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THE EFFECTS OF HONEY BEES ON CROSS-POLLINATION AND HYBRID SEED PRODUCTION IN SESAME (*Sesamum indicum L.*)

Hasan BAYDAR[1] *Fehmi GÜREL*[2]
[1]*Süleyman Demirel University, Faculty of Agriculture, Department of Field Crops,*
Isparta-TURKEY
[2]*Akdeniz University, Faculty of Agriculture, Department of Animal Science,*
07070 Antalya-TURKEY

ABSTRACT

Three sesame varieties (`Gölmarmara', `Margo' and `Yousung') with contrasting characters were grown in alternate rows of caged plots to exclude insects and non-caged plots to open to insect pollination in 1997 and then their progenies derived from the caged and the non-caged plants were grown to estimate the ratios of cross-pollination (RCP) and heterotic seed yield at two locations of Turkey, Antalya and Isparta, in 1998. The RCP were similar for the locations, but significantly different for the varieties and in the caged experiments. The RCP's were 4.29%, 18.69% and 11.72% in progenies from non-caged plots, and 2.40%, 4.61% and 4.46% in progenies from caged plots of the `Gölmarmara', `Margo' and `Yousung', respectively. And also, seed yield increased in the varieties were up to 9.52%, 39.65% and 21.49%, respectively, indicating practically hybrid seed production in sesame.

INTRODUCTION

Sesame is a valuable cultivated oil crop. It's oil has a very high quality and stability, due to a high content of unsaturated fatty acids and natural antioxidants. In spite of its excellent oil quality, sesame cultivation in the world is limited because of its low seed yield (Ashri, 1989). The development of sesame cultivation largely depends on the increase in seed yield. One of the most efficient methods is to use the heterosis which practically enables the production of hybrid seed. There have been many reports of heterosis for yield and yield components in sesame indicating the commercial exploitation of hybrid vigour which is one of the most promising methodology for increasing seed yield (Quijada & Layrisse , 1995). Using the genetic male sterility in sesame hybrid seed production requires different efforts, such as controlled hand-pollination(Osman & Yermanos, 1982). However, Honey bees, one of the best natural pollinators, could be used in hybrid seeed production.. Sesame is an important nectar and pollen source for Honey bees in the intensive sesame production areas.

Although sesame is considered to be self-pollinated, natural cross-pollination ranging from less than 10% to over 50% has been reported(Pathirana, 1994) and pollination with insects increases seed yield and improves seed quality on a reclaimed land where native pollinators are scarce (Caron, 1979) The activity of insects especially honey bees is largely responsible for the natural-cross pollination observed when the wind strength is minimal (Pathirana, 1994).

This research was conducted to estimate the RCP and heterotic yield increases under both self-and open-pollination by applying cage experiments under two different environmental conditions of Turkey during two successive years.

MATERIALS AND METHODS

In this research, three varieties of *Sesamum indicum L.* with contrasting characters and a colony of honey bee (*Apis mellifera L.*)were used as materials. The single capsule per leaf axil and

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branched stem characters of `Gölmarmara' are dominant over the three capsules per leaf axil and non-branched stem in `Margo' and `Yousung'. The black seed colour in `Yousung' and the brown seed colour in `Margo' are dominant over the white seed colour in `Gölmarmara'. All these characters which were used as markers to estimate the ratios of the cross-pollination (RCP) in sesame are simply inherited or expressed by a single gene (Weiss, 1983; Hu, 1985).

Three varieties self-pollinated for several years to obtain genetical purity were sown in alternate rows (10 m length with 70 cm apart) at the farm of Akdeniz University, Faculty of Agriculture in Antalya in the second week of June, 1997. Three alternate rows consisting of the plants of the three different varieties were covered by cages (3x2.5x2 m) with nets to exclude insects as three replications before the flowering time. The plants of non-caged plots were pollinated by honey bees whose hive was placed near the experimental field.

The progenies derived from the three varieties grown in both caged and non-caged alternate rows were sown at the farm of Mediterranean Agricultural Research Institute in the low land zona, Antalya (elevation 51 m) in 22 June 1998 and at the farm of Süleyman Demirel University in the high land zona, Isparta (elevation 980 m) in 15 May 1998. The experimental design at the two locations was randomized Complete Block Design with three replications. Each plot contained 3 rows of 5 m length with 70 cm between the rows. At maturity, all progenies were scored for dominant characters to estimate the RCP and harvested to estimate hetorotic seed yield.

RESULTS AND DISCUSSION

The ratios of cross-pollination (RCP), seed yields and seed yield increases in the progenies derived from caged and non-caged plants of the varieties at two locations were presented in Table 1 and Table 2, respectively.

The ratios of cross-pollination were similar at two locations, but significantly different for the varieties and for the caged experiments. They were 4.29%, 18.69% and 11.72% in the progenies from non-caged plots, and 2.40%, 4.61% and 4.46% in the progenies from caged plots of the `Gölmarmara', `Margo' and `Yousung', respectively (Table 1). The differences between the caged and the non-caged values could mainly be due to the honey bees pollinated intensively the flowers of the non-caged or open-pollinated sesame plants. Seed yields of the progenies derived from non-caged plants were dramatically higher than that of the progenies derived from the caged plants, depending on the RCP (Table 2). These differences were mainly due to the heterosis occurred in the progenies from the cross-pollinated seeds. Yield increases in the varieties were up to 9.52%, 39.65% and 21.49%, respectively (Table 2), indicating practically hybrid seed production in sesame.

Honey bees were responsible for 73% of insect visits to sesame flowers (Lee et al., 1995). The lower percentages of the RCP from the caged plants were mainly caused by wind. In this case, the main pollinators in sesame were insects, especially honey bees, and then wind. The sesame varieties showed different response to the cross-pollination. The main reasons for these differences discussed as following;

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Table 1. The ratios of cross-pollination (RCP %) in the progenies derived from the caged and non-caged plants of the varieties at two locations

Varieties	Locations		Mean
	Antalya	Isparta	
`Gölmarmara'			
non-caged	3.53 c	5.05 c	4.29
caged	1.79 c	3.01 c	2.40
difference	1.74	2.04	1.89
`Margo'			
non-caged	20.59 a	16.80 a	18.69
caged	4.18 c	5.05 c	4.61
difference	16.41	11.75	14.08
`Yousung'			
non-caged	11.85 b	11.60 b	11.72
caged	4.73 c	4.20 c	4.46
difference	7.12	7.40	7.26
Mean			
Non-caged	11.99	11.15	11.57
Caged	3.56	4.08	3.82
Difference	8.43	7.07	7.75
F value	43.84**	28.42**	
L.S.D. (5%)	3.41	3.19	

Values within a location followed by the same letter are not significantly different at the 5% level L..S.D

Table 2. The seed yields and seed yield increases of the progenies derived from the caged and non-caged plants of the varieties at two locations (kg/da)

Varieties	Locations		Mean
	Antalya	Isparta	
`Gölmarmara'			
non-caged	89.04 a	32.50 a	60.77
caged	80.56 b	30.46 a	55.51
increase %	9.52	6.27	8.65
`Margo'			
non-caged	51.52 c	20.90 b	36.21
caged	31.09 d	14.83 c	22.96
increase %	39.65	29.04	36.59
`Yousung'			
non-caged	24.59 de	15.33 c	19.94
caged	19.28 e	13.26 c	16.27
increase %	21.59	13.50	18.40
Mean			
Non-caged	55.05	22.91	38.98
Caged	43.64	19.51	31.57
Increase %	20.72	14.84	18.98
F value	148.09**	142.74**	
L.S.D. (5%)	7.68	2.20	

Values within a location followed by the same letters are not significantly different at the 5% level L.S.D

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The flowering biology of the varieties: Flowering time and duration of the varieties were different. `Gölmarmara' flowered earlier (4 days before) and matured later (9 days after) than the other varieties during the first year. The natural cross-pollination of `Gölmarmara' might be reduced by the lack of out-pollens from other varieties in the extrem periods.

The flowering morphology of the varieties: The varieties used in this study were genetically different; single flower per leaf axil in `Gölmarmara', and three flowers per leaf axil in `Margo' and `Yousung'. Producing more flower per unit area during the mean flowering periods, `Margo' and `Yousung' attracted the bees more than `Gölmarmara', causing more cross-pollination.

Special preference of honey bees: Nectar and pollen production capacity, sugar content in nectar, scent, colour and shape of the flowers, which are characteristic of the varieties, may be attractive or repellent to honey bees preference. It was also observed that although pollen collectors were always entering into the corolla providing cross-pollination, nectar collectors not always but often collected the nectars by holing the base of corolla with their tongue while on the flowers, without causing cross-pollination.

The main reason of the low seed yields under Isparta condition might be due to environmental effects, because semi-mountain climate of Isparta region is not optimal for sesame cultivation in contrast to Antalya region

The results suggest that honey bees increase significantly the ratios of cross-pollination and so heterotic seed yield, giving way to practical hybrid seed production in sesame, particularly if female parents with cytoplasmic or genetic male sterility are provided.

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