UDC 575:633.15
DOI:10.2298/GENSR1301135D
Original scientific paper

DEPENDENCE OF THE PRODUCTIVITY OF MAIZE AND SOYBEAN INTERCROPPING SYSTEMS ON HYBRID TYPE AND PLANT ARRANGEMENT PATTERN

Željko DOLIJANOVIĆ[*1], Snežana OLJAČA[1], Dušan KOVAČEVIĆ[1], Milena SIMIĆ[2], Nebojša MOMIROVIĆ[1] and Života JOVANOVIĆ[2]

[1]University of Belgrade, Faculty of Agriculture, Institute of Field and Vegetable crops, Belgrade-Zemun, Serbia
[2]Maize Research Institute, Zemun Polje, Belgrade-Zemun, Serbia

Dolijanović Ž., S. Oljača, D. Kovačević, M. Simić, N. Momirović and Ž. Jovanović (2013): *Dependence of the productivity of maize and soybean intercropping systems on hybrid type and plant arrangement pattern.*Genetika, Vol 45, No. 1, 135-144.

Intercropping systems could improve utilization of the most important resources (soil, water and nutrients), provide a better control of weeds, pests and diseases, and finally higher productivity, especially under rain-fed growing conditions. This study aimed to determine the effects of three maize (*Zea mays* L.) prolific hybrids (FAO 500, 600 and 700) and the spatial intercrop patterns on the above-ground biomass and grain yields of maize and soybean (*Glycine max* L. Merrill), on chernozem soil type at Zemun Polje, Belgrade, in 2003, 2004 and 2005. The experimental design was a complete randomized block with four replications and three treatments: 3 rows of maize and 3 rows of soybean in strips for each maize hybrid (three variants, 3 rows of maize and 3 rows of soybean in alternate rows for each hybrid (another three variants) and monocrops of both maize and soybeans.

To optimize the ecological and economic benefits of maize/soybean intercrop in terms of yield, variety selection and compatibility of the component crops should be made using established agronomic management practices involving the two crops. Suitable maize varieties for maize/soybean intercrop systems are varieties that have less dense canopy. These varieties would therefore have lesser shading effect to the understory beans. However,

Corresponding author: Željko Dolijanović**,** University of Belgrade, Faculty of Agriculture, Institute of Field and Vegetable crops, dolijan@agrif.bg.ac.rs; +381 11 2615-315 ext. 321, fax: +381 11 3161-987

establishment of an appropriate spatial arrangement of the component crops would be essential to alleviate negative effects especially on the less competitive crop.

The intercropping system in alternate rows showed significantly higher above-ground biomass and grain yields in comparation with both the strip intercropping system and maize monocrops in 2004. Soybean gave significantly lower above-ground biomass and grain yield in intercrops than in monocrops. Maize prolific hybrid growing in intercropping with soybean as legume crop, increased productivity of cropping system, especially in favourable agroecological conditions.

Maize and soybean yields reduction could have also been due to inter-specific competition for resources such as nutrients and water. Moreover, performance of the currently grown varieties in the semi-arid regions depends on the amount of rainfall received during the growing season.

Key words: maize prolific hybrids, above-ground biomass, grain yield, intercrops and monocrops

INTRODUCTION

Cereal-legume mixtures are the most productive form of intercropping since the cereals may benefit from the nitrogen fixed in the root nodules of the legumes in the current year or in the subsequent years (UNDIE *et al.,* 2012). Legume-based cropping could help to increase the soil organic matter contents, thereby enhancing soil quality, as well as having the additional benefit of sequestering atmospheric C (GREGORICH *et al*., 2001). Maize-soybean intercropping may also be a way of saving irrigation water, especially in situations of limited water resources (OUDA *et al*., 2007) as intercrops conserve water, largely due to an early high leaf area index and a high leaf area (OGINDO and WALKER, 2005). The incorrect selection of crops, *i.e*., intercropping of incompatible species, can result in one crop completely suffocating the other; that is adverse effects (competition). The selection of hybrids and varieties is an extremely important issue, which depends mostly on the system and the aim of the intercropping (OLJAČA *et al.,* 2000; DOLIJANOVIĆ *et al*., 2007). In additive intercropping, the selection of the major crop (due to interest in yields) is as important as the minor crop. A minor crop should be a variety that will not expose the major crop to competitive pressure.

Rainfall variability from season to season has been shown to reduce crop yields, especially in semi-arid region. Maize-soybean intercrops, which are the most prevalent in these areas, may not necessarily give the best returns in terms of yield or cash because farmers do not necessarily select the most compatible maize varieties for intercropping. Maize phenological development was not significantly affected by intercropping. High temperatures and water stress in dry areas could be inhibitory factors to establishment of rhizobia-legume symbiosis. Early maturing maize varieties could be less competitive than late maturity varieties for growth resources, which similarly influence rhizobia-legume symbiosis. Above-ground yields and grain yield of maize prolific hybrids are higher than standard hybrids in intercropping system, especially under favourable meteorological conditions including irrigation (DOLIJANOVIĆ *et al*., 2007).

Older generations of maize hybrids selected in lower densities have, as a rule, more robust plants and less erect top leaves. Newer generations of maize hybrids are characterised by a better ability of plants to be grown, selected in higher densities (60-100,000 plants ha^{-1}), have less robust plants, ears are placed more lower, while the angle of top leaves in relation to the stalk is smaller (SIMIĆ *et al.,* 2012). Intercropping system has some limitations that prevent their application on large areas (BIABANI, 2009). There are many reasons for this: lack of machinery necessary for such purposes, means for plant protection, lack of varieties and hybrids better-adapted to such growing conditions, *etc*. The best cultivars for monocrops might not be the most suitable for mixed cropping (O`LEARY and SMITH, 2004).

The aim of this study was to determine the advantages of prolific late maturity maize hybrids (FAO 600 and 700) in relation to a prolific medium early maturity maize hybrid (FAO 500) in intercrops and monocrops. Another objective was to evaluate the impact of spatial pattern of maize–soybean intercrops on the yield of above-ground biomass and grain of maize and soybean under semi arid conditions and rain-fed regime.

MATERIALS AND METHODS

We used a randomised complete block design with four replications. Each year the previous crop was winter wheat. Stubble was ploughed down to a depth of 10 cm immediately after harvesting the wheat and primary tillage in the autumn was performed to a depth of 25 cm and left fallow until soil preparation in the spring. Ten to 15 d prior to sowing in the spring, granular NPK fertiliser (15:15:15; 80 kg ha^{-1} of each active ingredient), plus 90 kg of N a.m. was incorporated with the seedbed preparation. All treatments of the experimental field were fallowed autumnal and incorporating granular NPK fertiliser (15:15:15; 80 kg ha^{-1} of each active ingredient), plus 90 kg of N a.m. with the seedbed preparation. Seeds were sown during the last 10 days of April. Three experimental ZP maize prolific hybrids, designed for intercropping production, with different lengths of growing season (EPH2-FAO 500, EPH4-FAO 600 and EPH11-FAO 700) and soybean cultivar Nena of FAO maturity group II were used in the study.

Experimental design

The intercrops were designed according to the method of additive series. Soybean was added to maize, representing major crop among the intercrops, with the density as it was in monocrop. Spatial designs in this additive series method were sowing of maize and soybean in strips and in alternate rows. Treatments showed six rows of each maize hybrid and six rows of soybean in monocrops. The intercrops consisted of 3 rows of maize and 3 rows of soybean in strips for each hybrid of maize (three treatments) and 3 rows of maize and 3 rows of soybean in alternate rows for each hybrid (another three treatments). Maize was sown in rows 70 cm apart and with a within-row spacing of 40 cm (35.714 plants ha^{-1} in monocrops, while the row distance, i.e. within-row spacing for soybean was 70 cm, i.e. 3.57 cm, (400,000 plants ha^{-1}). The within-row spacing in intercrops was half of the distance in the monocrops (i.e. 20 cm between maize plants and 1.78 cm between soybean plants). Each plot replicate was 21 m^2 with rows of 5 m.

Measurements

Half of each plot (10.5 m^2) was harvested for measuring the above-ground biomass of each crop (DICKEY-John Corporation, GAC II, USA-grain analysis computer II generation) at the mid-stage of soybean pod formation, corresponding to the milky to waxy stage of maize: September 10, 2003, September 9, 2004 and September 27, 2005. Grain yield was determined at full maturity from the remaining half of the experimental plots, and moisture adjusted to 14 %

(maize) and 12 % (soybean). Half-plots were harvested for grain yield on September 24, September 30 and October 19, in the respective years. Biomass and grain yield were analysed by analysis of variance. The LSD test was used to separate means when the F-test was significant (STATISTICA 8.0 for Windows).

Meteorological conditions

Meteorological data for 2003-2005 (Table 1) showed that the first year was characterised by a lack of rainfall and higher air temperatures particularly during the summer months. A sufficient amount of rainfall registered in July, and then in September and October, have influenced delay of maturity and made harvest of crops more difficult. Besides, the mean annual air temperature was somewhat higher (19.7 ^{o}C) in 2003, whereas in 2004 there were optimal air temperatures during the growing period, and 2004 was considered to be exceptionally favourable for arable farming in general. The third year, 2005, was similar to the previous year, but with a higher amount of rainfall.

Table 1. Mean monthly air temperatures (°C) and total monthly rainfall (mm) for the growing period in 2003–2005 in Belgrade.

Year	Temperature	Months							Average
	Rainfall	April	May	June	July	August	September	October	or sum
2003	°C	12.2	21.6	25.0	23.4	25.8	18.4	11.5	19.7
	mm	22.0	40.0	33.0	116.0	5.0	57.0	124.0	361.0
2004	°C	13.5	16.2	20.7	23.0	22.3	17.7	15.9	18.5
	mm	69.0	62.8	107.1	93.7	88.1	45.8	30.6	497.1
2005	°C	13.1	17.7	20.2	22.9	21.4	18.9	13.8	18.3
	mm	53.0	48.0	94.0	90.0	145.0	56.0	27.0	708.0

Above-ground biomass

Above-ground biomass of maize was lower in both monocrops and strip intercropping in comparison to soybean above-ground biomass in 2003, Table 2. Significantly lower biomass was achieved in soybean intercrops (12.9 and 17.4 t ha^{-1}) comparing to above-ground biomass achieved in monocrops (21.2 t ha^{-1}).

The analysis of the above-ground biomass of soybean in both intercrops and monocrops in 2004 indicated very significant variation of biomass under the impact of the spatial arrangement pattern. The arrangement in alternate rows was more favourable for maize since the above-ground biomass of 35.2 t ha^{-1} was higher than the biomass recorded in the monocrop (34.2 t ha^{-1}) and in the strips (32.3 t ha^{-1}). The highest soybean biomass was recorded in the monocrop (22.3 t ha^{-1}), because soybean always show weaker competitive ability in a maize–soybean intercrops. The strip intercrops were more favourable for soybean in 2004 (16.1 t ha^{-1}) comparing to alternate row intercrops (14.4 t ha^{-1}). Above-ground biomass of maize and soybean in 2005 was generally lower than in 2004; in 2005 only soybean monocrop yield (25.6 t ha^{-1}) was higher than in 2004 (22.3 t ha^{-1}). There were significant differences ($p \leq 0.05$) in maize yield according to the spatial pattern and type of hybrids. Yields recorded in intercrop variants were significantly lower (30.7-A_1 and 28.9 t ha^{-1}-A_2) compared to maize monocrop yield (38.9 t ha^{-1}): however, there were no differences ($p > 0.05$) between the two different spatial patterns.

Properties of increasing productivity of maize prolific hybrids have not expressed, in inter- and monocrops variants in 2003. Reason for that is very unfavourable meteorological conditions. Specific property of increasing productivity of prolific hybrids, especially in high density conditions (intercropping) has expressed only in 2004. Above ground biomass in alternate row intercrops was significantly higher than in strip intercrops and monocrop variants. This property has expressed in 2005 only in monocrop variants. The highest above ground biomass was obtained in variants with the late maturity hybrids (FAO 700), especially in monocrops in 2005 (43,1 t ha^{-1}) and in intercrops in 2004 (40,5 t ha^{-1}-A_1 i 33 t ha^{-1}-A_2). The difference in the above-ground biomass yields between the hybrids FAO 500 and FAO 600 was not statistically significant. The yields of soybean in the maize–soybean intercrops were significantly lower than those obtained in the monocrop, especially under unfavourable growing conditions when the competitive ability of maize was strongly expressed. The differences in soybean above ground biomass with different hybrids were not statistically significant in intercrop variants (table 2). Exceptionally low yields of the above-ground biomass of soybean were recorded in the intercrops with late maturity maize hybrids in 2005, regardless of the intercropping system (A_1-8.6 t ha^{-1} *vs.* A_2-8.9 t ha^{-1}).

Table 2. Maize and soybean above-ground biomass in intercrops and monocrops (t ha^{-1}).

Crops	Hybrids	2003		2004		2005	
		Maize	Soybean	Maize	Soybean	Maize	Soybean
A_0	B_1	15.8		34.7		38.3	
	B_2	16.1		32.7		35.5	
	B_3	19.7		35.3		43.1	
	Average	17.2	21.2	34.2	22.3	38.9	25.6
A_1	B_1	13.1	13.8	31.3	17.7	29.4	10.4
	B_2	16.0	11.4	33.7	14.4	27.9	11.6
	B_3	21.0	13.7	40.5	14.0	34.9	8.6
	Average	16.7	12.9	35.2	14.4	30.7	10.3
A_2	B_1	17.2	19.2	31.2	16.8	28.1	11.6
	B_2	15.4	16.3	32.5	15.4	27.4	12.4
	B_3	17.2	16.6	33.0	16.0	31.2	8.9
	Average	16.6	17.4	32.3	16.1	28.9	10.9

LSD		2003		2004		2005	
		Maize	Soybean	Maize	Soybean	Maize	Soybean
0,05	A	4.1^{ns}	2.9^{**}	3.5^{ns}	2.8^{**}	3.2^{**}	3.7^{**}
	B	4.1^{ns}	2.9^{ns}	3.5^{ns}	2.8^{ns}	3.2^{**}	3.7^{ns}
	AB	7.1^{ns}	5.0^{ns}	6.1^{ns}	4.9^{ns}	5.5^{ns}	6.5^{ns}

A-plant arrangement pattern (A_0–monocrops; A_1- alternate rows; A_2-strips); B- maize prolific hybrids (B_1-FAO 500; B_2-FAO 600; B_3-FAO 700); *, ** significantly different at $p \leq 0.05$ and $p \leq 0.01$. ^{ns} Not significantly different.

Grain yields

The grain yields of maize and soybean very significantly varied under the effects of the spatial patterns in 2003, Table 3. The maize grain yield obtained in the monocrops (6.7 t ha^{-1})

was significantly higher than the yields recorded in the intercrops; A_1 (4.5 t ha^{-1}) and A_2 (4.4 t ha^{-1}). The highest soybean grain yield in 2003 was recorded in the monocrop (1.8 t ha^{-1}).

Table 3. Grain yield of maize and soybean in intercrops and monocrops (t ha^{-1}).

Crops	Hybrids	2003		2004		2005	
		Maize	Soybean	Maize	Soybean	Maize	Soybean
A_0	B_1	6.7		9.4		8.3	
	B_2	6.3		9.0		8.9	
	B_3	7.2		10.7		9.5	
	Average	6.7	1.8	9.7	2.2	8.9	2.5
A_1	B_1	4.4	0.7	9.9	1.7	7.2	1.5
	B_2	4.6	0.9	12.2	1.2	7.4	1.5
	B_3	4.5	0.8	14.3	1.5	8.6	1.2
	Average	4.5	0.8	12.2	1.5	7.8	1.4
A_2	B_1	4.7	0.8	10.4	1.6	6.6	1.4
	B_2	4.3	0.9	9.8	1.5	6.4	1.4
	B_3	4.1	0.9	13.3	1.9	5.9	1.6
	Average	4.4	0.9	11.1	1.6	6.3	1.5
LSD		2003		2004		2005	
		Maize	Soybean	Maize	Soybean	Maize	Soybean
0,05	A	0.6^{**}	0.2^{**}	1.5^{**}	0.5^{**}	0.4^{**}	0.2^{**}
	B	0.6^{ns}	0.2^{ns}	1.5^{**}	0.5^{ns}	0.4^{*}	0.2^{ns}
	AB	1.0^{ns}	0.4^{ns}	2.6^{ns}	0.8^{ns}	0.7^{**}	0.3^{ns}

A-plant arrangement pattern (A_0–monocrops; A_1- alternate rows; A_2-strips); B- maize prolific hybrids (B_1-FAO 500; B_2-FAO 600; B_3-FAO 700); *, ** significantly different at $p \leq 0.05$ and $p \leq 0.01$. ^{ns} Not significantly different.

In 2004, the maize and soybean yields in intercrops and monocrops were significantly higher than in 2003. Maize grain yields have varied under effects of both observed factors, while the yields of soybean grain significantly varied only under the impact of the spatial pattern. In this year, average grain of yield was significantly higher in intercrops (12.2 t ha^{-1}-A_1 and 11.1 t ha^{-1}-A_2) than in monocrop of maize (9.7 t ha^{-1}).

Average maize grain yields were higher in the alternate row intercropping system than in the strip intercropping system, and statistical significant obtained only in 2005 (table 3). The grain yield was the highest in the latest maturity maize hybrid (FAO 700) in all cropping systems (mono- and intercrops). The highest soybean grain yield was obtained in the monocrop in all years, which was a statistically very significantly higher than yields recorded in the alternate rows and strips (table 3). Lower grain yields of soybean were obtained in alternate row variants than in strips and the differences among the yields of soybean in the intercrops were not statistically significant.

DISCUSSION

The first year was characterised by a lack of rainfall and higher air temperatures particularly during the summer. The lowest above-ground biomass of maize in both intercrops and monocrops which was recorded in 2003, shows that the prolific maize hybrids did not tolerate soil moisture deficiency. In 2004, favourable conditions for nitrogen fixation (temperature, humidity) have contributed to the undisturbed growth of both crops and to a less distinctive maize competitive pressure (DOLIJANOVIĆ *et al.*, 2007). The reason for the lower yield in 2005 than 2004 primarily was the irregular distribution of rainfall throughout the crop growing season, mainly because of somewhat higher amount of precipitation in July and August during crop flowering. Data analysis of the above-ground biomass of both maize and soybean yields in 2003–2005 show that the intercrop was not more efficient in regards to above-ground yields, particularly during the first year of investigation. Under the drought conditions and high temperatures, intraspecies competitiveness was very intensive, since the monocrop and intercrops showed lower yields (OLJAČA *et al.,* 2007). The high and regular rainfall during the 2004 (Table 1) favoured the growth of maize, but suppressed the growth of soybean (Table 2 and 3), as also reported by VERDELLI *et al* (2012). Soybean plants, being deep rooted, to some extent can withstand dry periods resulting in higher grain yields, as observed for the monocrop treatments in the third year (Table 3).

Moreover, the spatial pattern was of significant importance; the alternate row intercropping systems were more favourable for prolific hybrids of maize, while the strip intercropping system was more favourable for soybean, which is in agreement with the results presented by DOLIJANOVIĆ *et al* (2007) and VERDELLI *et al* (2012). Soybean plants are sufficiently close to the maize plants in alternate row systems for the transfer of nitrogen to maize root hairs to influence each row of maize plants, which was particularly evident in the case of favourable soil moisture conditions in 2004. Considering the intensive competitive ability of the prolific latest maturity hybrid (FAO 700), it is concluded that it had the highest yields, especially in alternate rows. The difference between prolific and non-prolific (standard) hybrids is in the fact that prolific hybrids produce a few ears per plant. The essential idea for the development of prolific hybrids is to increase maize yield with the application of conventional cropping practices or to lower their variability under unfavourable agroecological conditions. Recently developed hybrids are actually all prolific as they have been selected for the growth under conditions of greater sowing densities, which should result in one to two ears per plant regardless of modifications in the vegetative space. Selection of such hybrids was initiated by Dr Vladimir Trifunović at the Maize Research Institute, Zemun Polje as far back as 1957. Into the first cycle of selection, this breeder included genetically distant source materials, such as a gene of so call *Ladys fingers,* popping maize variety that used to be known for its prolificacy (SARATLIĆ *et al.*, 2007).

Soybean was the weaker competitor in association with maize in the applied additive intercropping design and therefore the differences among the grain yields of soybean in the monocrops were larger in relation to those in the intercrops, especially with late maturity maize hybrids. Nodulation and nodule longevity of soybean intercropped with maize are generally increased, a fact attributed to an improved microclimate that favours the survival and effectiveness of rhizobia. In addition, the exudates produced by maize may also stimulate nodulation in common- and/or soybean. Moreover, the non-legume absorbs more mineral N from the soil, stimulating nodule formation and biological N fixation (BNF) in the legume partner. In fact, the soil mineral N availability is one of the main limiting factors to BNF. Finally, shorter nodule longevity in sole cropping is attributed to higher soil temperatures than in intercropped systems (CARDOSO *et al.,* 2007). Consequently, the differences in the yield of soybean directly are related to the spatial pattern and to the maturity of given maize hybrid. The intercropping system based on the method of additive series showed lower benefits regarding the increase of grain yield for both maize and soybean (Table 3). The reason for the lower maize and soybean yields among the intercrops concerning the smaller sowing distances within the row, was the enhanced interspecies and intraspecies competition for the basic factors. In maize–soybean intercropping systems, maize plant belonging C4 carbon assimilation pathway being dominant is usually much more competitive than legumes, first of all due to rapid initial growth (KITONYO *et al.,* 2013).

The results obtained by many author shows that maize grain yield mainly being increased in intercrops, while soybean grain yield being reduced to some extent. MADDONNI *et al* (2006) reported that maize grain yield in intercrops have increased on average by 18-29 % (irrigation regime), in relation to yields in monocrops, while the corresponding values for soybean decreased by 12-22 %. Maize yield in the strips significantly increased in the three seasons (13–16%) as compared to that in the monocrops. Conversely, yields of soybeans in the strips were 2 to 11% lower than that in the monocrops (VERDELLI *et al.,* 2012). In strip intercropping, the width of the strip needs to be wide enough to allow seeding and harvesting operations although narrow enough to allow the interaction of the components of the mixture to occur. Depending on the scenario and the circumstances, interaction is not only dependent on the availability of resources but also on the structure of the crops and cultivars used (KOVAČEVIĆ and LAZIĆ, 2012).

CONCLUSION

Maize prolific hybrids intercropping with soybean, as legume crop, increased productivity of cropping system in favourable meteorological conditions. In dry conditions the advantages of these hybrids could be expressed only on soils with irrigation. Maize prolific hybrid with the longer maturity later had the higher the above-ground biomass and grain yields of maize in both cropping systems. The alternate row intercrops were more favourable for maize and the strip intercrops were more favourable for soybean. The highest soybean yield was recorded in the monocrop, because soybean in a maize–soybean intercrop is always the weaker competitor.

ACKNOWLEDGEMENT

A part of this study was supported by the Ministry of Education and Science of the Republic of Serbia through the scientific project "Integrated system of field crop cultivation: conservation of biodiversity and soil fertility", Reg. No. TR-31037.

Received July 7h, 2012
Accepted November 07th, 2012

REFERENCES

BIABANI, A. (2009): Agronomic performance of intercropped Wheat cultivars. Asian J. Plant Sci. *8*: 78-81.

CARDOSO, E.J.B.N., M.A. NOGUEIRA, S.M.G. FERRAZ (2007): Biological N_2 fixation and mineral N in common bean-maize intercropping or sole cropping in southeastern Brazil. Exp. Agric., *43*: 319–330.

DOLIJANOVIĆ, Ž., S. OLJAČA, D. KOVAČEVIĆ, M. SIMIĆ (2007): Effects of different maize hybrids on above-ground biomass in intercrops with soybean. Maydica *52*: 265–271.

GREGORICH, E.G., C.F. DRURY, J.A. BALDOCK (2001): Changes in soil carbon under long-term maize in monoculture and legume-based rotation. Can. J. Soil Sci. *81*: 21–31.

KITONYO, O.M., G.N. CHEMINING'WA, J.W. MUTHOMI (2013): Productivity of farmer-preferred maize varieties intercropped with beans in semi-arid Kenya. International Journal of Agronomy and Agricultural Research (IJAAR). *3 (1)*: 6-16.

KOVAČEVIĆ, D., B. LAZIĆ (2012): Modern trends in the development of agriculture and demands on plant breeding and soil management. Genetics, *44 (1)*: 201-216.

MADDONNI, G.A., A.G. CIRILO, M.E. OTEGUI (2006): Row width and maize grain yield. Agron. J. *98 (6)*: 1532–1543.

MUONEKE, C.O., M.A.O. OGWUCHE, B.A. KALU (2007): Effect of maize planting density on the performance of maize/soybean intercropping system in a guinea savannah agro ecosystem. African J. of Agric. Res. *2*: 667-677.

O`LEARY, N., M.E. SMITH (2004): Uncovering corn adaptation to intercrop with bean by selecting for system yield in the intercrop environment. J. Sust. Agric. *24*: 109-121.

OGINDO, H.O., S. WALKER (2005): Comparison of measured changes in seasonal soil water content by rained maize–bean intercrop and component cropping in semi arid region in South Africa. Phys. Chem. Earth. *30*: 799–808.

OLJAČA, S., R. CVETKOVIĆ, D. KOVAČEVIĆ, G. VASIĆ, N. MOMIROVIĆ (2000): Effect of plant arrangement pattern and irrigation on efficiency of maize (*Zea mays*) and bean (*Phaseolus vulgaris*) intercropping system. J. Agric. Sci. *135*: 261–270.

OLJAČA S., S. VRBNIČANIN, M. SIMIĆ, L. STEFANOVIĆ, Ž. DOLIJANOVIĆ (2007): Jimsonweed (*Datura stramonium* L.) interference in maize. Maydica. *52 (3)*: 329-335.

OUDA, S.A., T. EL MESIRY, E.F. ABDALLAH, M.S. GABALLAH (2007): Effect of water stress on the yield of soybean and maize grown under different intercropping patterns. Austral. J. Basic and Appl. Sci. *1*: 578–585.

SARATLIĆ G., G. STANKOVIĆ, V. ANĐELKOVIĆ, M. BABIĆ, K. KONSTANTINOV (2007): Science as sustainable development background Maize Research Institute "Zemun Polje" contribution. In: Science as sustainable development background. Konstantinov K., Anđelković V. (Ed.), Serbian Genetics Society, Belgrade, 1-22.

SIMIĆ, M., Ž. DOLIJANOVIĆ, R. MALETIĆ, L. STEFANOVIĆ, M. FILIPOVIĆ (2012): Weed suppression and maize productivity by different arrangement patterns. Plant, Soil and Environment, *58 (3)*: 148-153.

UNDIE, U.L., D.F. UWAH, E.E. ATTOE (2012): Effect of Intercropping and Crop Arrangement on Yield and Productivity of Late Season Maize/soybean Mixtures in the Humid Environment of South Southern Nigeria. Journal of Agricultural Science *4 (4)*: 37-50.

VERDELLI, D., H.A. ACCIARESI, E.S. LEGUIZAMON (2012): Corn and Soybeans in a Strip Intercropping System: Crop Growth Rates, Radiation Interception, and Grain Yield Components. International Journal of Agronomy, *2012:* 1- 17.

PRODUKTIVNOST ZDRUŽENOG USEVA KUKURUZA I SOJE U ZAVISNOSTI OD TIPA HIBRIDA I PROSTORNOG RASPOREDA

Željko DOLIJANOVIĆ[1], Snežana OLJAČA[1], Dušan KOVAČEVIĆ[1], Milena SIMIĆ [2], Nebojša MOMIROVIĆ[1], Života J OVANOVIĆ[2]

[1]Univerzitet u Beogradu, Poljoprivredni fakultet, Beograd, Srbija
[2]Institut za kukuruz, “Zemun polje”, Zemun Polje, Beograd, Srbija

Izvod

Gajenjem združenih useva može se poboljšati iskorišćenost najvažnijih resursa (zemljišta, vode i hranljivih materija), obezbediti bolja kontrola korova, štetočina i bolesti, i povećati produktivnost, posebno u uslovima prirodnog vodnog režima. Cilj ovih istraživanja jeste da se utvrde uticaji tri različita višeklipa hibrida kukuruza (FAO 500, 600 i 700) i prostornog rasporeda (naizmenični redovi i trake) na prinose nadzemne biomase i zrna združenih i čistih useva kukuruza i soje. Istraživanja su obavljena na zemljištu tipa černozem u Zemun Polju, Beograd, tokom 2003, 2004 i 2005. godine. Ogledi su izvedeni po planu potpuno slučajnog blok sistema u četiri ponavljanja i tri tretmana: združeni usev kukuruza i soje u trakama za svaki hibrid kukuruza (tri varijante), združeni usev kukuruza i soje u naizmeničnim redovima za svaki hibrid (još tri varijante) i čisti usevi kukuruza i soje. U združenom usevu u naizmeničnim redovima su dobijeni značajno veći prinosi nadzemne biomase i zrna kukuruza. Ispitivani višeklipi hibridi kukuruza iz različitih FAO grupa zrenja, gajeni u združenom usevu sa sojom, imali su pozitivan uticaj na prinos, kako nadzemne biomase, tako i zrna, ali samo u 2004. godini koja je ocenjena kao najpovoljnija sa stanovišta meteoroloških uslova, posebno količine i rasporeda padavina.

Primljeno 07. VII 2012.
Odobreno 07. IX. 2012.