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Role of Honey Bee Pollination in Quality Seed Production of Cauliflower for Scalingup of Livelihood in Vaishali District of Bihar

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ABSTRACT

An On farm trial was conducted at KrishiVigyan Kendra, Vaishali, Bihar to study the impact of planned honeybee pollination on the seed production and quality of Cauliflower seeds as well as pollination behavior of *Apis mellifera*. More number of bees were found visiting the crop under net house condition (6.05 , 5.35, 5.05 bees/plant at all the three locations of traditionally seed producing Hariharpur, Rajapakar and Chakwaravillages of Vaishali district.Bees in the open conditions were found to spend less time on flower as compared to the net house conditions. Honeybees played an important role in enhancing the seed production of cauliflower at all location under study. Planned honeybee pollination was found to result maximum impact on the seed production seeds/pod in the range of 15.50-19.10 seeds/pod in net pollination as compared to 13.60-17.20 seeds/pod in open condition. Similarly, average 1000 seed wt. in net pollinated condition was 3.30-4.19 gm whereas 3.00-3.97 gm in open field condition, and the yield in net condition was in range 534-637 kg/ha with additional income of 14 to 17 lakh rupees per hectare.

Keywords:Honey Bee, *Apis Mellifera*, cauliflower, pollination services,Scalingup of livelihood

INTRODUCTION

Agriculture is the basis of the livelihood of over 80 percent of the rural population in Bihar (Pandey *et al.*, .2012). However, most of the farmers are marginal or small land-holding families, cultivating less than one hectare of land**.** The small and marginal farmers of Bihar are increasingly taking up vegetable cultivation to improve their income (Bharat *et al.*, 2014). In Vaishali district of Bihar the vegetable based farming system among different category of farmers is most prevalent (Suman, 2014). The farmers here traditionally produce seeds of local variety of early cauliflower *Brassica oleracea* under open field situation.Low seed yield and quality due to inadequate pollination is major problem of cauliflower seed producing farmers. Inadequate pollination in crops is due to several factors and the most important of which includes lack of adequate number and diversity of pollinators. All possible ways of increasing the sustainable productivity and carrying capacity of the farming systems in order to improve the livelihoods of marginal households should be explored (Partap and Pratap 1997 & 2000). Amongst several factors attributing to increase productivity, the most important of which include the number of bee pollinators. Research has shown that pollination by honey bees increases fruit set, enhances fruit quality and reduces fruit drop in apple (Dulta and Verma, 1987), peach, plum, citrus, kiwi and strawberry (Partap and Partap, 2000). Bee pollination does not only increase the fruit set but also reduced fruit drop in apple, peach, plum and citrus (Dulta and Verma, 1987; Partap and Pratap., 2000). The experiment conducted AICP on Honeybee Research and Training (ICAR) at various agricultural university have shown that honeybee pollination enhanced seed production and quality of seed in various vegetable crops such as cabbage, cauliflower, radish, broad leaf mustard and lettuce (Verma and Partap,1994). The global population of managed honey bee hives has increased by 45 percent during the last half century (Gallai *et al.*, 2009) but with the spread of intensive agriculture capacity to provide sufficient pollination services may be stressed, andmore pronouncedly in the developing world than in the developed world (Aizen and Harder 2009). Bee colonies can be most effectively utilized in not only the production of cauliflower seed but also improve seed qualitatively, therby improving farmers income (Abrol, 2007). Cross pollination of entomophilous crops by honeybees is considered as one of the effective and cheapest method for triggering the crop yield both qualitatively and quantitatively (Abrol, 2012) It has been estimated that the value of additional yield obtained due to bee pollination 15-20 times more than the value of all the hive products put together and the total value of pollination services rendered by all insects globally comes in excess of 100 billion US dollars annually.In India 50 million hectares of land is under bee dependentbut tapping only about 1/4th of the available floral resources of the country and estimated losses in due to absence of bee pollination has been estimated to be around Rs.10,000 to Rs.55,000 per hectare in some crops.We need to increase our understanding of pollination as a critical element in the world's food supply, and pay greater attention to the maintaining of pollination services in agricultural management.

Thus, there is a need to ensure pollination by conserving the pollinators and attracting them towards the crop fields. This can be achieved only through planned honeybee pollination,

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owing to the fact that honeybees are the only pollinators which we can be managed. Pollination by insects is inevitable for *Brassica*, since they are generally incompatible (Sihag, 2001) and the pollen is heavier and sticky, which is unable to be easily wind borne. Even though, the bees are reported as marvelously coevolved pollen transferring devices for *Brassicas* , the pollination potential and economic importance of the effect of honeybees on these vegetables still needs to be established. There are reports that placing of 3-5 bee colonies of *Apis ceranaindica*/ a cre of crop have increased the seed yield in sunflower by 79%, mustard by 55%, niger by 33%, sesame by 15%, safflower by 64%, cotton by 18%, litchi by 20%, coconut by 40%, and gourd crops by 20%.Bees are the most effective pollinators of crops and natural flora and are reported to pollinate over 70 percent of the world's cultivated crops. It has also been reported that about 15 percent of the principal crops are pollinated by domestic bees, while at least 80 percent are pollinated by the wild bees (Kenmore and Krell, 1998).

MATERIALS AND METHODS

On farm trial was conducted by KVK, Vaishali, (RAU, Bihar, Pusa) in year 2010-2012 on farmers field at three villages, namely, Hariharpur, Rajapakar and Chakwara which are traditional producers of cauliflower seed. Cauliflower was grown for seed production following the usual agronomic practices followed by farmers. Cauliflower grown for seed production was covered by net of 100 m^2 area in the farmer's field and the control plot was open pollinated farmer field of the same farmer. During anthesis, two honeybee colonies of *A. mellifera* containing approximately 10,000 bees in a bee box were kept inside the net house to aid the pollination. The honeybees (*A. mellifera* F.) were reared in Lang stroth boxes of size 50x40x30 cm at the KVK demonstration unit. Foraging activities like, time spent by a bee per flower and number of flowers visited by a bee per minute were observed by using a stop watch. The observations were made for five days when the plant was at full bloom, pollination activities were noticed at 12 Noon when there is bright sun shine and maximum bee activity. At harvest time, twenty randomly selected plants were tagged and number of pods per plant, number of seeds per pod and 1000 seed weight (5 replications) were recorded. The total seed yield in the net house area of 100 m^2 was also recorded and yield per ha was calculated. Similar observation was made in open pollinated field.

RESULTS AND DISCUSSION

The pollination behavior of A. *mellifera* was observed as described in Table 1. The average number of foraging bees/plant was found highest at Hariharpur (6.05) followed by Rajapakar (5.05) and at Chakwara (5.35) in net house condition, while it was 1.65, 1.30 and 1.25 at the three location respectively in open condition. Similarly the average time spent by bees per flower was 6.45, 6.92 and 5.54 seconds in net and 6.50, 6.82 and 5.39 seconds in open pollination at all three locations respectively. The average number of flowers visited per minute revealed higher values for open pollination with 9.65, 8.40 and 6.45 flowers visited per minute followed 8.15, 9.40 and 6.45 in net pollinated condition (Devkota *et al.*,2005).

Table 1: Pollination pattern of *A. mellifera* at different locations

Observations	Hariharpur		Rajapakar		Chakwara	
	Under Net	Open	Under Net	Open	Under Net	Open
Average no. of bees/ plant	5.05 (1.05)	1.45 (0.88)	5.25 (1.05)	1.30 (0.86)	5.35 (1.09)	1.25 (0.85)
Average time spent/ flower	5.45 (0.80)	5.65 (0.81)	5.92 (0.82)	5.82 (0.81)	4.54 (0.98)	4.39 (0.78)
Average No. of flowers visited/ min	7.25 (1.40)	7.40 (1.64)	5.45 (1.57)	5.55 (1.47)	7.40 (1.31)	7.65 (1.35)

Note: Mean of 5 days observations and fig. in parenthesis are SD values

There was marked improvement in seed production and overall seed quality and vigor in net honeybee pollination. In 2010-11, under net honeybee pollination produced 52.80 pods per panicle as against 46.20 pods in open pollinated crop, with an increase in pod setting to a tune of 12.50%. There was an increase of 12.25% in seeds per pod in planned honeybee pollinated crops and 9.09% increase in thousand seed weight resulting in 28.14% increase in seed yield at Hariharpur, whereas, in Rajapakar plants produced 42.70 pods per panicle in net honey bee plots as against 36.40 pods open pollination. An increase of 10.88% seeds per pod was observed in honeybee introduced crops resulted in 11.88% increase in seed yield (Devkota *et al.*, 2003). At Chakwara there was 42.30 pods per panicle in net where as it was 35.70 pods in the open plot. The thousand seed weight was found to be 4.15 and 3.97 g in the planned honeybee and natural pollinated crops, respectively (Table 2).

In second year of trial i.e., 2011-12 similar results were observed, net honeybee pollination increased the number of pods per panicle, seed per pod and thousand seed weight as compared to open pollinated crops. The seed yield of was 620.50 kg/ ha in honeybee pollinated crop, while open pollinated crop yielded 439.30 kg/ha. The seed yield was also high up to 574.00 kg/ha in honeybee pollinated crop

Table 2: Effect of net pollinated on seed production of Cauliflower at various location of Vaishali district in Bihar

Location	Parameters	2009-2010			2010-2011		
		Open pollinated	Net pollinated	% increase	Open pollinated	Net pollinated	% increase
Hariharpur	Siliquae/ Raceme panicle	46.20 (10.13)	52.80 (6.01)	12.50	48.20 (8.59)	55.10 (4.78)	12.52
	Seeds/Siliquae	13.60 (4.11)	15.50 (2.11)	12.25	13.20 (4.32)	16.70 (1.98)	20.96
	1000 seed wt.	3.00 (0.07)	3.30 (0.07)	9.09	3.04 (0.06)	3.36 (0.04)	9.52
	Seed yield	416.80	580.00	28.14	439.30	620.50	29.20
Rajapakar	Siliquae/ Raceme panicle	36.40 (7.92)	42.70 (4.22)	14.75	40.20 (3.91)	45.80 (3.43)	12.23
	Seeds/ Siliquae	17.20 (4.94)	19.30 (2.79)	10.88	16.70 (3.33)	19.10 (3.16)	12.57
	1000 seed wt.	3.08 (0.04)	3.14 (0.03)	5.26	3.00 (0.11)	3.11 (0.07)	9.91
	Seed yield	327.00	534.00	11.88	372.00	574.85	12.14
Chakwara	Siliquae/ Raceme panicle	35.70 (7.38)	42.30 (4.34)	15.60	39.10 (3.23)	45.60 (4.38)	14.25
	Seeds/ Siliquae	16.00 (3.98)	17.94 (2.82)	10.81	15.25 (3.75)	17.15 (2.37)	11.08
	1000 seed wt.	3.97 (0.10)	4.15 (0.09)	4.34	3.88 (0.15)	4.19 (0.07)	7.40
	Seed yield	379.00	534.00	20.00	415.00	637.00	23.53

Note: Figure in parenthesis are SD value

whereas it was 372.00 kg/ ha in the open pollinated crop at Rajapakar (Table 3). The increase in pods per panicle and seeds per pod was found 14.25 and 11.08%, respectively in honeybee introduced crop over open pollinated crop at Chakwara with the yield of 637Kg/ha in net honeybees pollinated crop.

Table 3: Increase in yield and economics

Location	Yield (Kg/ha)		Additional yield (Kg/ha)	Income increase (Rs) (@ 8,000/Kg)
	Open pollinated	Net pollinated		
Hariharpur	439.30	620.50	181.20	14,49,600.00
Rajapakar	372.50	574.56	202.06	16,16,480.00
Chakwara	415.00	637.30	222.30	17,78,400.00

Pollination behavior of *A. mellifera* was studied to observe its behavior resulting in change in quality and quantity of seed produced, this study was done for five days when the crop was at the full bloom and at 12 Noon when bee activity is quite high. As the bee colony was placed inside the net house, their numbers inside the net house was found to be higher resulting in higher number of pods per panicle and higher seeds per pod and overall seed yield in the net house when compared to open field conditions. Bees in open conditions spent less time on flowers as compared to the net condition, which may be due to closed and less flower availability. Similar result were reported in case *A. mellifera* which spend less time in broccoli flowers kept in open than in caged conditions (Devkota *et al.*, 2003; Devkota and Tapa, 2005). There was increase pod setting, seed setting and the seed yield at all the three locations. Abrol (2007) had reported that insect pollinators not only enhance the yield of the crop but also contribute uniform and early pod setting. The thousand seed weight was also reported to be 3.64g and 3.21g in honeybee pollinated and natural crop, respectively (Devkota *et al.*, 2003). Duran *et al.* (2010) stated an increase in yield of 50.34% in honey bee introduced field of *Brassica napus*with that of plots without bees.

CONCLUSION

This study result clearly indicates the importance of pollination services of honey bees and the role bee colonies can play in improving the quality and quantity of seed production of cauliflower in particular and other crops in general.

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