењето на ѓубрења, го зголемува жетвениот индекс. Највисоката вредност на жетвениот индекс беше постигната со примена на азотно фосфорни и само азотни ѓубрења. Во зависност од сортата, највисок жетвен индекс е добиен кај сортата Лазарица (46%), а најнизок кај сортата KG 4 (41%). Во периодот од три години, највисок жетвен индекс на зимската пченица е добиен кај сортата Лазарица (48%) во варијантата на ѓубре NP_2, со повисока доза на азот.

Клучни зборови: пченица, варијанти на ѓубре, жетвен индекс, сорти.

UDC:635.657”324”(560)
Original scientific paper

THE POSSIBILITIES OF WINTER CHICKPEA (*CICER ARIETINIM* L.) PRODUCTION IN MEDITERRANEAN CLIMATE CONDITIONS OF TURKEY

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Abstract
Chickpea (*Cicer arietinim* L.) is very important legumes in Turkey, and can be grown in rotation with wheat in semi-arid land under the Mediterranean climate conditions. It is traditionally sown in spring in this region and about 800-900 kg ha^{-1} seed yield can be obtained in this season, yet winter chickpea production has recently been spread in coastal regions of Turkey, and according to some research results, seed yield is about 2000-3000 kg ha^{-1} in fall sowing season under the Mediterranean conditions. But, one of the major problems is *Ascochyta blight* damage which occurs in winter crop production in this environment. Therefore, the varieties with resistance to blight disease should be used by farmers. There are some varieties resistance to related disease in this region. Late autumn or early winter sowing (Mid-November to Mid December) should be done for avoid from disease in the Mediterranean climate conditions of Turkey. Chickpea should be sown in 30-40 plant m^2 in these environmental conditions.
Key words: Winter Chickpea, Growing, Yield, *Ascochyta blight*, Mediterranean condition.

Introduction
Chickpea is the second most important pulse crop after dry bean for production in the world (FAO, 2010). Also, it is the most important food–legume crop in Turkey and Chickpea is used in cooking and as nuts. In recent years, although chickpea sowing area has been decreasing in Turkey due to increase in exports of Australia and Mexico, it is still 446.000 ha and average yield of chickpea is 1090kg ha^{-1} in Turkey (Anonymous, 2011). The Mediterranean region of Turkey is in the first rank in terms of chickpea sowing areas. In this region Chickpea is traditionally sown in spring. Therefore, seed yield is low because of drought climate during growth and ripening period and average seed yield of spring sown chickpea is 800-900 kg ha^{-1}. On the other hand the Mediterranean environment has a important potential for winter chickpea production. Because of the increasing the yield, instead of spring sowing, winter sowing of the chickpea enable to well results in the Mediterranean region. In recent years, winter chickpea area has been increasing in Mediterranean environment, but heavy soil is not favourable for winter chickpea production especially because of *Ascochyta blight* and overly vegetative growth. Permeable soil is more suitable than heavy soil for chickpea production. Chickpea can be grown in rotation with wheat in the Mediterranean climate conditions.

Techniques of Winter Chickpea Production

Selection of Cultivar

Selection of cultivar is very important for winter chickpea. *Ascochyta blight* is major problem in winter chickpea production because of rainy seasons. *Ascochyta blight*, caused by the fungus *Ascochyta rabiei* is the most serious disease of chickpea in Mediterranean region. The fungus can infect all above ground parts of the plant and it is highly prevalent in areas where cool, cloudy and humid weather occurs during the crop season. Unlike some insect control strategies, there is no economic threshold for ascochyta. Management strategies are aimed at preventing the occurrence of disease and limiting its spread. *Ascochyta blight* is managed through crop rotation, hygiene, seed treatment, prophylactic fungicide application and growing varieties with improved resistance. As seen figure 1, Mediterranean region has warm and humidity condition during the chickpea growing season in winter season. For this reason, the cultivars with resistance to *Ascochyta blight* such as Seçkin, İnci, Hasan bey, Izmir, Menemen-92, Aydın-92 originated in Turkey should be grown in the Mediterranean environment (Mart et al.,2011; Karaköy, 2011; Karaköy et al.,2011). Above mentioned cultivars have high potential for seed yield in winter chickpea production. Also as shown in the some research results, seed yield of chickpea is 2000-3000 kg ha^{-1} in winter sowing (Engin,1989; Singh and Saxena,1996; Anlarsal et al.,1999; Mart and Anlarsal, 2001;Yücel and Anlarsal, 2006).

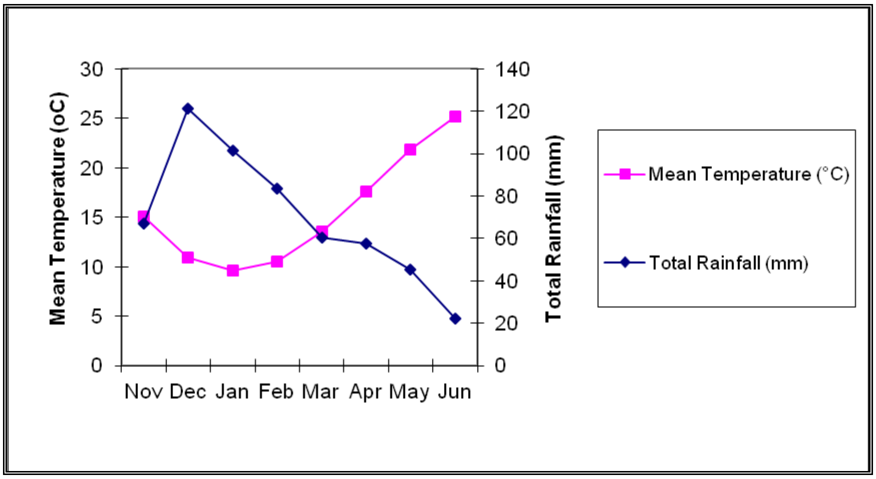

Figure 1. Long term avarage of precipitation and temperature of Adana (mediterranean region) in Turkey

In Mediterranean environmental conditions (Adana) in Turkey 100-seed yield and seed yield of some winter chickpea cultivars is given in Table 1.

Sowing Methods and Date

Date of sowing affects the growth and yield of chickpea. In the Mediterranean conditions early sowing (October) can increase the growth and seed yield. However, the plant can lodge because of overgrowth, which leads to a difficult harvest.

Also, the risk of *Ascochyta blight* increases in the seedling stage especially in rainy and warm of year. Chickpea sowing can be done during early winter, but very late sowing delays time to flowering and ripening of crop thus seed yield drastically decreases. Therefore, as seen Table 2, previously research carried out in Mediterranean condition indicated that the most suitable sowing time can be from Mid-November to Mid-December to obtain higher seed yield and avoid the disease risk.

Table 1. The seed yield (kg/da) and 100- seed weight on the some chickpea genotypes*

Genotypes	100-Seed Weight (g)	Seed Yield(kg/ha^{-1})
1.Inci	36.2	3223
2.Eser-99	46.5	2676
3.Gökçe	45.9	2683
4.İzmir-92	43.9	2393
5.Menemen-92	43.9	2606
6.Cevdet Bey	52.2	280.6
7.Damla	45.4	2844
8.Diyar-95	49.1	2743
9.FLIP 94-88C	36.4	3406
10.FLIP-91-222C	37.7	3311
11.FLIP 98-22C	45.8	3168
12.FLIP 98-106C	41.5	3644
13.FLIP 98-63C (Seçkin)	44.0	3089
14.FLIP98-56C	45.3	2939
15.FLIP 98 100C	41.8	3037
16.FLIP 98-101C	44.7	2540
17.FLIP 97-2111C	44.1	2799
18.FLIP 98-55C (Hasanbey)	46.9	2937
19.FLIP 92-164C	38.7	2868
Mean	43.7	2904

* Karaköy et al., (2010)

A high plant population shows a good response to soil moisture. For this reason, in rainy conditions, high plant density increases the seed yield of winter chickpea (Saxena and Sing,1987; Ozveren and Anlarsal 2001). It is sown with a row spacing of 45-60 cm and the recommended seed rate is 100-160 kg ha^{-1} by using machines depending on the seed size of cultivars. Compact and upright types give better response to high plant density than spreading types. Chickpea should be sown in 30-40 plants m^2 (Yücel and Anlarsal, 2006; Özdemir et al.,1996), but generally, in Turkey, sowing is done by broadcast methods.So, plant population gives a poor stand.

Seeding depth is an important factor affecting the germination. Chickpea is sown at 5-10 cm depth if there is enough soil moisture for germination. But, the seeding should be done in depth of 15 cm if soil moisture is deficient for germination (Singh and Saxena, 1999; Ozveren,1998).

Table 2. The effect of different sowing dates of chickpea cultivars on the seed yield and 100- grain weight *

Cultivars	Seed Yield(kg/da-1)	100-Seed Weight (g)
Akçin-91	174.6	39.5
FLIP 84-19C	177.1	36.0
FLIP 85-46C	102.6	39.4
FLIP 90-4C	192.5	42.2
Sowing Dates		
OCT, 2	145.1	39.7
OCT, 17	180.4	38.6
NOV, 2	191.9	38.9
NOV, 17	148.7	37.2
DEC, 2	142.5	42.2

*Mühür and Anlarsal (1996)

Table 3. The effect of different sowing depth on the seed yield (kg ha^{-1})*

Sowing Depth (cm)					
Cultivars	4	8	12	16	Mean
FLIP 92-164C	3781	3924	3912	4017	3908
FLIP 91-149C	3100	2686	2897	3107	2948
FLIP 91-61C	4204	4012	363.9	4154	4002
Mean	3695	3541	3483	3759	3619

*Ozveren (1998)

Fertiliser

Soils of the Mediterranean region are generally rich in Rhizobium bacteria**.** The good nodulation occurs under these conditions. Therefore inoculation of Rhizobium bacteria is not necessary in this region generally. For that reason, 30-40 kg ha^{-1} nitrogen as starter doses and application of 50-60 kg P_2O_5 kg ha^{-1} is favourable for before seeding. Although, some environmental conditions (pH precipitation and dry climate) affect nitrogen fixation negatively. In this case, inoculation of bacteria can increase N_2-fixation. Soils of Turkey have adequate amounts of potassium. So, the potassium (K) fertilizer is not required for chickpea. Iron-deficiency is common in many high pH calcareous soils in the Mediterranean region of Turkey.

Table 4. The effect of rhizobium bacteria strains on seed yield (kg/ha^{-1}) of some chickpea cultivars*

Cultivars	Rhizobium Strains			
	CP-31	CP-36	CP-39	Control (No İnoculation)
Aydın-92	2289	2263	2712	3267
Menemen-92	2803	2576	2226	2434
İzmir-92	2844	3338	3010	2399

*Erdoğan (2002)

Conclusions

There is a good potential for winter chickpea production in the Mediterranean climate conditions of Turkey. But *Asoschyta bligt* damage can occurs in rainy and warm conditions. Therefore it is necessary to use cultivars with resistant to *Asoschyta blight*, if suitable growing techniques of chickpea can be applied sowing areas and production will highly increase in comparison with today's in Mediterranean climate conditions.

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МОЖНОСТИ ЗА ПРОИЗВОДСТВО НА ЗИМСКИ НАУТ (*CICER ARIETINIM* L.) ВО УСЛОВИ НА МЕДИТЕРАНСКА КЛИМА ВО ТУРЦИЈА

Тон Ајбиган, Јуцел Дерија, Анласлар Емин

Апстракт
Наутот (*Cicer arietinim* L.) е многу важна мешункаста култура во Турција, и може да се одгледува во ротација со пченица во полупустински предели, во медитерански климатски услови. Традиционално, во овој регион се сее во пролет, а може да се добие принос на семе околу 800-900 кг ха$^{-1}$. Неодамна, производството на зимски наут се рашири и во крајбрежните региони на Турција и според добиените резултати од некои истражувања, родот е околу 2000-3000 кг ха$^{-1}$ при есенска сеидба во услови на медитеранска клима. Еден од главните проблеми се штетите предизвикани од *Ascochyta blight*, која во оваа средина се јавува при зимското производство. Затоа од страна на земјоделците треба да се користат сорти кои се отпорни на болести. Постојат некои сорти кои покажуваат отпорност на оваа болест во овој регион. За да се избегне оваа болест во услови на медитеранска клима во Турција, се препорачува доцна есенска или рана зимска сеидба (од средината на ноември до средината на декември). Во вакви еколошки услови, наутот треба да се сее во склоп од 30-40 растенија/м^2.

Клучни зборови: зимски наут, пораст, принос, *Ascochyta blight*, медитерански услови.

UDC: 635.657”324”(560)”2009/2012”
Original scientific paper

DETERMINING THE YIELD AND YIELD COMPONENTS IN SOME WINTER CHICKPEA GENOTYPES IN MEDITERRANEAN CLIMATE CONDITIONS

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Abstract

This study was carried out to aim to determine the performance of some promising chickpea genotypes. The research was conducted during winter season of 2009/2010 and 2011/2012 in Mediterranean climate conditions in Turkey. The experiment was arranged randomized blocks with three replications with four promising lines and two registered varieties. In this research, according to combined years chickpea genotypes were statistically different from each other for all of the characteristics. Plant height, main branch number, pod number per plant, seed number per plant, 100-seed weight, seed yield changed from 67.2 to 75.1cm, from 5.9 to 8.4 number, from 33.2 to 58.9 number, from 35.4 to 60.1 number, from 35.3 to 38.2 g, from 1876.3 to 2770.2 kg ha^{-1} respectively. As a result FLIP 00-39 and FLIP 01-54 lines should be suggested for winter chickpea grown in Mediterranean environmental conditions.

Keywords: chickpea, varieties, grain yield, yield component.

Introduction

Chickpea (*Cicer arietinum* L.) with low production cost, wide climate adaptation, use in crop rotation and atmospheric nitrogen fixation ability is one of the most important legume plants in sustainable agriculture system. The importance of the crop in human food stem from the fact that protein content of its seeds is about % 23, and this rate is rather low in comparison with other pulses, however, chickpea seeds are rich source of minerals and vitamins (Singh and Saxena, 1999). Also, it is being used increasingly as a substitute for animal protein in the diet of poor peoples.

Chickpeas are produced in over 45 different countries. World chickpea production is 9.685.967 ton and India is the world leader in chickpea production in 2007. Turkey is the third most important chickpea production followed by India and Pakistan, accounting for about five percent of total world production in 2007 (Anonymous, 2007). Chickpea is Turkey’s most important pulses. Chickpea sowing area is 446.000 ha and average yield 1090 kg ha^{1} (Anonymous,2011).Chickpea is sown at spring in Middle Anatolia and parade regions, but because of the increasing the yield, instead of spring sowing, winter sowing of the chickpea enable to well results in Aegean and Southeast regions with warmer climate in winter. However, cultivars which can be grown at wintry weather and have tolerant to ascochyta blight and cold should be used in sowing. With developed new cultivars, it was reported that about 1437 to 2213 kg ha^{-1} seed yield can be obtained from winter sowing of chickpea in Mediterranean environments (Yucel and Anlarsal, 2008).On the other hand Mart.,et al.(2011) found that seed yield of winter chickpea changed 1985.2-3680.5kg ha^{-1}.

The objectives of this study were:
- to determine the most suitable chickpea genotype which can be grown under rain fed condition of the Mediterranean,
- to investigate association between yield and other agronomical characters of different chickpea genotypes in the Mediterranean-type conditions of Turkey.

Material and methods

Experiments were carried out at the Research Area of Department of Field Crops of Cukurova University in Adana (35^o 18' E, 37^o 01' N; 23 m above sea level) during the winter seasons of 2009/2010 and 2011/2012 . The four cultivars named FLIP 00-39 C, FLIP 01-1 C, FLIP 01-34 **C** and FLIP 01-54 C, received from ICARDA along with 2 cultivars (as check, AYDIN and INCI) originated in Turkey were used as material. A randomised complete block design (RCBD) with four replicates was used to conduct treatments. Each plot consisted of four rows of 5 m length that were 45 cm apart. Prior to sowing, plants were fertilised with equivalent to 40 kg ha^{-1} N, and 40 kg ha^{-1} P_2O_5 in both growing seasons. Sowings were done on November 24 2009, and November 28 2011. Sowing of 2010 could not be done because of extreme rain. Emergence, flowering and podding dates were recorded when 50% of plants had emerged (January 2 2010, and January 2 2012), flowered (April 1-8 2010, and April 1-12 1 2012) and podded (May 7 2010, and April 29-May 1 2012) in each sub-plot. All plants were harvested at the end of June during both growing seasons. In the experiment, agronomical traits were measured considering the methods used in international pulses experiments of ICARDA. Five plats were chosen at random from the central row of each plot for data recording on plant height (PH: cm), branch number (BN: number per plant), pod number (PN: number per plant), and seed number (SN: number per plant). After harvest, 100-SW (100-SW: g) was determined by mixing the whole sample, and then 100 seeds were randomly counted and weighted. For seed yields (SY: kg ha^{-1}), all rows were harvested, threshed, cleaned, weighed and converted into kg ha^{-1}.
The research region has a Mediterranean climate with wet winters and hot dry summers. According to the long-term average from four decades of records, there is early total precipitation of 625 mm and mean temperature 18.7 ^oC. Mean temperature and total precipitation of the growing seasons during 2009-2010 and 2011-2012 are shown in Figure 1 and Figure 2.

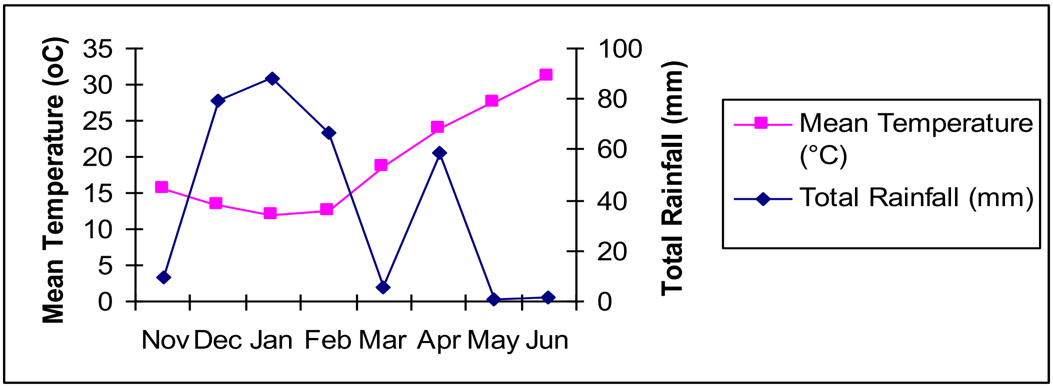

Figure 1. Mean temperature (^{o}C) and total rainfall (mm) in 2009-2010 growing seasons

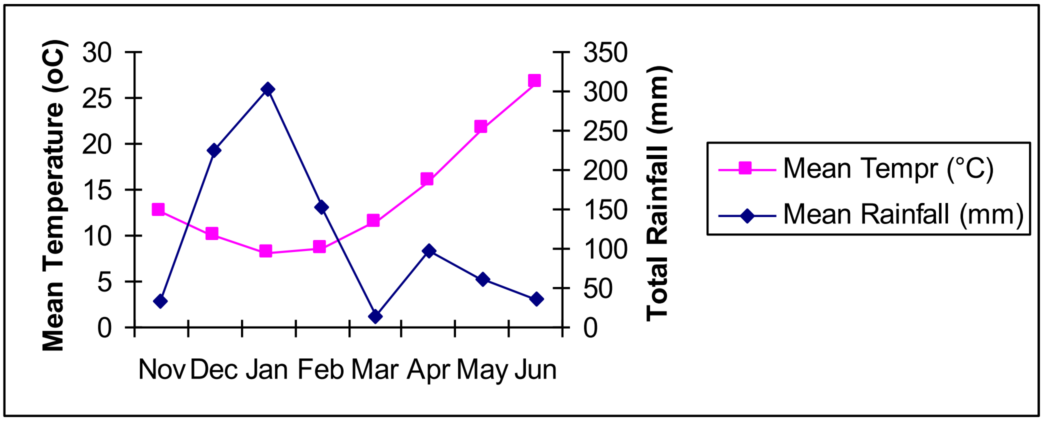

Figure 2. Mean temperature (^{o}C) and total rainfall (mm) in 2011-2012 growing season

The soil of the research area is clay that has a pH of 6.7, 1.2% organic matter, 23.6% $CaCO_3$ and 0.09% salt content. All data for each trait were statistically analysed separately the experimental years, and comparisons between means were made using least significant differences (LSD) at 0.05 probability level. All statistical analyses were performed using the SAS program (SAS Institute, 1999).

Results and discussion

Mean values and groups of 2009-10, 2011-12 and combined year about plant height, branch number and pod number obtained from chickpea genotypes were given in Table 1.

According to Table 1, the first growing season resulted in taller plant heights than the second growing season, in which average plant heights were 86.0 cm and 57.5 cm, respectively. Vegetative development of the plants continues until the initiation of the flowering. The longer time between emergences to flowering of chickpea resulted taller plant in the first growing season. Similar results are in agreement with those obtained by Yucel and Anlarsal (2008). There were significantly differences among the genotypes in both year and combined year. Plant height values were ranged between 89.5-78.5 cm, 61.2-51.5 cm and 75.1-67.2 cm, in 2009-10, 2011-12 and combined year respectively. FLIP 00-39, FLIP 01-34 and FLIP 01-54 genotypes recorded the highest value with significant differences in comparison to other cultivars at both growing seasons.

Branch number (number per plant) was higher in the second growing season compared with the first growing season (average 9.1 and 4.9 numbers per plant, respectively). This reduction in branch number could be attributed to the negative and significant correlation between plant height and branch number (Table 3). On the other hand, Ozveren Yucel and Anlarsal (2010), Farshadfar and Farshadfar (2008) and Malik *et al.* (2010) reported that branch number positively correlated with plant height. Branch number was affected by genotypes in 2011-12 and combined year. However, differences among the genotypes were not found significant in 2009-10. In terms of branch number, INCI cultivars produced significantly higher branch numbers compared with the other cultivars (Table 1).

Table 1. Mean values and groups of plant height (cm), branch number (number per plant) and, pod number (number per plant) of chickpea (*Cicer arietinum* L.) genotypes

	Plant Height (cm)			Main Branch Number (number per plant)			Pod Number (number per plant)		
Cultivars	2009-10	2011-12	Comb. Year	2009-10	2011-12	Comb. Year	2009-10	2011-12	Comb. Year
FLIP 00-39	89.5 a	59.9 a	74.7 a	4.7	10.7 ab	7.7 ab	80.1 a	37.7	58.9 a
FLIP 01-34	89.1 ab	61.2 a	74.9 a	4.7	7.1 cd	7.1 abc	35.3 d	34.1	33.2 c
FLIP 01-54	89.1 ab	60.7 a	75.1 a	5.6	9.5 abc	6.4 bc	61.2 c	39.9	47.6 b
FLIP 01-1C	88.3 ab	51.5 b	69.9 b	5.2	6.7 d	5.9 c	65.9 bc	31.3	48.6 b
AYDIN-	81.8 bc	55.9 ab	68.8 b	4.5	8.9 bcd	6.7 bc	62.4 c	33.4	47.9 b
INCI-	78.5 c	55.9 ab	67.2 b	5.1	11.7 a	8.4 a	79.2 ab	36.2	57.7 a
MEAN	86.0 A	57.5 B		4.9 B	9.1 A		64.0 A	34.0 B	
LSD (5%)	1.63	1.31	1.12	NS	0.58	0.35	3.01	NS	2.02

Pod number (number per plant) was higher in the first growing season compared with the second growing season (average 64.0, and 34.0 numbers per plant, respectively). This may be attributed to many factors such as water and temperature stress. As seen in Figure 1, during the podding and after the podding stage, total rainfall was higher but mean temperature was lower in 2011-12 comparison with 2009-2010. These results indicate that pod number is greatly influenced by temperature and precipitation. The effect of these factors during critical stages such as flowering and podding has previously been described in different crops (Al-Rifaee *et al*. 2004; Bakry *et al*. 2011; Anlarsal *et al* 2001, Bilgili *et al* 2010). Pod number values were ranged between 80.1-35.3, 39.9-31.3 number per plant in 2009-10 and 2011-12 growing seasons; combined values of two years were also changed between 57.7 and 33.2 number per plant. There were significant differences among genotypes in 2009-10 and combined year, and the highest value was recorded on FLIP 00-39 and INCI cultivars.

Mean values and groups of 2009-10, 2011-12 and combined year about seed number, 100 seed weight and seed yield obtained from chickpea genotypes were given in Table 2.

Seed number (number per plant) was higher in the first growing season compared with the second growing season (average 69.4, and 32.3 numbers per plant, respectively). The podding stage is a highly critical stage for production of chickpea and is affected by environmental factors. Any climatic fluctuation in this critical stage may cause serious losses in production. As seen Table 3, seed number was significantly and positively correlated with pod number. Differences between the two years in terms of seed number may be due to the higher pod number in the first growing season. Seed number values were ranged between 86.1-38.0, 34.8-29.9 and 60.1-35.4 number per plant in 2009-10, 2011-12 and combined years. There were significant differences among genotypes, and the lowest value was recorded on FLIP 01-34 in 2009-10 and combined year. According to Table 2, values of 100 SW were ranged between 38.28-35.9, 38.3-32.75g in 2009-10 and 2011-12 growing seasons; combined values of two years were also changed between 38.2-35.3g.

Seed yield (kg ha^{-1}) was influenced by growing season (Table 2). It was higher in the first growing season compared with the second growing season (average 2598.6, and 2269.9kg ha^{-1}, respectively). With regard to seed yield, there were significantly differences among genotypes and ranged between 2913.9-2280.6 and 2632.8-1472.0 kg ha^{-1}, between in 2009-10 and 2011-12 growing seasons; combined values of two years were also changed between 2770.2-1876.3 kg ha^{-1}.

Table 2. Mean Values and Groups of Seed Number (number per plant), 100-Seed Weight (g) and, Seed yields (kg ha^{-1}) of Chickpea (*Cicer arietinum* L.) Genotypes

	Seed Number (number per plant)			100-SW (g)			Seed Yield (kg ha^{-1})		
Cultivars	2009-10	2011-12	Comb.Year	2009-10	2011-12	Comb. Year	2009-10	2011-12	Comb. Year
FLIP 00-39	86.1 a	34.1	60.1 a	36.9 ab	38.3 a	37.6 ab	2472.2 bc	2356.4 a	2414.3 ab
FLIP 01-34	38.0 b	29.9	35.4 b	38.28 a	32.75 b	38.2 a	2508.3 bc	1472.0 b	2295.0 b
FLIP 01-1C	72.2 a	32.85	51.1 a	36.68 b	37.43 a	35.3 c	2280.6 c	2081.7 ab	1876.3 c
FLIP 01-54	72.75 a	30.95	51.9 a	36.5 b	36.88 a	36.7 b	2788.9 ab	2450.1 a	2619.5 ab
AYDIN	72.3 a	30.93	51.6 a	36.65 b	38.13 a	37.4 ab	2627.8 ab	2632.8 a	2630.3 ab
INCI	75.0 a	34.8	54.9 a	35.9 b	37.30 a	36.6 bc	2913.9 a	2626.6 a	2770.2 a
MEAN	69.4 A	32.3 B		36.8	37.1		2598.6 A	2269.9 B	
LSD (5%)	4.24	NS	2.67	0.32	0.65	0.31	7.12	15.07	10.17

The rainy conditions and lower of temperature during growth, flowering, podding and filling of pods stages adversely affected vegetative growth in 2011-12, therefore these situation resulted in the reduce of several agronomical characters contributing to seed yield such as plant height, pod number, seed number, and 100-seed weight. These results are in agreement with those obtained by Kayan and Adak (2012), who reported that rainfall affected grain yield, plant height, pod number per plant. Furthermore, in terms of seed yield, data given in Table 3 showed that positive and significant correlation between seed yield and plant height, pod number, seed number and 100 seed weight functioned as major contributors to seed yield of chickpea. These results represented that selection based on pod number, seed number and 100 seed weight increase seed yield.

Table 3. Correlations among characters in chickpea (*Cicer arietinum* L.) Genotypes (n=48)

Variable[1]	by Variable	Correlation	Signif Prob	Plot Corr
BN	PH	-0.6826	0.0000	
PN	PH	0.6619	0.0000	
PN	BN	-0.4662	0.0008	
SN	PH	0.7237	0.0000	
SN	BN	-0.5155	0.0002	
SN	PN	0.9440	0.0000	
100 SW	PH	-0.0722	0.6255	
100 SW	BN	0.3214	0.0259	
100 SW	PN	-0.2139	0.1443	
100 SW	SN	-0.1670	0.2566	
SY	PH	0.1992	0.1748	
SY	BN	0.0853	0.5645	
SY	PN	0.3594	0.0121	
SY	SN	0.3213	0.0260	
SY	100 SW	0.3390	0.0184	

[1] BN: branch number (number per plant), PH: plant height (cm), PN: pod number (number per plant), SN: seed number (number per plant), SY: seed yield (kg ha^{-1})

Conclusions

From the above results and discussion, the used cultivars have different seed's characters which can significantly affect their performance and the FLIP 00-39 and FLIP 01-54 genotypes were determined to be adaptable to Mediterranean-type conditions. These genotypes may be suggested for wintry weather chickpea grown.

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ОДРЕДУВАЊЕ НА ПРИНОСОТ И КОМПОНЕНТИТЕ НА ПРИНОС КАЈ НЕКОИ ГЕНОТИПОВИ ЗИМСКИ НАУТ ВО УСЛОВИ НА МЕДИТЕРАНСКА КЛИМА

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Апстракт

Студијата беше спроведена со цел утврдување на ефикасноста на некои потенцијални генотипови зимски наут. Истражувањето беше спроведено во текот на зимскиот период 2009/2010 и 2011/2012 во услови на медитеранска клима во Турција. Експериментот беше поставен во рандомизиран блок систем, во три повторувања со четирите потенцијални линии и две регистрирани сорти. Во ова истражување, според комбинираните години, генотиповите наут беа меѓусебно статистички различни во однос на сите карактеристики. Испитуваните карактеристики беа променливи и тоа за: висината на растенијата од 67,2 cm до 75,1 cm, бројот на главни гранки од 5,9 до 8,4 гранки, бројот на мешунки по растение од 33,2 до 58,9 мешунки, бројот на семки по растение од 35,4 до 60,1 семки, тежина на 100 семки од 35,3 до 38,2 g, и приносот на семе од 1876,3 до 2770,2 кг $ха^{-1}$. Од добиените резултати, линиите FLIP 00-39 и FLIP 01-54 може да бидат предложени за одгледување на зимски наут во услови на медитеранска клима.

Клучни зборови: наут, сорти, принос, компоненти на принос.