PRODUCTIVE CHARACTERISTICS OF THE MACEDONIAN VARIETIES SOYBEAN

Ljupcho Mihajlov[1], Verica Ilieva[1], Ilija Karov[2], Natalija Markova Ruzdik[1]
[1]Goce Delchev Univeristy, Faculty of Agriculture,
Department of Crop Production, 89, Goce Delchev str., p.o.box 201,
Shtip 2000, Republic of Macedonia, www.ugd.edu.mk
[2] Goce Delchev Univeristy, Faculty of Agriculture,
Department for Plant and Environment Protection, Goce Delchev str.,
p.o.box 201, Shtip 2000, Republic of Macedonia

Abstract

The paper explained the results of the researches conducted in 2009 and 2010 with both Macedonian soybean varieties. Soybean varieties (*Glycine max (L.) Merrill*) „Ilindenka" and „Pela" are the first Macedonian soybean varieties. These varieties were developed at the Institute of Southern Crops in Strumica. In 2004, were confirmed by the National Variety Commission of Ministry of Agriculture, Forestry and Water economy, and were introduced in the National Variety List. "Ilindenka" variety belongs to the II maturity group, which means that it needs 140-150 days to reach maturity in terms of cultivation in Macedonia. „Pela" is an earlier variety and belongs to (00) group or about 100 days are required for to achieve maturityin terms of cultivation in Macedonia. According to the results of two years of researches in Kocani region (eastern part of Macedonia), of these varieties was achieved average yield in both years of cultivation from 3 696 to 4 391 $kgha^{-1}$ for variety „Pela" and 3600 to 4128 $kgha^{-1}$ for variety „Ilindenka". The achieved results indicate that Macedonian soybean varieties maintain the genetic potential to yield on a high level. In agro ecological regions such as Kocani region and similar to, it can be achieved very satisfactory high yields of these varieties.

Key words: soybean, varieties, yield, region, maturity groups

INTRODUCTION

Successful [*Glycine max* (L.) Merr.] production requires the integration of inputs into a system that contains only those items necessary to optimize the amount of a quality product or net return. Inputs such a seed, pesticides, fertilizers, labor, machinery, and fuel that are basic to any management system, plus cost associated with financing, land (rent or ownership), and irrigation where used must all be considered and manipulated to provide the optimum opportunity for profit (Heatherly and Elmore, 2004). The soybean is commonly used as fodder, but in the last two decades more and more different products for human nutrition are spreading, as: cheese tofu, soybean milk, burgers, sausages, bread, different types of sweets and other products (Vratarić, & Sudarić, 2000). The soybean is extremely important in human nutrition because of the special chemical composition of the grains, it contains approximately 30-50% proteins and 18-24% oil, depending of the variety and cultivation conditions. The commercial varieties averagely contain up to 40% proteins and 20-22% oils, 34% carbohydrates and about 5% minerale elements: potassium (K), phosphorus (P), sulfur (S), calcium (Ca), iron (F), magnesium (Mg) и sodium (Na). Also, the grain is rich with vitamins: A, B-

complex, D, E and K. The proteins are rich in essential amino acids, especially with lysine and methionine. These amino acids are the most similar with the animal proteins, thus they have high biological value (Mihajlov, 2002).

From agro-technical aspect soybean improves the physical characteristics (structure) of the soil as nitrogen retainer enriches the soil with nitrogen. The inoculation of seeds before sowing, in terms of optimal humidity, temperature and neutral reaction of the soil solution, soybean can through nitrogen – fixation, create and leave in soil substantial nitrogen content of 40-50 kg /ha (Nenadićet al., 1995), and therefore represents an excellent pre-crop for cereal and others not legume crops. Cultivar selection is the first step to successful soybean management. New and improved cultivars are continually released to producers. These cultivars are evaluated in different production environments to determine their yield potential and supplemental traits such as resistance to diseases, nematodes, and insects, as well as tolerance to commonly used herbicides. (Boerma & Spetch, 2004). Grain yield is the most important characteristic in soybean breeding (*Glycine max(L.) Merrill)*, which depends on the genetic potential and the environmental conditions of soybean growing (Sudarić & Vratarić 2002).

In Macedonia soybean was first seen from 1925-1930 on a smaller parcels (mostly in gardens), and it was grown as coffee. After that period, especially from 1960 to 1965 occasionally there are some attempts to disseminate the soybean on major areas in agricultural enterprises and on the surfaces of individual farmers, but until now these activities have not delivered significant results and soybeans in the Republic of Macedonia is not yet present on large areas (Mihajlov, 2002).

The main activities of soybean expansion areas in the Republic of Macedonia have been achieved after many years of work of breeding and hybridization of soybeans by scientists at the Institute for Southern Crops in Strumica, in the period from 1994-2007. The selective material from different filiation disposed in the Institute in Strumica, motivate us to work on creating soybean varieties suitable for our climate conditions, with aim, to be created high productive, stable and adaptable varieties, resistant to lodging, disease and pests in the frame of 00 to II mature groups. As a result of several years of continuous work on this area, are created the first Macedonian soybean varieties that are subject to analysis and research in this paper.

The first new confirmed soybean varieties in Macedonia with their good productive characteristics have all predispositions for massive production. In Macedonia, soybean production has no tradition and from minimal 50 ha in 2001, overtakes only 500 ha in 2012 in entire country, although the average import for a year is about 50.000 t soybean or soybean products (Mihajlov et al., 2006).

The aim of this research is to determine the continuity of the stability of these two varieties in terms of their morphological, manufacturing and agro ecological characteristics.

MATERIALS AND METHODS

"Ilindenka" variety has been made by crossing the lines (L-111 x L-8) with "Balkan" variety, filiation from Serbia and Monte Negro while "Pela" variety is made with crossing between varieties: (015 from Serbia and Monte Negro x

"Sabina" from Austria) x "Oak Wision" from Canada. First crossings were made 1994. In the selection process is used the "pedigree method" (Mihajlov et al., 2006).

"Ilindenka" variety belongs to the II maturity group, which means that it needs 140-150 days to reach maturity at breeding conditions in Macedonia. „Pela" is an earlier variety and belongs to (00) group or about 100 days are required for its maturing in breeding agro climate conditions in Macedonia. The field experiments with these two varieties were conducted during two years, 2009 and 2010 on the surface of the Institute of rice despite Kocani, located at an altitude of 291-330 m, 41°47'42" east latitude and 19°45'22" east longitude, on an alluvial type of soil.

Every year pre-crop was rice. Basic and before sowing soil is performed by default, in terms optimal for sowing and in the same way, during the both years of setting the experiments, appropriate to the conditions and needs in Kocani production area. The experiment was conducted in 5 replications, by using randomized block design. The size of basic experimental plots was 15 m^2 (7.5 m x 2 m), whit 4 rows. The sowing is performed manually whit 50 cm space between rows and 5 cm space within rows, corresponding to the structure of 400 000 plants on 1 ha, respectively 600 000 plants on 1 hectare, appropriate of agricultural technical requirements of varieties.

During the vegetation the care was consisted of 2 hand digging inter row distance, in the first stage (V_1-V_2 Fehret all., 1971), developed simple leaves, and 1 to 2 pairs trifoliolate leaf and the second digging in stage (R_1) beginning of flowering, that time is match from middle may to middle june. The first irrigation with sprinclers (50 mm) is given in the second half of july, in the stage (R_3) start forming pods and second watering sprinkling with the same norm of water is performed in stage (R_5-R_6), start forming of seeds and their development, which takes place in early august. During the vegetation, there was no need for protection from diseases and pests in both years.

During the researches were analyzed following productive traits in soybean: number of nodes (knees), number of pods per plant, mass of seeds per plant (g), mass of 1000 grains (g), grain yield (kg ha^{-1}). Grain yield is assessed from all the plants in each experimental plot separately and it is minimized in kg ha^{-1}. The mass of grains per 1 plant, number of pods per plant and mass of 1000 grains were analyzed from ten plants of each repetition for each variety. All data obtained were processed statistically using the SPSS statistical software.

RESULTS AND DISCUSSION

Yield enlargement is conditioned by the genetic and agronomic improvements, respectively breeding better yielded varieties and using appropriate agrotechnical methods (Specht, & Greaf, 1996). Height of the yield except these factors, particularly influenced has the conditions of the year. Following are climate diagram of years of research (2009 and 2010) for the region of Kocani.

The agro-meteorological conditions during the years of study showed significant differences in the total amount of rainfall during the vegetation of soybean in both years of testing.

In 2010, compared to 2009, is measured a greater total amount of rainfall. In terms of average monthly temperatures in the vegetation period of soybean,

the values for the both years studied, roughly coinciding with the exception of July for which the average monthly temperature value is two degrees higher in 2010 as compared to 2009. In this month, the monthly amount of rainfall in 2009 (33mm, climate diagram 1), is significantly higher compared to 2010 (6,5 mm, climate diagram 2).

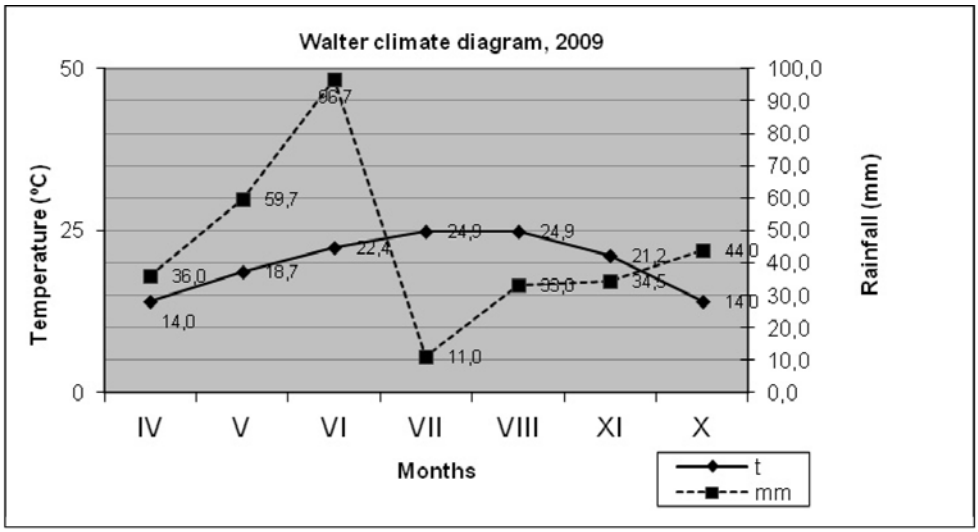

Figure 1. Walter climate diagram for 2009

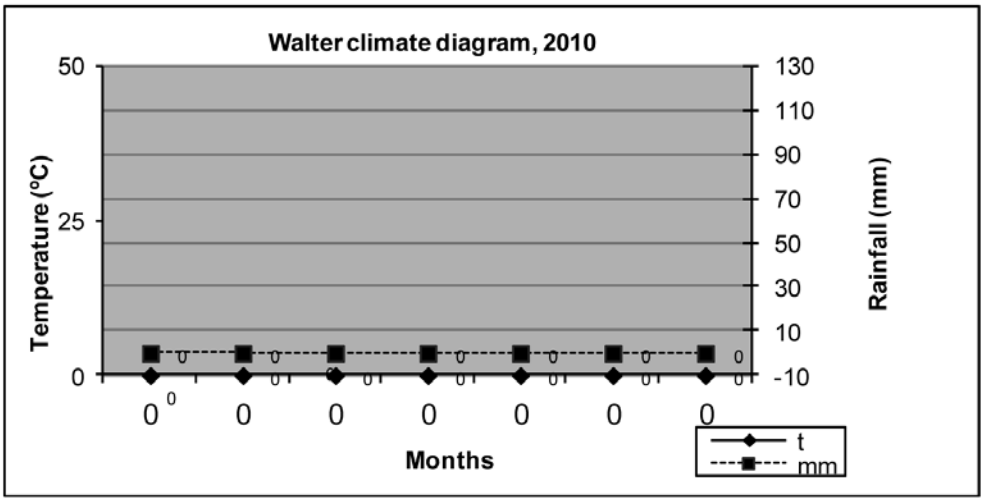

Figure 2. Walter climate diagram for 2010

Number of nodes (knees) – This productive property in soybeans, according to some authors is called „number of fertile floors". In relation to this property the ways of breeding of soybean in selection programs worldwide, are moving to getting varieties with shorter internodies with more pods per floor, or more

compact habitus (Sudarić et al., 1996). Data of the number of nodes (knees), per plant, were obtained after morphological analysis in the laboratory, after harvest. Average values for two annual for the number of nodes per plant range from 14-16 for variety Pella, and 14-18 for variety Ilindenka (table 1 and table 2). Average values for this property in 2009 are larger (16 and 18 nodes) compared with 2010 (14 nodes), at both varieties. The higher value of this property is probably due to the greater total amount of rainfall during the vegetation of soybeans in 2010 (climate diagram 2), compared to 2009 (climate diagram 1).

Number of pods per plant – The numbers of pods varies from 2 to more than 20 in a single inflorescence and up to 400 on a plant, (Carlson, 1973). According to researches of Konova et al.1976, the number of pods per plant, depending on the variety, (tested are 4 varieties), and the conditions of cultivation (on two localities), an average of 3 years was from 12,2 to 39,8. Results obtained of our researches show average number of pods per plant formed in both years of testing in range of 42 to 49 in both tested varieties. There were no statistically significant differences in the number of pods between the both varieties. Average values for this property are higher in 2009 (48 and 49) compared with 2010 (42 and 43, Tab.1 and 2), due on more favorable climatic conditions during the early reproductive stages (R_3-R_5) between the vegetation of soybeans in 2010 (Figure 2).

Mass of grains per plant – Productive indicator except the variety, conditions and region growing, largely depends on the number of plants per unit area (Mihajlov, 2002). The values of this quantitative property according to the results of Vratarić et al., 1999 expressed through, two-year (1996-1998) average for the two studied varieties of the same maturity groups with the varieties that we examine, for the area of Croatia were from 17.8 to 19.7 g. Average values obtained for this quantitative trait in our trials over two years in both varieties ranging from 12,3 to 15,2 g. These values are significantly lower than values obtained in Croatia (Osijek region), due to several factors, which is crucial higher average annual amount of rainfall and northern geographic location of the Osijek region in terms of Kocani.

Mass of 1000 grains – Property which is the highest degree of genetic depending on the variety and conditions of the external environment is the mass of 1000 grains. Heritability in this quantitative property is 70% (Brim, 1973). According to Hartwing, 1973 at the varieties with wide production, mostly mass of grains of soybean average ranges from 12 to 18 g for 100 grains. Results obtained of our tests for mass of 1000 grain between the both studied years range between 130,71 g to 140,38 g at the variety Ilindenka, (Table 2). Compared between years of testing, there were no significant differences in average values (from 135.9 to 138,62 g) at this quantitative property (Table 1 and 2). Uniformity of property mass of 1000 grains between varieties and years of testing in these trials, we explain with the fact that in the stages of pouring the grains (R_5-R_6), in both years of testing in both cultivars, was conducted intervention with sprinkling. Enough quantities of iirrigation with sprinclers (50 mm), water sediment in the period of reproductive development in tested soybean varieties, the corresponding density and properly applied crop nutrition, contribute to not achieve significant differences in the values of this productive property.

Grain yield – or variety production potential per unit area, is the most important indicator of the value of each variety. It is known that soybean varieties

Table 1. Statistical analyses and components of yield at variety Pela

Variety Pela	Number of nodes	Number of pods per plants	Mass of seed per plant (g)	Mass of 1000 seeds (g)	Grain yield (t/ha^{-1})
2009	16	49	15,20	136,57	4,131
2010	14	43	13,09	138,62	3,696
average	15	46	14,15	137,60	3,914
median	16	47	14,28	137,47	3,990
minimum	13	43	13,35	136,13	3,640
maximum	17	49	15,01	139,25	4,140
rang	4	6	1,66	3,12	0,500
variance	3,15	5,65	0,51	1,39	0,057
standard deviation	1,49	2,32	0,69	1,18	0,239
standard error	0,67	1,04	0,30	0,52	0,107
coefficient of variation	9,66	4,98	4,79	0,86	6,152

Table 2. Statistical analyses and components of yield at variety Ilindenka

Variety Ilindenka	Number of nodes	Number of pods per plants	Mass of seed per plant (g)	Mass of 1000 seeds (g)	Grain yield (t/ha^{-1})
2009	18	48	14,26	135,90	4,128
2010	14	42	12,30	136,51	3,600
average	16	45	13,28	136,21	3,864
median	16	46	13,39	137,69	3,905
minimum	15	38	10,72	130,71	3,645
maximum	18	54	16,42	140,38	4,015
rang	3	16	5,71	9,67	0,370
variance	1,30	45,35	5,99	20,48	0,023
standard deviation	1,03	6,17	2,19	4,04	0,153
standard error	0,46	2,75	0,98	1,81	0,068
coefficient of variation	6,21	13,32	15,98	2,97	4,008

significantly differ in terms of grain yield, as between different groups of maturity, and within the same maturity group. Grain yield is quantitative property, controlled by a number of genes that are influenced by external factors (Bhardway and Bhgasari, 1991). Heritability of this property according to Brim, 1973, varies from 3-58 %. Reviewing the results of the average grain yields for examined Macedonian varieties (Table 1 and 2), it is obvious that there is great variance in average grain yields of the two years, ranging 3,6 to 4,131 tha^{-1}. Obtained differences in grain yield of between tested varieties were statistically significant between the examined years in production. At differences in average values of grain yield between both varieties in the same year (3,6-3,696 and 4,128 and 4,131 Tab.1 and 2) there is no large variance. This indicates that both varieties are characterized by high potential of grain yield. Comparative analyses of the values of the return of these varieties in the period of their recognition or investigations by the National Variety Commission suggest the following:

– the average value of the return yield in both years of investigations (2002-2003), on a 3 localities in the Republic of Macedonia (Skopje, Strumica and Prilep), at variety Ilindenka is 4,0 t ha^{-1}.

– at variety Pela the average value of yield for the same period on the same localities is 3,63 t ha^{-1} (Mihajlov et al. 2006).

If these results compare with the results of the researches for productivity of our varieties, we notice that, except for high yield potential Macedonian varieties are characterized with a high degree of stability and adaptability.

CONCLUSIONS

Based on both years of researches of Macedonian soybean varieties Ilindenka and Pella, conducted through micro – field, laboratory experiments, and statistical analyzes, in a region where they have not been studied, can be concluded:

– pedo climatic factors in Kocani region are suitable for growing these two varieties of soybeans, which showed high resistance to loading and high degree of field tolerance to pathogens in soybeans;

– in the period of soybeans vegetation are established values of significant elements of yield (number of nodes, number of pods per plant, mass of seeds per plant and mass of 1000 grains), which are analyzed in this paper and are higher compared with the values of them on other localities in Macedonia, where the trials are conducted with these varieties in a period of their recognition (2004) until today.

– there was a positive correlation between all tested elements of yield and size of the yield, at both varieties in both years of researches;

– terms of year of growing have statistically significant impact on the values of the realized yield at both varieties (Figure 1 and 2; Tab.1 and 2);

– after almost 10 years from the introduction of these two varieties in the National List of Varieties of the Republic of Macedonia and their careful continuous annual renewal and maintenance of the breeders, the varieties show high yield potential, high degree of stability and adaptability in the region (Kocani), where they have not been grown;

– soybean as nitrogen fixator can and should be recommended for inclusion in crop rotation schemes in Kocani, which creates greater potential for obtaining higher yields of rice that is grown there as traditional culture;

– these varieties that are proven in production in the tested areas, can serve as initial material for breeding new varieties with higher yield potential and quality.

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