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Yield and Yield Components of Alfalfa Seed as Affected by the Sowing System Employed

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Abstract: Investigations of the seed yield and yield components of alfalfa cv. NS Slavija were conducted under agroenvironmental conditions in the region of the City of Nis on alluvial soil. An analysis was made of three-year research results obtained by alfalfa cultivation at inter-row spacings of 20cm, 40 cm and 60 cm. Under changeable climatic conditions in the above region, an average seed yield of 287.4 kgha-1 was obtained, the highest and the lowest yields being produced at inter-row spacings of 40 cm (311 kgha-1) and 60 cm (264.8 kgha-1), respectively. The highest number of inflorescences per stem was obtained at the 60 cm spacing (14.4 inflorescences/stem), the lowest number being recorded at the 20 cm spacing (9.9 inflorescences/stem), giving an average number of 12.6 inflorescences/stem. Planting at an inter-row spacing of 60 cm (8.10 pods/inflorescence) yielded the highest number of pods/inflorescence, whereas the lowest number was produced at the 20 cm spacing (5.91 pods/inflorescence). The number of grains per pod ranged from 3.64 (at the row spacing of 20 cm) to 4.18 (at the row spacing of 60 cm). A weak positive correlation was determined between the number of inflorescences/stem and seed yield (r=0.389), as opposed to the pod number/inflorescence and grain number per pod having a strong positive correlation with the seed yield (r= 0.764 and r=0.719, respectively).

Key words: alfalfa, seed yield, inter-row spacing, seed yield components.

Introduction

Alfalfa has high genetic potential for forage yield, which is often found to correlate negatively with the seed yield. As regards alfalfa acreage, about 900 t of quality seed in Serbia are needed on an annual basis (Karagic *et al*. 2007). An average alfalfa seed yield in Serbia is c.250 kg ha^{-1}, the great variations registered being dependent on agroenvironmental conditions. Therefore, alfalfa seed production is generally conducted on alfalfa areas used for the dual purpose of producing forage and retaining a cut of alfalfa, preferably the second one, for seed production.

Seed yield is considerably affected not only by climatic factors, but also by inter-row spacing, i.e. by an optimal number of plants per unit area. The stated factor has been a subject matter of research for a long time both worldwide and in Serbia. Numerous investigations reported high yields and quality of alfalfa seed as obtained by sowing alfalfa into wider rows and at lower seed rates used (Marble 1970, Eris 1988, Sowinski *et al*. 1996, Lukic 2000 *et al.*). However, other researches have revealed that wide-rowed crop planted at a lower seed rate does not always provide higher seed yields as compared to the narrow-rowed one with the inter-row spacing below 25 cm and higher seed rates as used in livestock forage production (Lovato and Montanari 1991, Vuckovic 1994). Given the importance of alfalfa, the objective of the present research was to examine the effect of the sowing system, i.e. the inter-row spacing employed on the yield and yield components of alfalfa seed.

Material and Method

The researches were conducted over 2001-2003 in the City of Nis suburbs. The alfalfa cv. NS Slavija was planted at three inter-row spacings of 20 cm, 40 cm and 60 cm on alluvial soil. In the first study year, being the year of crop establishment for examination of the yield and yield components of alfalfa seed, the first growth was used, and in the second and third years – the second one. Long-term data show that the region of Nis is characterized by a long summer period of drought extending through all summer months. However, during 2001, higher precipitations and more favourable distribution thereof induced two shorter periods of drought (May and July) and a bit longer one in September (Tab. 1). In 2002, drought lasted from mid May to the end of July, high precipitations registered in August affecting the maturation of alfalfa seed, hampering harvest and inducing seed yield losses. The most favourable conditions for alfalfa seed production were recorded in 2003, the year characterised by an extended period of drought during summer (Tab. 1). The yield of alfalfa seed was determined at a stage when 70-80% of the pods turned brown. The number of inflorescences per stem was identified upon sampling of 20 stems per replication, and that of flowers per inflorescence and pods/inflorescence was determined on a sample of 30 well developed inflorescences collected uniformly from the top, middle and bottom sections of the stem in each replication. The number of seeds per pod was obtained by calculating 30 randomly selected pods in each replication. The results were subjected to the analysis of variance (ANOVA), and the significance of differences between the values obtained were analyzed by the LSD test. The coefficient of correlation (r) was calculated in order to examine the correlation between the properties studied.

Tab. 1. Mean monthly temperatures (^{O}C) and total monthly precipitations (mm) over 2001-2003.

Year	Months												Aver.
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	I-XII
	Temperature – C^{O}												
2001	4.9	4.1	1.4	11.2	17.5	18.7	23.1	23.5	17.3	14.5	5.3	2.2	12.4
2002	-0.1	8.1	9.9	12.0	18.9	20.3	25.0	21.9	16.7	12.6	9.0	0.9	12.9
2003	0.1	-1.5	6.5	11.7	20.6	25.3	25.4	27.0	18.1	11.9	4.1	4.1	13.2
	Precipitation / mm												Σ
2001	20.9	41.5	60.2	165.5	40.9	89.0	56.9	87.1	127.2	5.8	42.6	18.2	755.8
2002	6.2	16.3	47.9	91.2	51.8	55.2	76.1	138.9	56.0	43.9	34.8	70.2	688.5
2003	84.2	16.0	8.2	42.0	74.9	33.9	32.1	26.8	43.2	132.2	10.9	2.7	507.1

Results and Discussion

The three-year results suggested that the highest and lowest yields of alfalfa seed were produced at the inter-row spacings of 40 cm (311 kg ha^{-1}) and 60 cm (264.8 kg ha^{-1}), respectively, the 20 cm spacing giving the yield of 286.5 kg ha^{-1} (Tab. 2).

Tab. 2. Seed yield, number of plants/ m^2, number of stems/ m^2 and plant height

Year	Inter-row spacing	Seed yield kg ha^{-1}	Seed components		
			No. of inflorescences per stem	No. of pods per inflorescence	No. of grains per pod
2001	20 cm	180.3	7.92	4.32	3.05
	40 cm	141.7	8.85	6.25	3.65
	60 cm	131.5	10.01	6.07	3.70
Average		151.2	8.93	5.55	3.46
LSD 0.05		17.78	0.56	0.32	0.19
0.01		23.65	0.75	0.42	0.25
2002	20 cm	232.8	11.25	5.95	3.68
	40 cm	288.8	17.08	7.27	3.80
	60 cm	255.5	17.95	8.32	4.10
Average		259.0	15.43	7.18	3.86
LSD 0.05		21.15	1.18	0.34	0.25
0.01		28.13	1.57	0.46	0.33
2003	20 cm	446.3	10.65	7.45	4.18
	40 cm	502.6	14.95	10.25	4.45
	60 cm	407.5	15.22	10.05	4.75
Average		452.2	13.6	9.25	4.46
LSD 0.05		26.33	0.94	0.55	0.29
0,01		35.02	1.25	0.73	0.38
Average 2001-2003	20 cm	286.5	9.94	5.91	3.64
	40 cm	311.0	13.63	7.92	3.96
	60 cm	264.8	14.40	8.10	4.18

The examination of the research years showed that 2001, the year of crop establishment, saw an average yield of 151.2 kg ha^{-1}, being considered a satisfactory one. In 2002, the average yield was 255.5 kg ha^{-1}, being in conformity with the republic average, whereas the highest yield was achieved in 2003 (an average of 452.2 kg ha^{-1}), the result obtained confirming the fact that the production of alfalfa seed was affected by weather conditions during the growing season of the seed crop. Similar results were reported by Eric (1988) who stressed that the highest seed yields were produced by sowing at spacings of 30 cm and 40 cm (251.4 kg ha^{-1} and 221.2 kg ha^{-1}, respectively), the lower seed yield being obtained with a further increase in row spacing to 50 cm (194.6 kg ha^{-1}). Askarian *et al.* (1995) showed that the highest seed yield was obtained by sowing the crop at a spacing of 45 cm (177.0 kg ha^{-1}), the seed yield decreasing as the row spacing was increased to 60 cm (149.0 kg ha^{-1}), but also as it was decreased to 30 cm and 15 cm (166.0 kg ha and 136.0 kg ha^{-1}, respectively). Similarly, Stanisavljevic *et al.* (2007) reported that the medium crop density (343.6 kg ha^{1}) produced the highest yields, as opposed to increasing and decreasing spacings inducing decreasing yields.

The highest number of inflorescences/stem was produced at the highest row spacing (14.4 inflorescences/stem), the lowest at a spacing of 20 cm (9.94 inflorescences/stem). In terms of the research years, 2002 gave the highest number of inflorescences/stem (15.43 inflorescences/stem), as opposed to the year of crop establishment yielding the smallest number (8.93 inflorescences/stem), whereas 13.60 inflorescences/stem were reported for 2003 (Tab. 2). The number of pods/inflorescence ranged from 5.91, as recorded at the stage of sowing at the 20 cm spacing, to 8.10 pods/inflorescence (inter-row spacing of 60 cm). As regards the research years, the highest number of pods/inflorescence was registered in 2003 (9.25 pods/inflorescence), the year characterized as being the most favourable one for seed production, and the lowest one in 2001 (5.55 pods/inflorescence). The 60 cm and 20 cm plant spacings produced the highest and the lowest number of grains/pod (4.17 and 3.64 grains/pods, respectively). The highest number of grains/pod (4.46 grains/pod) was produced in 2003, the lowest – in 2001 (3.46 grains/pod). Karagic (2004) reported the average number of 9.66 inflorescences per stem, 9.03 pods/inflorescence and 5.47 seeds/pod in the second and third years of alfalfa establishment. According to Ilic (2005), the number of flowers/inflorescence in 17 genotypes examined was 14.0 inflorescences/stem on average, whereas Djurovic *et al*. (2007) obtained an average of 9.37 inflorescences/stem, 7.31 pods/inflorescence and 5. 53 grains/pod in 5 genotypes studied.

Tab. 3. Correlation coefficient (r) of seed yield and yield components

	No. of inflorescences per stem	No. of pods per inflorescence	No. of grains per pod
Seed yield kg ha^{-1}	0.389	0.764	0.719

The examined seed yield components in alfalfa were found to correlate positively with seed yield (Tab. 3). The most significant positive correlation was observed between seed yield and pod number/inflorescence (r= 0.764), a weaker one

between the grain number/pod (r=0.719), and the weakest between the inflorescence number/stem and seed yield (r=0.389). Djurovic *et al.* (2007) reported the significant positive correlation between the seed yield and inflorescence number/stem i.e. pod number/inflorescence (r=0.52), as well as between seed yield and grain number/pod (r=0.47). The interdependence of seed yield and yield components was also reported by Hasquet (1990), Bolanos -Aguilar *et al*. (2001) etc.

Conclusion

The examination on the seed yield and yield components of alfalfa cv. NS Slavija suggested the following:

The highest and the lowest average three-year alfalfa seed yields under the environmental conditions of the Nis region were produced by sowing the crop at an inter-row spacing of 40 cm (311.0 kg ha^{-1}) and 60 cm (264.8, kg ha^{-1}), respectively. Seed yield was substantially affected by weather conditions, the highest average yield being obtained in 2003 (452.2 kg ha^{-1}) and the lowest in 2001 (151.2 kg ha^{-1});

The sowing system employing the inter-row spacing of 60 cm gave the highest number of inflorescences/stem, pods/inflorescence and seed/pod, the one using the 20 cm spacing producing the lowest numbers. Seed yield components were also greatly affected by weather conditions that induced considerable differences over the three-year research period. A significant positive correlation was found between the yield components and seed yield.

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PRINOS I KOMPONENTE PRINOSA SEMENA LUCERKE U ZAVISNOSTI OD NAČINA SETVE

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Rezime

Ispitivanja prinosa i komponenti prinosa semena lucerke sorte NS Slavija, izvršena su u agroekološkim uslovima niškog regiona na zemljištu tipa aluvijum. Analizirani su rezultati trogodišnjih ispitivanja, pri setvi lucerke na međurednim rastojanjima od 20 cm, 40 cm i 60 cm. U promenljivim klimatskim uslovima ovog regiona, ostvaren je prosečan prinos semena od 287,4 kgha^{-1}, najviši pri setvi na međurednom rastojanju od 40cm (311 kgha^{-1}) dok su najniži prinosi ostvareni setvom na međurednom rastojanju od 60 cm (264,8 kgha^{-1}). Ostvareno je prosečno 12,6 cvasti/stabljici pri čemu je najviše cvasti bilo pri setvi na međurednom rastojanju od 60 cm (14,4 cvasti/stabljici) a najmanje pri rastojanju od 20 cm (9,9 cvasti/stabljici). Najviše mahuna/cvasti bilo je pri setvi na rastojanju od 60 cm (8,10 mahuna/cvasti), a najmanje pri setvi na međurednom rastojanju od 20cm (5,91 mahuna/cvasti). Broj zrna po mahuni se kretao od 3,64 (međuredno rastojanje od 20 cm) do 4,18 zrna/mahuni (rastojanje od 60cm). Utvrđena je slaba pozitivna korelativna veza između broja cvasti/stabljici i visine prinosa semena (r=0,389), dok su broj mahuna/cvasti i broj zrna u mahuni imali jaku pozitivnu korelaciju sa prinosom semena (r= 0,764 odnosno r=0,719).