

HONEY BEES–POTENTIAL POLLINATORS IN HYBRID SEED PRODUCTION OF
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ABSTRACT : A study was conducted to find out the role of honeybees on pollination, seed setting and seed quality of hybrid sunflower. The foraging behavior of natural bee visitants was studied on the parental lines of sunflower hybrid NDSH1 during the flowering period. Most predominant bees observed are Rock bees, *Apis dorsata*, European bee, *Apis mellifera*, Indian bee, *Apis cerana indica* and Stingless bees, *Trigona irridipenis*. Bee visitants are more on R line compared to A line. The seed setting percentage and seed yield were significantly increased when the honeybees were supplemented to the open pollination. The yields were drastically reduced when the crop was covered with insect proof net. In addition, increased seedling vigour, germination%, field emergence, oil content and quality of seed was observed with the deployment of honey bees coupled with supplemental hand pollination.

Keywords: Sunflower, bee pollination, hybrid seed production, seed quality

INTRODUCTION

Sunflower (*Helianthus annuus L.*), is an allogamic plant, which needs insects on flowering, especially the honeybees for seed production. Individual sunflower florets are rarely self-pollinated with sticky heavy pollen and need pollen transferred to them from other florets, which can be done by using honeybees (Furgala, 1954; Free, 1963). Hybrid seed in sunflower is produced by using cytoplasmic male sterile (CMS) lines as female parents. The CMS line (A line) is pollinated with maintainer line, a male fertile line (B line) for its maintenance and with fertility restorer line (R line) for hybrid seed production. The Honey bees are the most important insects in the sunflower pollination process. Unlike other insects that visit flowers only for their own food, bees visit a greater number of flowers to fulfill the needs of their colony (Müller *et al.*, 2006). The foraging pattern of bees on sunflower flowers is a key issue in studies of pollination. Bees certainly are essential in seed production of sunflower because pollen must be transferred from male-fertile to male sterile plants (De Grandi-Hoffman and Chambers, 2006). This study aimed at observing the foraging behavior of honey bees and their efficiency of pollination on seed setting, seed yield and seed quality of Hybrid sunflower.

MATERIALS AND METHODS

Field investigations were carried out during *rabi* 2006-07 and 2007-08 at Seed Research and Technology Centre, Acharya N.G. Ranga Agricultural University, Rajendranagar, Hyderabad. The parental lines, CMS 235 as A line and RHA 859 as R line of sunflower hybrid, NDSH 1 were grown side by side in the ratio of 9:3 in plots of 5m x 5m by following all the recommended agronomic practices. There were 5 treatments *viz.*, open pollination, crop covered with net as control, crop partially caged with 4 frames *A. mellifera* colony, crop partially caged with 8 frames *A. mellifera* colony and bee pollination combined with hand pollination. These treatments were imposed in four replications. Honey bee activity was recorded at peak flowering stage on 10 capitula during morning (9-10 am) and evening hours (4-5 pm) both on A line and R line separately. All bees visiting the flower heads during that time were taken into consideration. Honey bee species *viz.*, Rock bees (*A.dorsata*), European bee (*A.mellifera*), Indian bee (*A. cerana indica*) and stingless bee (*Trigona irridipenis*) were recorded both on 'R' line and 'A' line separately.

The bee visit was expressed as mean number of honeybees visiting 10 capitula of parental lines per five minutes per observation. *A. mellifera* colonies were introduced into crop partially caged with insect proof nets. Hand pollination was carried out every day in the morning 8-10 am for a period of 10-15 days of flowering period. Yield and quality parameters like % seed set, seed yield, germination percentage, root length, shoot length and seedling vigour were recorded and oil percentage was estimated and the data was subjected for suitable statistical analysis.

RESULTS AND DISCUSSION

Honey bee visits on parental lines

The foraging behavior and frequency of visit of important bee pollinators viz., *A. dorsata*, *A. mellifera*, *A. cerana indica* and *Trigona irridipennis* during morning (9-10AM) and evening (4-5 pm) hours were studied and the data was given in Table 1 and Fig.1. There was no significant difference in bee visits during morning and evening hours. The bees visiting 'R' line more frequently compared to 'A' line. Among the bees visiting R line, *A. mellifera* abundance was more followed by stingless bee, *T. irridipennis* and *A. dorsata*. Among the different bees, the stingless bees. *T. irridipennis* was more abundant on A line followed by *A. mellifera* and *A. indica*. The female parent (A line) was visited by major nectar collectors due to greater availability of nectar and are in confirmation with the results of Rajagopal *et al.*, (1999) and Mohan Rao *et al.*, (1995) who also observed the visit of only nectar collectors to both the parental lines. Nectar collecting bees were more frequent on A line than pollen collecting bees during days and at peak visitation in sunflower cultivation. These results corroborate with those observed by Teixeira and Zampieron (2008) who stressed that nectar collecting bees exercised greater influence on sunflower pollination than pollen or nectar / pollen collecting bees. Bees that collect nectar tend to discard pollen stuck on their pollen basket while still the capitulum of sunflowers, causing indirect pollination (Free, 1993).

Table 1. Bee foraging on sunflower hybrid seed production.

Honey bee species	Average no. of bee visits / capitulum / 5 min *					
	A-line		R-line		Percent visits	
	Morning	Evening	Morning	Evening	A-line	R-line
Rock bee - <i>A. dorsata</i>	9.7	10.7	42.7	32.8	11	21
European bee - <i>A. mellifera</i>	21.2	23.8	68.8	60.0	23	36
Indian bee - <i>A. cerana indica</i>	13.1	15.3	23.5	27.6	15	14
Stingless bee - <i>Trigona irridipennis</i>	53.8	44.9	52.8	52.7	51	29
Total	97.8	94.7	187.8	173.1		

*The data is the average observations of 20 days in the peak flowering of sunflower.

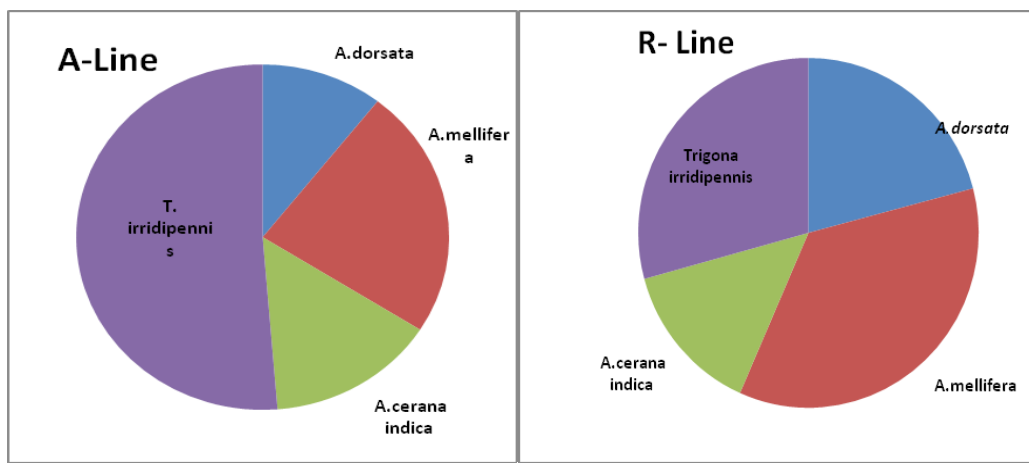


Fig.1. Per cent bee visits on parental lines of hybrid sunflower, NDSH 1.

Effect of bee pollination on seed setting and yield parameters

There were significant differences for all the quantitative and qualitative characters investigated among the different pollination methods (Table 2 and Fig. 2.). The pooled data indicated that the crop covered with insect proof net without honey bees recorded significantly lower seed setting % in both the years of study with a mean of 6.33% compared to other methods. All other pollination methods where honey bees were introduced were found to be significantly superior to open pollination (16.52 %). Highest mean seed setting percent of 74.13 % was recorded with bee pollination combined with hand pollination followed by bee pollination with eight frames and four frames (50.89 and 33.26% respectively). Honeybees + hand pollination gave significantly higher seed yield (14.4 q/ha) than open pollination (6.4 q/ha) and with crop caged with net (2.3 q/ha) there by the yield was increased about 526 % with honey bee + hand pollination and 178 % with open pollination compared to control plots. There were about 330 and 191 percent increased yield of sunflower due to introduction of honey bees of 8 frames and 4 frames colonies respectively. The supplemental honeybee pollination + hand pollination significantly increased the percentage of seed setting and seed yield compared with open. Pollination and crop in cages without honeybees. In a similar study with sunflower, Moreti *et al.*, (1996) reported that the number and weight of seeds and percentage of seed setting were significantly higher in the visited plant by insect (579.3, 41.2 g and 82.4% and 457.0, 23.4 g, 79.7% in 2 trials) than in plants protected by cages where insects were excluded (81.5, 2.2 g and 1.2% in first trial and 111.9, 3.2 g and 28.5% in the second). In another study with sunflower, Kumar and Singh (2003) found that the number of filled seeds per capitulum (728.2), seed set (75.5%) and 1000 seed weight (55.9 g) was highest with hand + insect pollination, than open pollination and the crop netted without bees. Our findings of increased pollination using honeybees in sunflower crop correspond to those of previous works. These results indicated that honey bee pollination could increase the yield due to increase in activity of the pollinators. These results corroborate those found by Du Toit (1990), Nderitu *et al.* (2008) and Oz Mehmet *et al.*, (2009), who reported increased production of sunflower seed in area with introduction of honey bees of 38 %, 53 % and 206 %, respectively, related to areas without bees. Present findings are also in agreement with different workers who reported increased yields due to bee pollination in different oil seed crops *viz.*, sunflower (Oz Mehmet *et al.*, 2009), niger (Sattagi *et al.*, 2001 and Guruprasad 2001) and mustard (Murasing, 2000).

Treatments	Seed set%			Seed Yield (q ha ⁻¹)			Percent increase in yield over control
	2006-07	2007-08	Mean	2006-07	2007-08	Mean	
Open pollination	23.88	10.23	16.52	4.03	8.70	6.4	178
Covered with net	11.88	1.16	6.33	2.06	2.50	2.3	-
Caged with 4 frames colony	19.87	47.1	33.26	3.34	10.08	6.7	191
Caged with 8 frames colony	51.6	50.18	50.89	8.64	11.15	9.9	330
Bee + Hand pollination	87.8	60.46	74.13	15.3	13.54	14.4	526
F-Test	Sig	Sig		Sig	Sig		
CD	4.90	3.27		0.71	2.29		
CV%	6.20	4.6		5.59	17.64		

Quality of hybrid sunflower seed

The Hybrid sunflower seeds obtained from honey bee pollination coupled with hand pollination showed significant superiority with higher percentage of germination accounting for 99 per cent followed by open pollination (96%) and Bee pollination (95%) compared to control plot without bees (93%).

The increase in germination percentage was obviously attributed to the increased bee visitation on crop during flowering period. These findings are in line with the results of Abrol (1996) in sunflower, Kalmath (2002) and Guruprasad (2001) on niger, Murasing and Virakthamath (2002) on mustard. The Root length, shoot length and seedling vigour index of germinating seeds obtained from plots with bee pollination + hand pollination was maximum (10.5 cm, 16.1 cm and 2614 respectively) compared to open pollination (10.2 cm, 14.27 cm and 2346), Honey bees – 4 frames (9.2 cm, 15.1 cm and 2351), Honey bees- 8 frames (9.8cm, 15.6 cm and 2456) and crop covered by net without bees (9.1 cm, 15.37cm and 2320 respectively) as depicted in Fig.2. The present results endorsed by the findings of Sattagi *et al.*, (2001) and Guruprasad (2001) who reported that bee pollination influence the root length, shoot length and seedling vigor index in niger. Hence the honey bee pollination not only increased the yield but also improved the quality of the crop. Such improvements have also been reported by some earlier workers. Increase in seedling vigour of safflower due to bee pollination was reported by Lingappa *et al.*, (1999). The highest oil content was recorded with the honey bee + hand pollination (39.6 %) followed by Honey bees-8 frames (37.1%), Honey bees- 4 frames (36.7%) compared to open pollination (35.6%) and control plot without bees (31.6%) (Fig. 2).

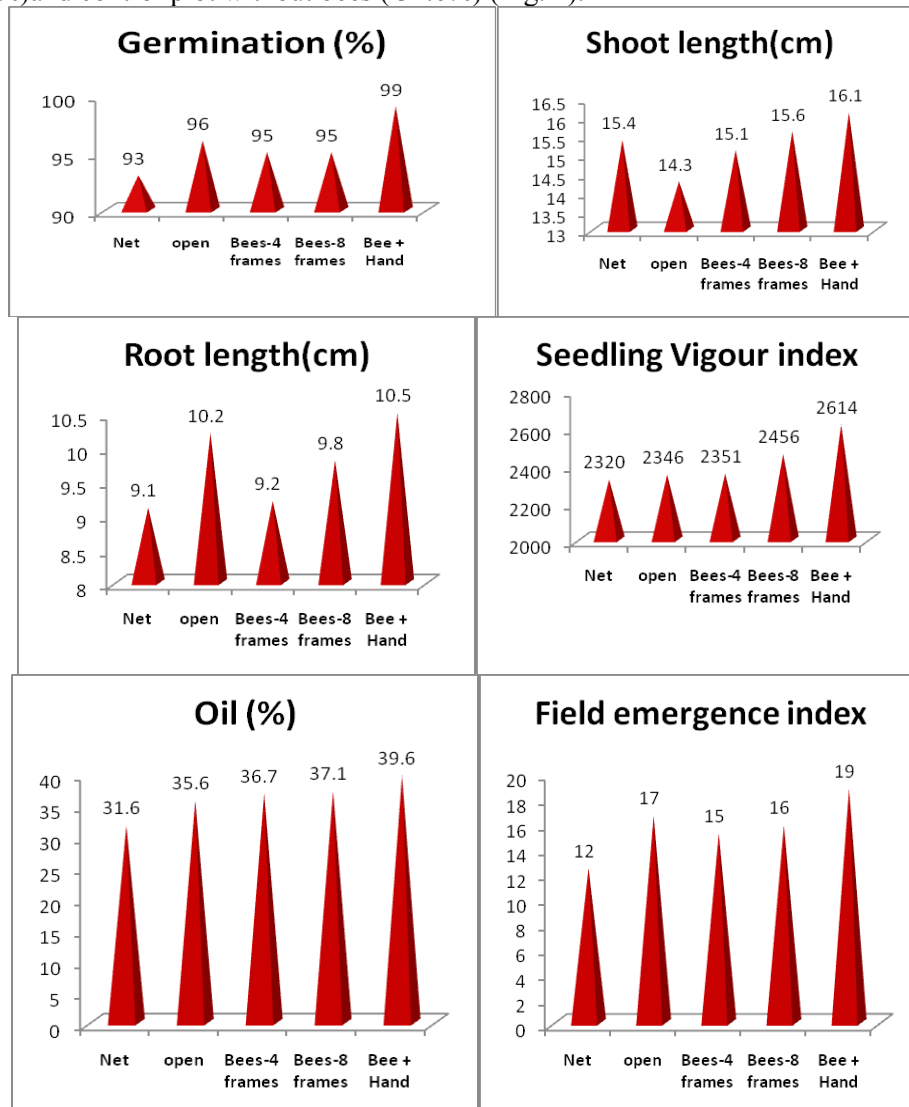


Fig 2. Effect of honey bees on seed quality parameters of hybrid sunflower, NDSH 1

These findings corroborate the results of Mahmood and Furgala (1983), who reported that the 25 sunflower cultivars were found with higher seed oil content when pollinated by honey bees. A considerable increase in oil content in niger seeds due to bee pollination is also reported by Kulkarni and Dhanorkar (1998). Present study revealed that beneficial effect of the honey bees in increasing the oil content of sunflower seed. Field emergence studies indicated that Hybrid sunflower seed produced through bee pollination coupled with hand pollination maintained their supremacy with high field emergence index (18.72) followed by open pollination (16.55) and bee pollination- 8 frames and 4 frames (15.79 and 15.13 respectively) compared to control (12.36). In the crop covered with net with very low seedling vigour and poor field emergence and low oil content indicated the inferior seed produced due to lack of insect activity in the netted plot.

The results clearly proved that the augmentation of honey bee colonies in the sunflower field during flowering period would be advisable to improve the qualitative and quantitative yield parameters of sunflower. Our results confirmed previous reports of higher production of seed yield in sunflower with introduction of colonies of honeybees. Increasing productivity may be related to more activity and foraging behavior of *A. mellifera* colonies. Therefore, the introduction of honeybees on agricultural crops, especially in hybrid sunflower cultivation, is an alternative to increase seed production, mainly in agricultural areas where natural pollinators are scarce.

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