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СОДРЖИНА
CONTENT

ПРЕДГОВОР

Универзитетот „Гоце Делчев" во Штип, со донесување на Законот за основање на Државен универзитет „Гоце Делчев" – Штип, започна со работа на 27 март 2007 година како високообразовна институција со четири факултетски единици и со дисперзија на наставата во Штип, Струмица и Кочани. Денес, за само две години од своето постоење, оваа институција прерасна во еден од водечките високообразовни центри во Република Македонија, втор по големина, со 13 факултети и 1 висока школа и со дисперзија на наставата во 12 општини: Штип, Струмица, Кавадарци, Гевгелија, Кочани, Свети Николе, Виница, Берово, Радовиш, Прилеп и Скопје. На прагот од третата академска година, во нашите современо опремени амфитеатри, предавални, лаборатории и кабинети, својата иднина ќе ја градат околу 10.000 студенти кои заедно со околу 500 вработени ќе ги доградуваат темелите на овој млад, но модерен и перспективен Универзитет.

Земјоделскиот факултет, како интегриран дел од Универзитетот „Гоце Делчев" - Штип, ги следи модерните и современите трендови на високото образование. Според потребите на пазарот на трудот во државава, наставата се организира во 4 општини и тоа: Штип, Струмица, Кавадарци и Свети Николе. Тригодишните студии се на Општа насока, а четиригодишните студии се организирани по модули: модул Агроменаџмент (Штип); модул Интегрално земјоделско производство (Струмица); модул Енологија (Кавадарци) и модул Преработка на земјоделски производи (Свети Николе).

Покрај наставно-образовната дејност, голем дел од своите активности Земјоделскиот факултет ги посветува на науката и истражувањето. Како плод од стручно-апликативната и научноистражувачката дејност на Земјоделскиот факултет произлегува и оваа издание на Годишниот зборник, што во континуитет се објавува по осми пат.

Македонското земјоделско производство има долгогодишно искуство и богата традиција, така што нашите земјоделски производи се познати по квалитет во регионов и пошироко. Инволвирањето на науката во аграрот е еден од нашите водечки приоритети, со што го унапредуваме производството на здрава храна по квалитет и по квантитет, придонесуваме за развојот на индустријата за преработка на земјоделските производи, влијаеме во управувањето на македонските природни ресурси, а со тоа непосредно и во развојот на руралната и урбаната средина.

Ова издание на Годишниот зборник на Земјоделскиот факултет при Универзитетот „Гоце Делчев" е уште една потврда за нашата севкупна активност и стремеж за негување, подобрување и осовременување на македонското земјоделско производство.

Издавачки одбор **Одговорен уредник**
Штип, септември 2009 год. **Ректор, проф. д-р Саша Митрев**

INTRODUCTION

The "Goce Delcev" University – Stip, resumed operation following the enactment of the Law that founded it. The university opened on March 27th, 2007, and established itself as an institution of higher learning made up of four colleges and three affiliates located in Stip, Strumica and Kochani.

Today, a mere two years after its establishment, this university has developed into one of the leading centers of higher education in the Republic of Macedonia. It is now the second largest in the country, and consists of 14 colleges and affiliates in different municipalities, including Stip, Strumica, Kavadarci, Gevgelija, Kochani, Sveti Nikole, Vinica, Berovo, Radovish, Prilep and Skopje.

The university has entered its third academic year and already acquired state-of-the-art equipment for its amphitheaters, lecture rooms, laboratories and offices. In that short time 10.000 students and 500 employees came together to build their future and upgrade the foundation of this young, modern, but remarkably prosperous university.

As an integral part of the "Goce Delcev" University – Stip, the College of Agriculture pursued contemporary trends in higher education that complement the requirements of the national labor market. The college has organized its teaching and scientific work in four different municipalities: Stip, Strumica, Kavadarci and Sveti Nikole. The College of Agriculture, within its department of general studies that offers a three and a four year degree, is organized according to various modules: agricultural management in Stip, integrated agricultural production in Strumica, enology in Kavadarci and production and manufacturing of agricultural produce in Sveti Nikole.

The College of Agriculture dedicates a large portion of its activities to science and research, in addition to its educational/teaching function. This annual edition, the eight in a series, is the result of applied expertise and scientific research performed at the "Goce Delcev" University College of Agriculture.

Macedonian agricultural production has long experience and a rich tradition that has led to its excellent reputation in the broader region. Introducing science into the agrarian sector has been a priority in advancing the qualitative and quantitative production of healthy foods. This process contributes to the development of food manufacturing, and to the university's scientific impact on the proper management of Macedonia's natural resources. This has had a positive effect on the development of rural and urban environment.

This issue further confirms that our overall activity facilitates the goal of fostering, improving and modernizing Macedonian agricultural production.

Editorial Board **Editor in chief**
Stip, September, 2009 **Rector, Prof. Dr. Sasa Mitrev**

UDC: 635.655-158(497.2)"2002/04" Оригинален научен труд
Original research paper

DETERMINATION OF SURVIVAL AND RESTORATION ABILITY OF A SOYBEAN STAND ON A NATURAL BACKGROUND OF WEED INFESTATION

Plamen Atanasov Marinov-Serafimov*, Tsvetanka Georgieva Dimitrova*, Ljupco Mihajlov**

Abstract

The study was carried out during the 2002–2004 period in the Institute of Forage Crops – Pleven, branch Pavlikeni. The objective of the study was to determine survival and reproductive ability of soybean under a mixed type of weed infestation depending on environmental agro-climatic conditions. The weed infestation in the studied agrophytocenosis varied of 61.5 to122.6 plants/ m^2, with predominance: *Amaranthus spp.*, *Solanum nigrum* (L.) and *Sorghum halepense* (L.) Pers. Survival ability (l_x) of soybean plants grown on a natural background of weed infestation till technical ripeness of the crop was within the range of 0.76 to 0.96 and depended on the degree of weed infestation of the stand and rainfall amount. Soybean grown on a natural background of weed infestation under the conditions of the study had relatively good restoration ability (*R*) varying from 1.16 to 5.09.

Key words: *soybean (Glycine max (L.) Merril.), Survival ability, restoration ability*

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ОПРЕДЕЛУВАЊЕ НА ПРЕЖИВУВАЊЕТО И РЕГЕНЕРАТИВНАТА СПОСОБНОСТ НА ПОСЕВИ ОД СОЈА ПРИ ПРИРОДНИ УСЛОВИ НА ЗАПЛЕВУВАЊЕ

Пламен Атанасов Маринов – Серафимов*, Цветанка Димитрова*, Љупчо Михајлов**

Краток извадок

Испитувањето е направено во периодот од 2002 до 2004 година во Институтот за фуражни култури – Плевен, филијала Павликени. Целта на испитувањето беше да се утврди преживувањето и репродуктивната способност на сојата при мешан тип на плевелна вегетација и во зависност од агроклиматските услови на средината. Плевелна вегетација која преовладува на површина од 61,5 до 122,6 растенија/m^2 е од следниве видови: *Amaranthus spp*., *Solanum nigrum* (L.) и *Sorghum halepense* (L.) Pers.

Преживувањето (l_x) на сојата одгледувана при услови на доминантна плевелна вегетација од поникнување до техничка зрелост на културата се движи во граници од 0,76 до 0,96 и зависи од степенот на заплевување на посевите и од количеството на врнежи.

Сојата одгледувана во природни услови на заплевување во однос на условите на ова испитување има релативно добра обновителна способност (R), која варира во границите од 1,16 до 5,09.

Клучни зборови: *соја (Glycine max (L.) Merril.), преживување, обновителна способност.*

1. Introduction

Relatively low competitiveness of soybean against the weeds is determined by the slow growth rate at the initial stages of its development (Lyubenov, 1988; Stoimenova, 1989; Tjitrosemito, 1991; Hartzler, 2003; Marinov-Serafimov, 2005). Competitive effect of different weed species in a number of agricultural crops has been explained in many publications (Legere and Schreiber, 1989; Trankov, 1990; Alexieva and Stoimenova, 2002; Nacova, 2003; Conley and Stoltenberg, 2003; Nacova, 2004), but the studies concerned definite weed species in different agricultural crops and concrete soil and climatic conditions.

According to data of Stoimenova (1987), Alexieva and Stoimenova (2004) and Bensch et al. (2003), weed infestation of a soybean stand with *Amaranthus retroflexsus* (L.) and other species of late spring weeds till the end of crop vegetation decreased by 29.3 to 73.2% the structural elements

of yield (pod number, seed number and seed weight per plant). The reports on restoration ability of soybean are sporadic and extremely limited (Seidel and Hepperly, 2005). Georgiev (1997), Sabev and Tonchev (2001) found that soybean showed high restoration ability at the initial stages of its development, but those studies were directed to unfavorable abiotic factors of environment.

The objective of the study was to determine survival and reproductive ability of soybean under a mixed type of weed infestation depending on environmental agro-climatic conditions.

2. Materials and methods

The study was carried out between 2002 – 2004 year, in the Institute of Forage Crops – Pleven, branch Pavlikeni, on a soil subtype of moderately leached *chernozem* with the soybean variety Pavlikeni 121. The trial was laid out by the perpendicular method with four replications and a size of harvest plot of 5 m^2 under non-irrigating conditions and standardized stand density of 250 000 plants ha^{-1} with the following variants: 1) soybean grown in a weed-free stand; 2) soybean grown on a natural background of weed infestation.

The degree and species composition of weed infestation in the studied variants were determined by the quantitative method at the end of crop vegetation in number/m^2 in constant sampling plots of 1 m^2.

The survival ability of soybean plants was determined at the end of crop vegetation in an area of 5 m^2 with four replications for all trial variants. The yield structural elements (pod number, seed number and seed weight per plant) were determined by the methodology of Stoimenova (1990).

The survival ability under weed infestation of soybean was determined by the methodology of Begon et al. (1986).

The following formulas were used for mathematical processing of experimental data of the characteristics:

Reproduction frequency (R): $R = \frac{\sum m_{X1}}{\sum m_{X2}}$;

Plant survival ability till the end of vegetation (l_x): $l_x = m_{x2}/m_{x1}$;

Death intensity of soybean plants (K_X): $Kx = gm_{x1} - lgm_{x2}$;

where: m_{X1} - plant number m^2 and structural elements of yield (pod number, seed number and seed weight per plant) at the end of crop vegetation in the control variant - soybean grown in a weed-free stand; m_{X2} - plant number m^2 and structural elements of yield (pod number, seed number and seed weight per plant) at the end of crop vegetation in the variant of soybean grown on a

natural background of weed infestation; *lg* – logarithm.

Death of soybean plants (d_x): $d_x=l_{x2}-l_{x1}$;

where: $l_{X1} = 1.0$ (constant) – survival ability of soybean plants per m^2 and structural elements of yield (pod number, seed number and seed weight per plant) at the end of crop vegetation in the control variant - soybean grown in a weed-free stand; l_{X2} - survival ability of soybean plants per m^2 and structural elements of yield (pod number, seed number and seed weight per plant) at the end of crop vegetation on a natural background of weed infestation.

Rate of natural increase of population (r_r): rr lnR ;

where: (*R*)- reproduction frequency of soybean plants; *ln* – natural logarithm.

Agro-meteorological conditions during the growing season of the studied soybean agrophytocenosis were also observed. Major agro-climatic characteristics of the period of study were recorded: rainfall amount (in mm) and average 24-hour air temperature on average for the growing season (in ^{0}C). The Marton's index (I) was used to characterize the aridity during the growing season (after Kuzmova, 2003). Mathematical and statistical processing of the experimental data was performed with the programme product STATGRAPHICS Plus for Windows Version 2.1.

3. Results and discussion

Estimating the complex effect of some major meteorological factors, rainfall amount and average 24-hour air temperatures, with regard to soybean biological requirements during the crop growing season, the studied years can be divided conventionally into two groups: 2002 and 2004 – with favorable conditions for soybean growth and development at aridity (I) of the growing season: 34.9 and 24.1, respectively and 2003 – unfavorable at aridity of 14.7, since I<20 (Table 1)

The total rainfall amount during the period of study can be presented in the following ascending order: 2003 < 2004 < 2002 and in inverse relation with regard to average 24-hour air temperatures. The agro-meteorological conditions during the years of study (except for 2003) showed slight temperature deviations –0.3 ^{0}C and stronger variability in the rainfall amount from 60 to 161%, as compared to those for the many-year period (Table 1).

The weed density in the studied agrophytocenosis varied within relatively wide limits from a number of 61.5 to 122.6 m^2 (on average for the period a number of 92.1 m^2) and depended on rainfall amount and distribution during the growing season. The weed infestation was a mixed type, with predominance of late spring weeds 90.5%: Solanum nigrum (L.) – 49.3% and Amaranthus spp.

- 37.3% and some rhizomatous ones, such as Sorghum halepense (L.) Pers. – 9.5% in the weed communities (Table 2).

Irrespective of that the weed numbers in the studied agrophytocenosis was a variable value, it changed within certain limits. In years supplied with rainfall (2002 and 2004), the degree of weed infestation ranged from a number of 92.2 to 122.6 m^2 and remained on a definite level with different deviation and in years with drought, such as 2003, the degree of weed infestation was a number of 61.5 m^2 (Table 2).

The changes in the soybean plant density depended on rainfall amount and distribution and method of crop growing – with weeds and as a pure stand. In years supplied with rainfall (2002 and 2004) till the phenological stage of technical ripeness the coefficient of soybean plant death (d_x) varied from 0.04 to 0.15 and in years with drought (2003) to 0.24, as compared to the control variant, the differences being statistically significant at P=0.05% except for 2002.

The analysis (Table 3) of the results of survival ability (l_x) of the soybean plants grown on a natural background of weed infestation in relatively favorable years for soybean development (2002 and 2004) varied within comparatively narrow limits from 0.85 to 0.96, while in the relatively unfavorable year 2003 the survival ability of the soybean plants was 0.76.

Death intensity of soybean plants (K_x) varied from 0.02 to 0.14 and depended on the degree of stand weed infestation and on the concrete agro-meteorological conditions for the period of study.

In years supplied with rainfall (2002 and 2004) (K_x) ranged from 0.02 to 0.14 and with drought (2003 year) – 0.12. The higher death intensity of soybean plants in the relatively favorable year 2004, as compared to the dry year 2003, could be explained by the higher degree of stand weed infestation, which resulted also from density increase in the studied agrophytocenosis (Tables 2 and 3). Lewerich and Levin (1979), determining the death intensity of Ph. drummondii, reported similar results.

The yield structural elements (pod number, seed number and seed weight per plant) were variable values, varied within a wide range and depended on the agro-meteorological factors – rainfall and average 24-hours air temperature amount during the soybean growing season and degree of stand weed infestation.

Since the density of the soybean stand was the same, 250 000 plants ha^{-1} in all trial variants, the yield structural elements (pod number, seed number and seed weight per plant) depended mainly on stand weed infestation and on rainfall amount and distribution during the crop growing season.

During the years of study (2002 – 2004), the weed infestation of the soybean stand from emergence to technical ripeness exerted a negative influence on the structural elements of the yield from a soybean plant, the differences being statistically significant at P=0.05% for all studied characteristics.

The reduction of the yield structural elements (d_x) in the weed infested variants varied as follows: pod number from 0.65 to 0.90, seed number from 0.76 to 0.94 and seed weight per plant – from 0.32 to 0.97, as compared to the control variant.

In years with drought (2003), the reduction of the yield structural elements (d_x) (pod number, seed number and seed weight per plant) ranged from 0.90 to 0.97, as compared to the control variant and in years (2002 and 2004) supplied with rainfall for soybean development, that reduction varied from 0.32 to 0.81.

The intensity of reduction of the yield structural elements (K_x) depended on the same factors and followed the relations found in the reduction (d_x) of the yield structural elements. In years supplied with rainfall (2002 and 2004) (K_x) varied from 0.17 to 0.76 and in years with drought from 0.72 to 1.25.

The intensity of reduction (K_x) of the yield structural elements depended on the integral effect of agro-meteorological factors and stand-weed infestation could be arranged in the following ascending order: seed weight per soybean plant → pod number per plant → seed number per plant.

All structural elements of the yield were in correlation relation to rainfall amount and distribution during the soybean growing season (r varied from 0.758 to 0.998) and to degree of stand weed infestation (r was within the range of 0.836 to 0.999).

The analysis of the obtained results during the years of study showed that the reproduction rate (R) and the rate of natural increase of population density (r_r) of the soybean plants in the studied agrophytocenosis varied within the limits from 0.15 to 5.09 (Table 3).

The highest values – from 1.43 to 5.09 were found for (R) and (r_r) when observing the number of pods and seeds per plant in the studied agrophytocenosis, while the reproduction coefficients (R) and the increase rate (r_r) of plant number and seed weight per plant ranged from0.15 to 2.22. Therefore, soybean possessed relatively good restoration ability depending on the method of its growing – as a pure stand or in an agrophytocenosis.

Irrespective of the relatively high reproduction coefficients (R) of soybean grown on a natural background of weed infestation, a decrease of the yield structural elements was found averagely for the period of study, as follows: pod number - 78.7%, seed number - 83.3% and seed weight per plant - 67.3%. Therefore, the stand weed infestation and meteorological factors (rainfall amount and average 24-hour air temperatures) were the most important factors limiting the soybean plant development and determining the soybean grain yield.

4. Conclusion remarks

The weed infestation in the studied agrophytocenosis was a mixed type; with predominance of late spring weeds - 90.5% including: *Solanum nigrum* (L.) – 49.3%; *Amaranthus spp.* – 37.3%; *Setaria spp.* – 11.0%; *Chenopodium album* (L.) – 2.2%; *Abutilon theofrasti* Medic and *Hibiscus trionum* (L.) – 0.1% and rhizomatous weeds - *Sorghum halepense* (L.) Pers. – 9.5%.

The degree of stand weed infestation varied within relatively wide limits from a number of 61.5 to 122.6 /m^2 and depended on rainfall amount and distribution during the soybean growing season.

All structural elements of yield (pod number, seed number and seed weight per plant) varied within a wide range and depended on rainfall amount and distribution during the soybean growing season (r varied from 0.758 to 0.998) and degree of stand weed infestation (r ranged from 0.836 to 0.999).

Under the conditions of the study and weed infestation character, the survival ability (l_x) of the soybean plants till the phenological stage of crop technical ripeness was within the range from 0.76 to 0.96.

Soybean grown on a natural background of weed infestation under the conditions of the study had relatively good restoration ability (R) varying from 1.16 to 5.09 and there was a slight increase of soybean plant population - r_r ranged from 0.15 to 1.63.

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Table 1. Rainfall amount (mm), air temperature (0C) and index of aridity (I) for the for the April – September period
Табела 1. Сума на врнежи (mm), температура на воздухот и коефициенти на засушување за периодот од април-септември

Years Години	Rainfall (mm) Врнежи (mm)		Average 24-hour air temperature (0C) Среднодневна температура на воздухот (0C)		Index of aridity (I) for (IV – IX) Индекс на аридност за (IV – IX)
	For the 1961-2000 period / За периодот 1961-2000				
	IV – IX 322.4 mm	Deviation, % Отстапување %	IV – IX 18.6 0C	Deviation, 0C Отстапување 0C	
2002	518.6	161	18.9	-0.3	34.9
2003	194.8	60	20.3	+1.4	14.7
2004	349.8	109	18.9	-0.3	24.1

Note: The period was arid at I < 20 / Бележка: Периодот беше ариден при I < 20

Table 2. Dynamics of weed density during the 2002-2004 period of study
Табела 2. Динамика на плевелната вегетација за периодот од 2002 - 2004год.

Biological groups of weeds Биолошки групи на плевели	Years / Години			Average for 2002-2004 Средно за периодот 2002-2004	% of total quantity % на вкупно количество
	2002	2003	2004		
I. Late spring weeds, including: I. Доцни пролетни плевели:					90.5
Abutilon teofrasti Medic.	0.0	0.2	0.0	0.07	0.1
Amaranthus spp.	13.0	12.7	67.6	31.10	37.3
Chenopodium album L.	1.0	0.5	4.0	1.83	2.2
Hibiscum trionum L.	0.0	0.1	0.1	0.07	0.1
Solanum nigrum L.	36.4	36.4	50.4	41.07	49.3
*Setaria spp.	16.0	11.6	0.0	9.20	11.0
II. Rhizomatous weeds II. Коренищни: *Sorghum halepense (L.) Pers.	25.8	0.0	0.5	8.77	9.5
Total / Вкупно	92.2	61.5	122.6	92.1	100

* stem number / m2 / број на стебла / m2

Table 3. Survival ability of soybean plants depending on the method of crop growing
Табела 3. Преживување на сојата во зависиност од начинот на одгледување на културата

Period Период	Variants Варијанти	Characteristics / Карактеристики						
		m_x	l_x	d_x	K_x	$l_x.m_x$	R	r_r
Plant number m2 / Број на растенија m2								
2002	1	25.0a	1.00	-	-	25.0	1.16	0.15
	2	24.1a	0.96	0.04	0.02	23.1		
2003	1	25.0b	1.00	-	-	25.0		
	2	19.1a	0.76	0.24	0.12	14.5		
2004	1	25.0b	1.00	-	-	25.0		
	2	21.3a	0.85	0.15	0.14	18.1		
Pod number per plant / Број на мешунки на 1 растение								
2002	1	44.6b	1.00	-	-	44.6	4.18	1.43
	2	15.7a	0.35	0.65	0.39	15.1		
2003	1	18.1b	1.00	-	-	18.1		
	2	1.8a	0.10	0.90	1.00	1.4		
2004	1	53.9b	1.00	-	-	53.9		
	2	10.4a	0.19	0.81	0.76	8.9		
Seed number per plant / Број на семиња на 1 растение								
2002	1	120.6b	1.00	-	-	120.6	5.09	1.63
	2	28.6a	0.24	0.76	0.63	27.6		
2003	1	40.7b	1.00	-	-	40.7		
	2	2.3a	0.06	0.94	1.25	1.8		
2004	1	115.0b	1.00	-	-	115.0		
	2	23.3a	0.20	0.80	0.69	17.1		
Seed weight per plant / Тежина на семиња по 1 растение								
2002	1	15.0b	1.00	-	-	15.0	2.22	0.80
	2	4.0a	0.27	0.73	0.57	3.9		
2003	1	2.4b	1.00	-	-	2.4		
	2	0.08a	0.03	0.97	0.72	0.06		
2004	1	16.3b	1.00	-	-	13.9		
	2	11.1a	0.68	0.32	0.17	9.5		
LSD at 95% confidence interval / LSD при 95% доверителен интервал								

Legend: 1) soybean grown in a weed-free stand; 2) soybean grown on a natural background of weed infestation; m_x – experimentally recorded plant number m^2, pod number, seed number and seed weight per plant at the end of crop vegetation; l_X –survival ability of plants till the end of vegetation; dx – death of soybean plants; K_x – death intensity; $l_x.m_x$ – numerical values of the studied characteristics depending on the method of soybean growing; R – reproduction frequency; r_r – rate of natural increase of the population.

Легенда: 1) соја одгледува во плевелно чисти посеви; 2) соја одгледувана во природно заплевени услови; m_x – експериментално бележан број на растенија на m^2, број на мешунки, број на семиња и тежина на семињата од едно растение при крај на вегетацијата на културата; l_X - преживеаност на растенијата на крај од вегетацијата; dx - изумирање на сојта; K_x - интензитет на изумирање; $l_x.m_x$ – бројната вредност на испитуваните карактеристики зависи од начинот на одгледување на сојата; R - фрекфенција на репродукција; r_r - мерки за природно зголемување на популацијата.