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The Influence of Row Spacing on Fertile Node Number of Soybean under Irrigation Conditions

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Abstract: Three row spacings and three soybean cultivars were examined under irrigation conditions during a two-year study. The objective was to determine the influence of row spacing changes on fertile node number of soybean. The analysis of variance was performed on data following a two-factorial split-plot design , with cultivar and row spacing as main plot and subplot factors, respectively (Hadzivukovic 1991). The number of nodes with pods present was significantly dependent on maturity group. The late cultivar was determined to have a significantly greater number of nodes with pods (1.95 to 2.78), as compared to the early and medium maturity cultivars. An increase in row spacing resulted in an increasing number of fertility nodes (12.05, 12.37, and 13.51). A positive correlation was established between yield per plant and fertile node number.

Key words: row spacing, irrigation, fertile node, soybean.

Introduction

Soybean production is aimed at achieving high and stable yields per plant and per unit area. The ways to attain this include irrigation and soybean planting at different row spacings. In the present soybean production, the row spacing used was

50 cm, being an optimal row spacing based on researches (Relic 1996; Hrustic *et al.*, 1998; Tatic *et al.*, 2002). In order to extend soybean production to private farms which do not grow sugar beat and other plants which generally require a 50 cm row spacing, it is necessary to explore the possibility of soybean production at a row spacing of 70 cm, the common row spacing for most row crops. The practical advantage of the 70 cm row spacing lies in the use of a seeding device and row crop cultivators without row space changes. The latest research results suggest that soybean, due to a large number of efficient herbicides, could be cultivated also at a 25 cm row spacing. For high and stable yields, soybean has a high water requirement. As its needs cannot be met only by precipitation in the conditions of Serbia, irrigation water should be applied throughout the critical periods.

The objective of this study was to determine the effect of row spacing and maturity group on fertile nodes of soybean under irrigation conditions, applying 25, 50 and 70 cm row spacings.

Material and Method

Two-year (2003-2004) examinations were conducted on the effect of row spacing on soybean yield per plant under irrigation conditions on the production fields of »Krivaja« PLC, Backa Topola, on carbonate chernozem, after wheat as the preceding crop.

The research involved three cultivars of different maturity group developed at the Institute of Field and Vegetable Crops in Novi Sad, being as follows:

- Proteinka, an early cultivar, 0 maturity group
- Novosadjanka, a medium maturity group, I maturity group and
- Vojvodjanka, a late cultivar, classified into II maturity group by its growing period.

The experiment was set up as a two-factor split-plot design in four replications, with cultivars and three row spacings of 70, 50 and 25 cm used as two main plots and subplots, respectively. The plot was 5 m long, its width depending on the row spacing used. Planting was conducted on April 21 in the first year, and April 21 in the second year. The row spacings of 50 and 70 cm had each an equal number of plants sown per unit area, being 500,000 for Proteinka, 425,000 for Novosadjanka and 375,000 plants for Vojvodjanka. At the 25 cm row spacing, a 10% higher number of plants was used - 550,000 for Proteinka, 467,500 for Novosadjanka and 412,500 for Vojvodjanka. Throughout the growing season, all necessary management practices were used. Irrigation water was applied using a self-propelled centre-pivot irrigation device with a great working width. The irrigation rate was adapted to meteorological conditions, precipitation amount and distribution and temperature.

Harvest was carried out at full maturity, at grain moisture content under 14%. Mid-row plants were used for analysis (10 plants).

Analysis of variance was used to examine statistical data and a two-factor split-plot design and LSD test were employed to identify the variation effects and interactions, respectively.

Temperature and precipitation data were obtained by the Meteorological Station in Backa Topola, and irrigation data were provided by »Krivaja«, PLC. Potential evapotranspiration (ETP) was calculated using a hydrophytothermic index (hi) established by Bosnjak (1983), showing how many liters of water were uptaken by plants on ETP per every degree of mid-day temperature. Irrigation was used throughout the critical water-need periods for soybean. Water balance was used for analysis of irrigation efficiency.

In 2003, the total requirements in soybean growing season were ETP = 518.1 lm^{-2}, real evapotranspiration being ETR = 339.1 lm^{-2}. The difference between potentional and real evapotranspiration was indicated by the water deficit sum, m = 179 lm^{-2} (Tab.1.). In 2004, the total requirement was ETP = 458.4 lm^{-2}. The total real evapotranspiration ETR = 389.6 lm^{-2} was lower than potential evapotranspiration, the total deficit in the growing season amounting to m = 68.7 lm^{-2} (Tab. 2).

Table 1. Soybean water balance in irrigation terms for 2003.

Element	Apr	May			June			July			August			Sep	sum
	III	I	II	III	I	II	III	I	II	III	I	II	III	I	
hi	0.11		0.11			0.17			0.18			0.17		0.11	
t ºC	15.5	23.0	20.5	23.2	25.8	25.5	24.4	23.3	23.2	26.6	26.0	25.8	27.9	18.0	
ETP(lm^{-2})	17.1	25.3	22.6	28.1	43.9	43.4	41.5	41.9	41.8	52.7	44.2	43.9	52.2	19.8	518.1
$P^{(1)}$ (lm^{-2})	4.7	0	2.7	33.4	0.7	12.0	21.8	0.4	15.0	28.9	2.2	4.9	8.3	0.1	135.1
$I^{(2)}$ (lm^{-2})	21.2	0	14.1	0	23.5	47.0	23.5	0	0	0	23.5	0	0	0	152.8
Δ	8.9	-25.3	-5.8	5.3	-19.7	15.7	3.8	-41.5	-26.8	-23.8	-18.5	-39.0	-43.9	-19.7	
$r^{(3)}$ (lm^{-2})	60.0	34.7	29.0	34.3	14.6	30.3	34.1	0	0	0	0	0	0	0	
ETR(lm^{-2})	17.1	25.3	22.6	28.1	43.9	43.4	41.5	34.5	15.0	28.9	25.7	4.9	8.3	0.1	339.1
$m^{(4)}$ (lm^{-2})	-	-	-	-	-	-	-	7.5	26.8	23.8	18.5	39.0	43.9	19.7	179.0
$s^{(5)}$ (lm^{-2})	8.9	-	-	-	-	-	-	-	-	-	-	-	-	-	8.9

$P^{(1)}$- precipitation; $I^{(2)}$- irrigation; $r^{(3)}$- reserves (available water storage); $m^{(4)}$-minus (water deficit); $s^{(5)}$- precipitation surplus

Table 2. Soybean water balance in irrigation terms for 2004.

Element	Apr	May			June			July			August			Sep	sum
	III	I	II	III	I	II	III	I	II	III	I	II	III	I	
hi	0,11		0,11			0,17			0,18			0,17		0,11	
t ºC	15.2	15.7	15.7	19.0	19.1	21.9	22.1	24.5	22.3	24.0	23.5	24.1	22.9	19.4	20.7
ETP(lm^{-2})	16.7	17.3	17.3	23.0	32.5	37.2	37.6	44.1	40.1	47.5	40.0	41.0	42.8	21.3	458.4
$P^{(1)}$ (lm^{-2})	11.8	48.1	20.5	10.5	38.8	14.7	10.3	2.6	0	70.5	0.3	0.9	44.9	4.5	278.4
$I^{(2)}$ (lm^{-2})	0	0	0	0	0	0	0	16.4	32.8	16.4	0	0	23.5	0	89.1
Δ	-4.9	30.8	3.2	-12.5	6.3	-22.5	-27.3	-25.1	-7.3	39.4	-39.7	-40.1	25.6	-16.8	
$r^{(3)}$ (lm^{-2})	55.1	60.0	60.0	47.5	53.8	31.3	4.0	0	0	39.4	0	0	25.6	8.7	
ETR(lm^{-2})	16.7	17.3	17.3	23.0	32.5	37.2	37.6	23.0	32.8	47.5	39.7	0.9	42.8	21.3	389.6
$m^{(4)}$ (lm^{-2})	-	-	-	-	-	-	-	21.1	7.3	-	0.3	40.1	-	-	68.7
$s^{(5)}$ (lm^{-2})	-	25.9	3.2	-	-	-	-	-	-	-	-	-	-	-	29.1

$P^{(1)}$- precipitation; $I^{(2)}$- irrigation; $r^{(3)}$- reserves (available water storage); $m^{(4)}$-minus (water deficit); $s^{(5)}$- precipitation surplus

The results on water balance for the growing season in both years suggest that 2004 was more favourable for soybean production under irrigation conditions.

Unfavourable weather conditions induced the formation of a much greater number of lateral branches per plant (Dozet and Crnobarac 2007).

Results and Discussion

The average number of nodes with pods in the two research years was 12.64, the number for 2003 and 2004 being 11.98 and 13.30, respectively (Tab. 3.).

Table 3. The fertile node number as dependent on the cultivar and spacing used

Year	Spacing (cm) (B)	Cultivar (A)			$\bar{x}$ B	Factor	LSD	
		Proteinka	Novosa-djanka	Vojvo-Djanka			1%	5%
2003	25	11.18	11.05	13.03	11.75	A	2.77	1.83
	50	11.78	10.35	13.23	11.79	B	1.30	0.95
	70	11.58	11.68	13.93	12.40	A*B	2.26	1.65
	$\bar{x}$ A	11.51	11.03	13.40	**11.98**	B*A	2.78	1.91
2004	25	12.85	10.43	13.78	12.35	A	1.94	1.28
	50	11.93	11.45	15.45	12.94	B	1.06	0.77
	70	14.30	13.65	15.88	14.61	A*B	1.83	1.33
	$\bar{x}$ A	13.03	11.84	15.04	**13.30**	B*A	2.10	1.45
		Average 2003 – 2004			**12.64**			

In both years, the cultivar Vojvodjanka was determined to have the highest number of nodes with pods, the result being significant for 2003, and highly significant for 2004, as compared with the other two cultivars. No statistically significant differences were determined between the Proteinka and Novosadjanka cultivars.

An increase in spacing resulted in an increase in the number of nodes with pods. The 2003 results did not show statistical differences, but the row spacing of 70 cm used in 2004 induced a significantly high number of nodes as compared to the other spacings showing no differences.

In 2003, the effect of spacing on the number of nodes with pods was not statistically significant. However, in 2004, the spacing of 70 cm used in the cultivars Proteinka and Novosadjanka resulted in a significant increase in node number as compared to the spacings of 50 and 25 cm. No statistical differences were determined between the latter two spacings. The Vojvodjanka cultivar plants cultivated at the 25 cm spacing had a significantly and very significantly lower number of nodes with pods as compared to the ones grown at 70 and 50 cm spacings.

The Vojvodjanka cultivar produced a significantly higher node number at all three spacings, in both research years, as compared to the cultivar Novosadjanka. In 2004, at a row spacing of 25 cm, the cultivar Novosadjanka gave a lower node number as compared to the cv. Proteinka. Differences between the cultivars Vojvodjanka and

Proteinka grown at the spacing of 70 cm were significant in both years of research, as well as in 2004, at a spacing of 50 cm.

A positive correlation was established between the soybean yield per plant and fertile node number per plant in both research years (Fig.1.).

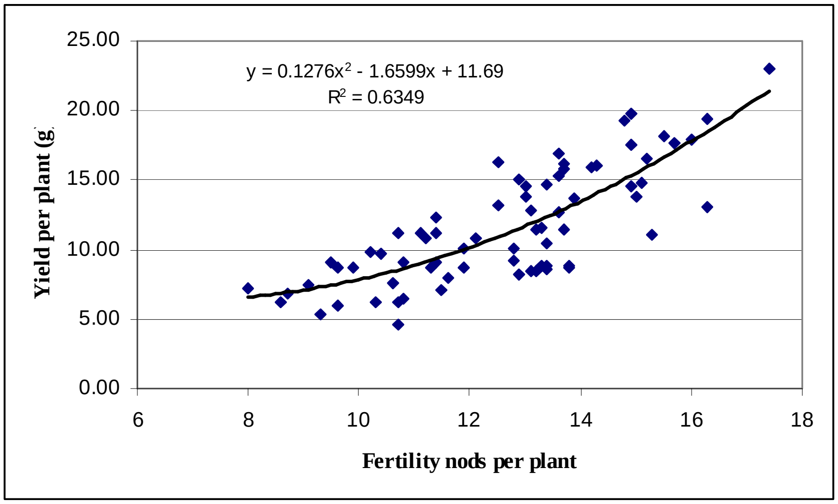

Figure 1. Correlation between yield per plant and fertile node number per plant in soybean

Conclusion

The results obtained suggested the following:

The number of nodes with pods was significantly dependent on maturity group. The late cultivar was determined to have a significantly higher number of nodes with pods (ranging from 1.95 to 2.78) as compared to other cultivars.

Increases in spacings induced an increase in the number of nodes with pods (12.05, 12.37 and 13.51).

A positive correlation was established between the fertile node number and yield per plant.

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UTICAJ MEĐUREDNOG RAZMAKA NA BROJ PLODNIH NODIJA KOD SOJE U USLOVIMA NAVODNJAVANJA

- originalni naučni rad -

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Rezime

U dvogodišnjem istraživanju ispitivana su tri međuredna razmaka i tri sorte soje različite grupe zrenja u uslovima navodnjavanja. Cilj je bio da se ustanovi u kojoj meri promena međurednog razmaka utiče na broj plodnih nodija kod soje. Podaci su obrađeni analizom varijanse po metodi dvofaktorijalnog split – plot ogleda, gde su faktori ispitivanja: sorta (velika parcela) i međuredni razmak (podparcela) (Hadživuković 1991). Broj nodija s mahunama bio je značajno zavisan od grupe zrenja. Kasana sorta, imala je značajno veći broj nodija s mahunama (1.95 do 2.78) u odnosu na ranu i srednjestasnu sortu. Povećanjem međurednog razmaka setve dolazilo je do povećanja nodija sa mahunama (12.05, 12.37, 13.51). Utvrđena je pozitivna korelacija između prinosa po biljci i broja plodnih nodija.