EFFECTS OF GENOTYPE, GROWING CONDITIONS, AND SEVERAL PARAMETERS OF SUNFLOWER ATTRACTIVENESS FOR BEE VISITATION

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Abstract

Effects of genotype and fertilizers on the production and availability of nectar and visitation by pollinators were analyzed. We analyzed four sunflower hybrids (Velja, NS-H-45, NS-H-111 and NS-H-702) and their parental lines grown in three fertilization treatments. Disc flower corolla length and nectar content were studied in the hybrids and their parental lines. The monitoring of bee visitation at flowering was done nine times per day. Nectar content was determined with the use of the micropipette method. The flower nectar content differed significantly among the genotypes, ranging from 2.53 mg/10 flowers (Velja) to 15.57 mg/10 flowers (Ha-98B) in 2002, and from 2.45 mg/10 flowers (Velja) to 9.65 mg/10 flowers (Ha-74A) in 2003. The highest average nectar content in 2002 (7.36 mg/10 flowers) was found in the control treatment and the lowest (6.67 mg/10 flowers) in the 100:100:100 NPK treatment, while in the next year we obtained the opposite results. The highest bee attendance was recorded in NS-H-111 in the first year and in NS-H-702 in the second year, and the lowest in Velja in both years. The largest bee attendance was recorded in the 50:50:50 treatment in both years. Corolla length in the treatments ranged from 9.11 mm (control) to 9.23 mm (100:100:100), while in the genotypes it ranged between 7.95 mm (Ha-26B) and 11.14 mm (CMS-3-8B). The longest corollas were found in flowers whose pistils had not yet emerged (9.51 mm). The largest bee attendance was observed at 0900h.

Introduction

Sunflower (*Helianthus annuus* L.) attractiveness for pollinators is caused by several factors. The most important of them are flower color and scent, and nectar and pollen content and quality. The importance of these factors varies depending on the environment. In Serbia and Montenegro, the most important sunflower pollinator is the domestic bee that represents 50-90% of all sunflower pollinators (Miklič, 1996). Seed yield at the locations without bees is lower because of lower fecundation (Špehar et al., 1986; Waghchoure et al., 1988). Some

authors found that the bee visitation is directly influenced by nectar production (Golubović et al., 1992; Kamler, 1997), while others did not observe this phenomenon (Montilla et al., 1988; Matienko, 1992).

Corolla length affects the nectar availability and bee visitation, and indirectly affects the number of seeds formed. According to the results of Balana et al. (1992), the mouth part with which bee takes the nectar is 6.46 mm long. Joksimović et al. (1996) found variability in corolla length. It varied from 7 to 11.2 mm in A analogs, from 7.7 to 10 mm in B analogs, and from 6.7 to 9.2 mm in restorer lines.

The effect of environmental factors on nectar secretion and bee visitation is very strong. The decrease in honey production, as well as in seed yield, from sunflower fields recorded during previous years, concurs with a general decrease in the level of cultivation, and especially with the decrease and complete absence of sunflower fertilization.

The effect of weather on nectar secretion and bee visitation is even greater. Because of the global climate change in the last few years, the weather conditions during sunflower flowering were not favorable. The influence of certain weather factors is different and very complex.

The aim of this experiment was to explain complex influence of genotype, fertilization and year on nectar production and availability, as well as on bee visitation in sunflower.

Materials and Methods

Four sunflower hybrids (Velja, NS-H-45, NS-H-111 and NS-H-702) and their parental lines were used in this experiment. Tested genotypes were mechanically sown on a station trial for fertilizer treatments started in 1996. The distance between rows was 70 cm, the distance within the row 25 cm.

The effect of fertilizers was studied in four treatments (control, 50N:50P2O5:50K2O, 100N:100P2O5:100K2O, 150N:150P2O5:150 K2O), and nectar content and corolla length in the first three treatments. The sample size for the seed yield determination was 100 plants per repetition and 300 plants on the trial level per treatment; for nectar content, 10 flowers per plant; and for corolla length, 30 flowers per plant; three plants per treatment. Nectar content in flowers was measured by the microcapillary method, and corolla length was determined with millimeter paper. Flowers whose pistils had withdrawn (marked as the flowers of the first zone), flowers whose pistils had stigmas (flowers of the second zone) and flowers whose pistils had not yet emerged (flowers of the third zone) were taken for corolla length determination.

Bee visitation was observed only in hybrids, during the whole flowering period (10-11 days depending on the hybrid), from 22 June to 9 July, 2002, and from 19 June to 6 July, 2003. Bee counting on capitula was done on nine occasions, at 0700, 0800, 0900, 1100, 1300, 1500, 1600, 1700, and 1900h. The number of bees was observed on ten capitula.

Obtained results were analyzed by ANOVA for two-and three-factorial trials (statistical program MSTATC).

Results and Discussion

The highest nectar content in 2002 was observed in a fertile analogue of line Ha-98 (15.57 mg/10 flowers), while hybrid Velja had the lowest nectar content (2.53 mg/10 flowers). In that year, significant differences between genotypes were found (Table 1). Mother components had significantly higher nectar content than hybrids, and in most cases restorer lines as well. Sterile analogues had higher nectar content than fertile analogues in three out of four cases, but the differences were not significant. Line RHA-583 had the highest nectar content among restorer lines (6.10 mg/10 flowers), and line RHA-113N had the lowest nectar content (2.74 mg/10 flowers).

The lowest average nectar content was found in the 100:100:100 treatment, while the other variants did not differ significantly. However, when the results for single genotypes were taken in account, fertilization did not have any specific effect on nectar content.

Table 1. Nectar content in 2002 (mg/10 flowers).

Genotype	Fertilization			Av. Genotype
	0:0:0	50:50:50	100:100:100	
Velja	2.96	1.88	2.76	2.53
NS-H-45	3.84	4.16	5.90	4.63
NS-H-111	3.76	4.00	4.68	4.15
NS-H-702	6.74	3.74	3.66	4.71
RHA-113N	2.18	3.36	2.68	2.74
RHA-r-pl-	3.08	4.58	2.80	3.49
RHA-583	5.64	6.16	6.50	6.10
CMS-3-8A	7.42	6.30	7.36	7.03
CMS-3-8B	5.70	6.14	6.86	6.23
Ha-74A	16.88	9.22	10.98	12.36
Ha-74B	8.40	16.38	8.12	10.97
Ha-26A	7.74	8.40	2.76	6.30
Ha-26B	6.52	5.86	3.46	5.28
Ha-98A	14.32	14.40	14.58	14.43
Ha-98B	15.26	14.48	16.98	15.57
Av. Fertil.	7.36	7.27	6.67	7.10

LSD	Genotype	Fertilization	Gen. x Fertilization
5%	0.92	0.41	1.59
1%	1.21	0.54	2.10

The highest nectar content in 2003 was in the sterile analogue of line Ha-74 (9.65 mg/10 flowers), while the lowest nectar content was found in hybrid Velja (2.45 mg/10 flowers). The differences between genotypes were significant (Table 2). Sterile analogs had a higher nectar content than fertile analogs in three out of four cases, and those differences were significant in two cases. RHA-583 had the highest nectar content among restorer lines (6.14 mg/10 flowers), and the lowest nectar content was found in RHA-113N (2.54 mg/10 flowers).

The lowest average nectar content was found in the control fertilization treatment, while the other two treatments did not differ significantly.

Table 2. Nectar content in 2003 (mg/10 flowers).

Genotype	Fertilization			Av. Genotype
	0:0:0	50:50:50	100:100:100	
Velja	2.42	1.88	3.04	2.45
NS-H-45	3.94	5.58	6.60	5.37
NS-H-111	3.28	6.60	5.38	5.09
NS-H-702	4.66	5.96	4.20	4.94
RHA-113N	1.58	2.26	3.78	2.54
RHA-r-pl-	2.80	4.02	2.10	2.97
RHA-583	5.46	5.76	7.20	6.14
CMS-3-8A	4.80	4.54	5.92	5.09
CMS-3-8B	4.36	5.40	6.80	5.52
Ha-74A	10.40	8.44	10.12	9.65
Ha-74B	7.38	8.26	8.98	8.21
Ha-26A	3.00	5.62	2.28	3.68
Ha-26B	3.72	4.44	2.46	3.54
Ha-98A	8.04	7.86	7.88	7.93
Ha-98B	6.98	7.64	7.00	7.21
Av. Fertil.	4.85	5.62	5.59	5.36

LSD	Genotype	Fertilization	Gen. x Fertilization
5%	0.68	0.30	1.18
1%	0.90	0.40	1.55

The longest corollas among mother components, as well as among all genotypes were found in CMS-3-8B (11.14 mm), and the shortest in Ha-26B (7.95 mm). The differences between genotypes were significant (Figure 1). NS-H-111 and NS-H-702 had the longest corollas among the hybrids (9.56 and 9.55 mm, respectively), and Velja had the shortest ones (8.57 mm). RHA-583 was the restorer with the longest corollas (9.15 mm), and RHA-R-pl-2/1 with the shortest ones (8.12 mm).

Significantly shorter corollas were found in the first fertilization treatment (9.11 mm), while the other two treatments did not differ significantly. Average corolla length in the first zone was 8.84 mm, in the second zone was 9.21 mm, and in the third zone 9.51 mm. The differences between lengths were significant.

The largest bee attendance in the flowering period was observed in hybrid NS-H-111 in 2002, and in hybrid NS-H-702 in 2003, while in both years hybrid Velja had the lowest bee attendance (Figure 2). The largest bee attendance in the both years was found in the 50:50:50 treatment. Bee attendance was higher in the first year than in the second.

The lowest bee attendance, as well as lowest nectar content was observed in hybrid Velja. Based on these observations it can be concluded that the bee attendance is directly correlated with the nectar content, which is in accordance with the results obtained by

Golubović et al. (1992) and Kamler (1997), but in disagreement with the results of Montila et al. (1988) and Matienko (1992).

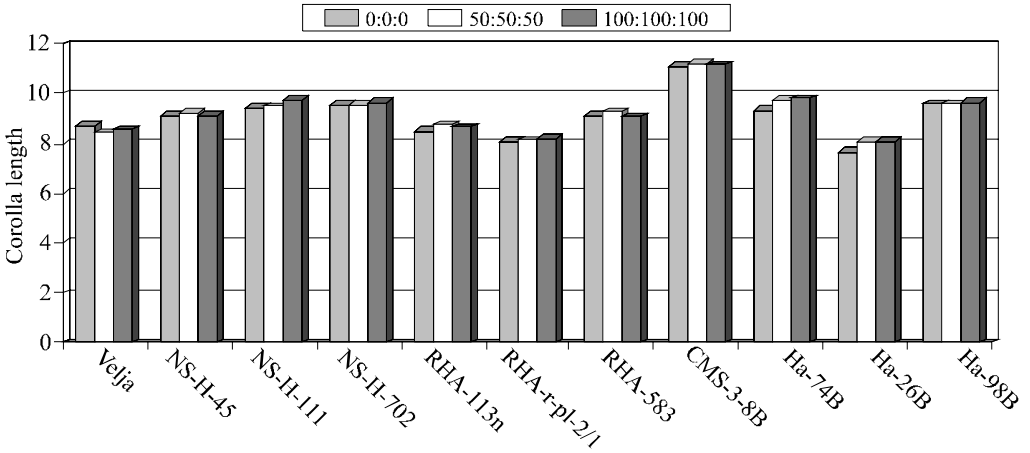

Figure 1. The effects of fertilization and genotype on sunflower corolla length.

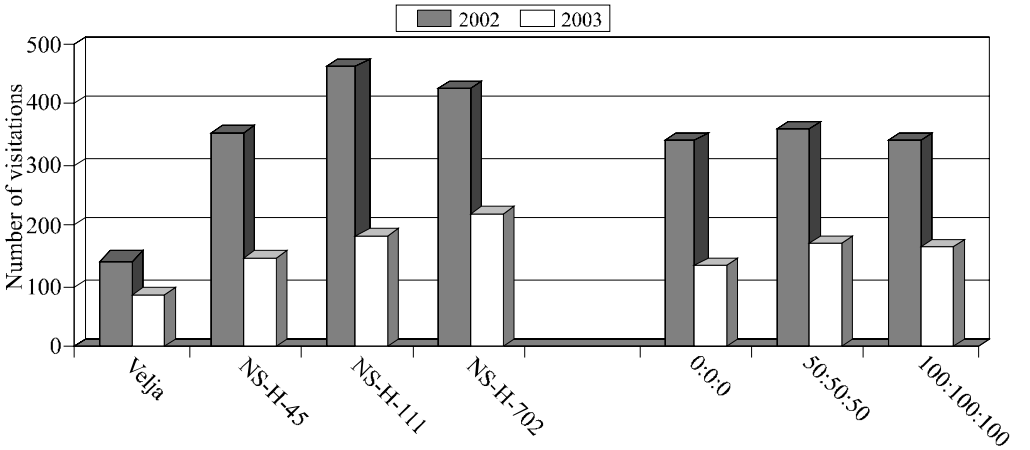

Figure 2. Bee attendance in the flowering period (number of visitations on 10 capitula, 9 observations per day).

The effect of fertilization on nectar production and bee attendance was different. Different trends in different years were observed for nectar content, but the 50:50:50 was always on the top. A similar situation was observed for the bee attendance as well. When genotype and year were taken in account, differences in nectar secretion and bee attendance were higher than in fertilization. Based on those observations two conclusions could be drawn. Either the effect of fertilization on nectar production and bee attendance is very low, which is in disagreement with the results of Miklič et al. (2002), or that effect could not be observed during 2002 and 2003 because of higher effects of other factors especially all climatic conditions.

Corolla length in tested sunflower hybrids was the lowest in hybrid Velja, while there was no statistical difference between hybrids in the hybrids with the longest corollas - NS-H-111 and NS-H-702. Hybrids with longer corollas had a higher bee attendance, which means that corolla length did not have any effect on attendance, i.e., that the nectar was available in all tested hybrids. Miklič (1996) obtained the same results for some other NS sunflower hybrids.

Differences in corolla length between flowering zones, as well for most of the genotypes were significant on the average. Atlagić et al. (1996) and Joksimović et al. (1996) did not find significant differences in corolla length between flowering zones in CMS lines and B-analogues, while those differences were significant in restorer lines.

Nectar production, which depended more on year and genotype than fertilizer treatment, had a great effect on bee attendance. Corolla length did not have a significant effect on bee attendance. Interpretation of reciprocal effect of all factors was rendered more difficult because of the effect of the environment and difficulties in providing identical conditions for all genotypes.

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