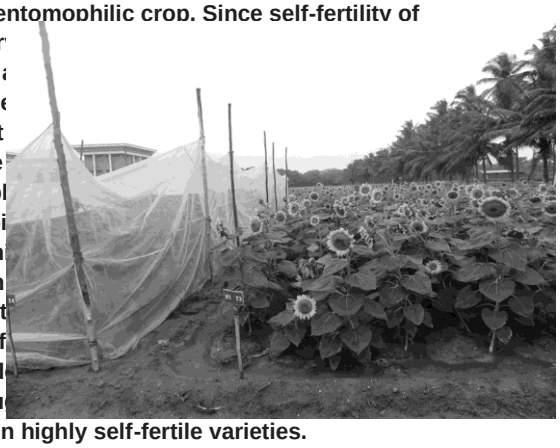
Madras Agric. J., 101 (7-9): 269-272, September 2014
https://doi.org/10.29321/MAJ.10.001196

Yield Enhancement in Self-fertile Sunflower (*Helianthus annuus L.*) by Honeybees

M. Ramya*, M. Muthuraman and P.A. Saravanan
Department of Agricultural Entomology
Tamil Nadu Agricultural University, Coimbatore - 641 003

Sunflower (*Helianthus annuus* L.) is an important entomophilic crop. Since self-fertility of sunflower varieties vary widely, they need the inter productivity. A less self-fertile variety *viz*., Morden a CO5 were used for experimentation to ascertain the productivity of sunflower. A paired plot experiment and pollinator exclusion was conducted to explore Seed yield per head was more in open pollinated pl set in less self-fertile Morden was doubled. Seed oi pollination than in pollinators excluded heads. In h seed oil content were 11.4 and 5.8 per cent more in treatments, respectively. Yield difference between t higher in less self-fertile Morden than in highly self oil content, germination percentage and vigour ind of pollinators in both the varieties. This study brou marginally increasing the yield of sunflower even in highly self-fertile varieties.



Key words: *Helianthus annuus*, Pollination, Honey bees, Self-fertile variety, Yield

Sunflower (*Helianthus annuus L*.) is an important oilseed crop. Bee pollination is highly essential for good seed set in sunflower. Of all the insects lured to sunflower, honeybees are the best pollen vectors. They play a crucial role in cross pollinating the disc florets leading to final seed set and seed yield (Mohan Rao *et al.,* 1995). Bee pollination enhances both quantity and quality of sunflower seeds (Wakhle *et al.,* 1977). Most of the varieties of sunflower are protandrous and hence, they are obligate outbreeders. In addition, presence of certain proteins, *viz.,* callose on stigmatic surface inhibits the germination of self pollen preventing self-fertility. Recently evolved sunflower varieties and hybrids possess high levels of self-compatibility when compared to older varieties. In such cultivars, a disc floret can be pollinated by pollens produced in the same floret as they are self-fertile. Although self-fertile cultivars and hybrids out produce self-incompatible cultivars, all these modern cultivars, also continue to get benefit from insect pollination (Arya *et al*., 1994). This hypothesis is not yet validated thoroughly. Hence, the present study was taken up to ascertain the role of pollinators in highly self-fertile variety in comparison with less self-fertile traditional variety.

Materials and Methods

A field experiment was laid out at Agricultural Research Station, Bhavanisagar to study the role of honey bees in sunflower production during summer season (February to April, 2012) in FRBD with two varieties *viz.,* Morden (less self-fertile) and CO5 (highly self-fertile). Each variety was planted in plots of size 12 x 18m, separately with a spacing of 60 x 30 cm. Half of each plot was covered with nylon mosquito mesh cages prior to flowering to restrict pollinators. Another half of each variety was kept open to permit the visit of insect pollinators (Plate 1).

Plate 1. Sunflower plot covered with nylon net to exclude pollinators

Pollinator population on sunflower heads was assessed by visual scanning in open pollination plots at hourly interval from 6.00 am to 6.00 pm during peak period flowering and the abundance of bees at various hours was estimated. In addition, the composition of pollinators was also found out. After

*Corresponding author email : mkramyasri@yahoo.com

maturation, five heads were chosen from each plot for estimating the yield both quantitatively and qualitatively. Both filled and chaffy seeds removed from heads were counted and weighed separately. Seed set per cent per head was worked out both on number basis and weight basis in each sample head to estimate the seed yield per head.

Oil content, 100 seed weight, weight by volume per cent, germination per cent, speed of germination and vigour index were assessed to study the effects of pollinators visitation on yield quality. Oil content was estimated by using the standard protocol ((Dorina *et al*., 2008). Test weights were estimated by assessing the weight of hundred seeds randomly selected from each head. Weight by volume was also estimated for each sample. Seeds collected from each head was weighed (W) and their volume (V) was measured. Weight by volume percentage was calculated by using the formula (W/V) x 100. Germination test was carried out by inclined plate method and on tenth day the number of seeds germinated was counted and germination percentage was worked out (Erulan *et al.*, 2009). For finding out speed of germination, from third day onwards the number of germinated seeds were counted upto tenth day. The speed of germination was worked out by using following formula.

$$\text{Speed of germination} = \frac{X_3}{3} + \frac{X_4 - X_3}{4} + \frac{X_5 - X_4}{5} + \ldots + \frac{X_{10} - X_9}{10}$$

Where, X is number of seeds germinated on respective day

The length of shoot and root of each seedling were measured on tenth day. Vigour index was worked out by using the following formula (ISTA, 1996).

Vigour index = (Root length + Shoot length) X Germination %

Results and Discussion

Both *Apis* and non- *Apis* bees (97.3%) were found to forage actively on sunflower heads. Major *Apis* bee pollinators observed were rock bee, *Apis dorsata* F. (46.8%) and Indian bee*, A. cerana indica* F. (10.7%). The non- *Apis* pollinators mainly lured to sunflower were stingless bees, *Trigona* (21.4%) and small carpenter bee, *Ceratina* (18.4%). Among honey bees *A.dorsata* outnumbered other visitors. Dominance of rock bees could be attributed to the presence of perennial nest congregations of *A.dorsata* in the research farm. Honeybees foraged throughout the day with two peaks (Fig.1) due to bimodal availability of pollen during the male phase from the disc florets.

Table 1a. Impact of pollinators on quantitative yield of sunflower varieties - Morden and CO5

Treatment	Seed set % / head (Number basis)			Seed set % / head (Weight basis)			Seed yield/head (g)		
	Morden	CO5	Mean	Morden	CO5	Mean	Morden	CO5	Mean
OP	68.7	89.9	79.3	91.8	97.0	94.4	55.1	46.8	51.0
	(56.2)	(72.3)	(64.3)	(74.8)	(80.4)	(77.6)			
PE	32.2	78.5	55.4	62.9	94.6	78.8	32.7	29.8	31.2
	(33.3)	(62.7)	(48.0)	(53.4)	(77.0)	(65.2)			
Mean	50.5	84.2		77.4	95.8		43.9	38.3	41.1
	(44.7)	(67.5)		(64.1)	(78.7)				
	V	T	VXT	V	T	VXT	V	T	VXT
SED	4.4	4.4	6.2	4.8	4.8	6.8	4.7	4.7	6.6
CD(0.05%)	9.6	9.6	NS	10.5	10.5	NS	NS	10.2	NS

OP: Open pollination PE: Pollinator exclusion ; Note: Numbers inside parentheses are transformed values

Table1b. Impact of pollinators on qualitative yield of sunflower varieties - Morden and CO5

Treatment	100 Seed weight (g)			Weight by volume (%)			Oil Content (%)		
	Morden	CO5	Mean	Morden	CO5	Mean	Morden	CO5	Mean
OP	5.2	4.1	4.7	34.3	36.9	35.6	35.0	38.9	37.0
				(35.8)	(37.3)	(36.6)	(37.6)	(41.1)	(39.3)
PE	2.1	4.4	3.3	21.6	34.4	28.0	21.3	33.1	27.2
				(27.5)	(35.9)	(31.7)	(31.6)	(39.0)	(35.3)
Mean	3.7	4.3	4.0	28.0	35.7		28.2	36.0	
				(31.6)	(36.6)		(34.6)	(40.0)	
	V	T	VXT	V	T	VXT	V	T	VXT
SED	0.4	0.4	0.6	1.5	1.4	1.9	1.6	1.6	2.3
CD(0.05%)	NS	0.9	1.2	2.9	2.9	4.2	3.5	3.5	NS

OP: Open pollination PE: Pollinator exclusion ; Note: Numbers inside parentheses are transformed values

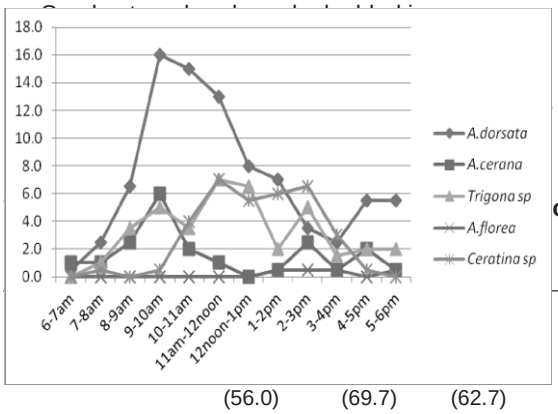


Fig. 1. Abundance of bee pollinators during various hours of a day

on of sunflower varieties - Morden and CO5

				Speed of germination (days)			Vigour index		
	Morden	CO5	Mean	Morden	CO5	Mean	Morden	CO5	Mean
				5.9	1.3	3.6	17.6	13.2	15.4
							(27.6)	(14.0)	(20.8)
				1.8	2.5	2.2	12.9	5.5	9.2
	(56.0)	(69.7)	(62.7)				(24.4)	(17.6)	(21.0)
Mean	56.4	77.2		3.9	1.9	2.9	15.3	9.4	
	(56.8)	(64.2)					(26.0)	(15.8)	
	V	T	VXT	V	T	VXT	V	T	VXT
SED	2.9	2.8	4.0	0.5	0.5	0.7	2.3	2.3	3.3
CD(0.05%)	6.2	6.2	NS	1.1	1.1	1.5	5.1	5.1	NS

more when compared with CO5 because of its less self-fertile nature. There was a marked hike in oil content to an extent of 13.7 per cent in open pollination in Morden variety, whereas it was only 6.8 per cent in CO5 (Table 1b). Earlier studies on the role of bees in increasing the productivity of nine self-fertile hybrids of sunflower to an extent of 36 per cent adds support to the necessity of bee pollination even in highly self-fertile varieties (Burgstaller, 1990). Germination percentage and vigour index were significantly more in open pollination plots than in pollinators excluded plots in both the varieties. Morden seeds produced from open pollination plots grew more vigorously and recorded a vigour index of 17.6 (Table 1c). Seeds with the additional amount of food reserves could be a possible cause for higher germination percentage and greater vigour index.

Calmasur and Ozbek (1999) reported that open-pollinated sunflowers had an average of 1151 filled seeds per flower head weighing 67.2 g compared to 373 per head weighing 16.4 g in caged plots without bees and the oil content of seeds was 39.2 per cent and 32.4 per cent, respectively. This study supports the present finding.

produced in open pollination were heavier and plumpier with less number of chaffy seeds. Hence, the filled seeds weighed more and recorded more weight /volume percentage in Morden variety. But such variations were not marked in CO5. In case of Morden, the yield gap due to pollinator absence was not cent per cent self-fertile, they too needed some amount of alien pollen grains for pollination. The percentage weight of set seeds in Morden variety was significantly more in open pollination (91.8 %) than in pollinator excluded plots (62.9 %). But in CO5 the difference was only minimal. Seeds

Conclusion

Sunflower heads were very much preferred by both *Apis* and non-*Apis* bees. Honey bees were the dominating pollinator fauna of sunflower. The study has brought out clearly that autogamy (self pollination) was possible even in less self-fertile varieties and cross pollination could occur even in highly self-fertile varieties. Bee pollinators were indispensable in less self-fertile sunflower varieties like Morden. Bees played a crucial role in the dispersal of pollen grains thereby augmenting the sunflower yield both qualitatively and quantitatively. Inadequate pollination was one of the major causes for chaffy seeds in sunflower heads. Autogamy in sunflower always resulted in seeds with higher oil content. In addition, such seeds germinated well and produced vigorously growing seedlings. In highly self-fertile varieties like CO5 pollinators also played some role in enhancing the seed yield marginally. The pollinators lured to highly self-fertile sunflower varieties while collecting floral rewards during their foraging trips moved actively on sunflower heads there by assisting in self pollination. In addition, they also assisted in cross pollination since all highly self-fertile varieties are not showing cent percent self-fertility.

References

Arya, D.R., Sihag, R.C. and Yadav, P.R. 1994. Diversity, abundance and foraging activity of insect pollinators of sunflower at Hisar (India). *Ind. Bee J.*, **56(3-4):**172-178.

Burgstaller,H. 1990. Importance of the honey bee for the seed yield of sunflowers. *Schweizerische Bienen-Zeitung*, **113**(9): 510-515.

Calmasur,O. and Ozbek,H. 1999. Pollinator bees (Hymenoptera, Apoidea) on sunflower (*Helianthus annuus* L.) and their effects on seed setting in the Erzurum region [Turkey]. *Turkish J. Biol.*, **23**: 73-89.

Dorina,B., Vasile,M.C., Paul,S.A. and Dan,F.I. 2008. Improvement of sunflower oil extraction by modeling and simulation. *Revue Roumaine de Chimie*, ***53*(9):** 881–888.

Erulan,V., Soundarapandian, P., Thirumaran, G. and Ananthan,G. 2009. Studies on the effect of *Sargassum polycystum* : Extract on the growth and biochemical composition of *Cajanus cajan* (L.). *American-Eurasian J. Agric. & Environ. Sci*., **6 (4):** 392-399.

ISTA, 1996. International Seed Testing Association. Zurich, Switzerland.

Mohan Rao,G., Nadre,K.R. and Suryanarayana,M.C. 1995. Studies on pollination of male sterile line for foundation seed production in hybrid sunflower. *Ind. Bee J*., **57(4):**170-173.

Wakhle,D.M., Shakuntala Nair,K. and Phadke,R. P. 1978. Effect of bee-pollination on the oil and protein content in the seeds of sunflower *(Helianthus annuus* L.). *Indian Bee J.,* **40**, 1-2.

Received: August 20, 2013; Accepted: June 21, 2014