

Effect of bee pollination on yield of coriander, *Coriandrum sativum* Linnaeus

■ P.N. PATIL AND J.J. PASTAGIA*

Department of Entomology, N.M. College of Agriculture, Navsari Agricultural University, NAVSARI (GUJARAT)
INDIA

ARTICLE INFO

Received : 23.11.2015
Revised : 10.02.2016
Accepted : 24.02.2016

KEY WORDS :

Coriander, *Apis cerana*, Flower visitors, Pollination, Honeybees, Yield

ABSTRACT

Among different flower visitors of coriander, *Apis florea* was the predominant visitor followed by *A. dorsata* and *A. cerana*. The activity of flower visitors were more at 11 00 h followed by at 10 00 h. Among different bee species, the activity of *A. florea* was reported from 09 00 to 12 00 h and from 16 00 to 18 00 h with maximum activity at 10 00 h. The activity of *A. dorsata* was observed from 09 00 h to 12 00 h and from 15 00 h to 18 00 h with maximum activity at 11 00 h. The studies on the effect of bee pollination on yield of coriander was undertaken at Spices Research Station, College Farm, Navsari Agricultural University, Navsari during *Rabi* 2010-11 by confining *A. cerana* bees in plots of coriander variety DH 5 in cage condition *i.e.* Bee pollination (BP) which was compared with open pollination (OP) and pollination without insects (PWI). The number of filled seeds/umbel was significantly higher in BP (54.03) followed by OP (49.62) and lowest in PWI (27.40). The per cent seed set was significantly higher in BP (69.51 %) followed by OP (62.21 %) and minimum in PWI (54.89 %). Highest yield was obtained in BP (14.57 q/ha) which was at par with OP (14.26 q/ha) but significantly higher than PWI (11.66 q/ha). The 1000 seed weight was also highest in BP (5.68 g) which was statistically at par with OP (5.28 g) but significantly higher than PWI (4.09 g). The germination per cent of seed was also significantly higher in BP (75.91 %) which was followed by OP (73.09 %) and the lowest in PWI (62.76 %). The results indicated that bees have significant role in enhancing yield and quality in terms of seed weight and germination percentage of coriander.

*Corresponding author:
Email: aayoj2000@yahoo.com

How to view point the article : Patil, P.N. and Pastagia, J.J. (2016). Effect of bee pollination on yield of coriander, *Coriandrum sativum* Linnaeus. *Internat. J. Plant Protec.*, 9(1) : 79-83.

INTRODUCTION

The honeybees play an important role in pollination of many seed crops, vegetables, oilseeds, fruits, spices and fodder crops. The honey bee species *viz.*, *Apis*

cerana and *A. mellifera* are the only pollinators which can be hived in bee-boxes and moved from place to place and installed in the field for pollination as and when required. Coriander flower produces both hermaphrodite

and staminate flowers. The hermaphrodite flowers are completely protandrous with anther maturity before the stigmas becomes receptive, (Nemeth and Szekely, 2000) so it requires the pollen from other flowers with the help of pollinators. Ramanujam *et al.* (1964) reported that the honeybees are the major pollinators and cross-pollination is estimated to be up to 50 per cent in coriander. The studies on the pollination requirement of coriander crop was made by Glukhov (1955); Shelar and Suryanarayana (1981); Hussain and Abdel-Aal (1982); Baswana (1984); Sethi (1999); Khalid *et al.* (2008); Anonymous (2010) and Singh *et al.* (2010). The present study is directed to access the role of honeybee, *A. cerana* on yield and quality parameters of coriander, *C. sativum*.

MATERIAL AND METHODS

To study the effect of bee pollination on yield of coriander, the experiment was conducted during *Rabi* 2010-11 at Spices Research Station, College Farm, Navsari Agricultural University, Navsari. Coriander crop (variety DH 5) was sown in three plots measuring 5m x 5m comprising of three treatments. In first and third treatments *i.e.*, bee pollination and pollination without insects, mosquito nets (6 m x 5m x 1.5 m) were erected on standing crop before the initiation of flowering. In treatments of bee pollination, a bee colony of *A. cerana* with four frames with honey store was confined inside the net at twenty per cent flowering and kept till completion of flowering. In treatment of pollination without insects, the pollinators were excluded from the plot by netting while in open pollination treatments; the natural pollinating insects had free access to the flowers. Castor and turmeric were the available crops in the vicinity of the experimental site. Fairly a good number of *A. florea* colonies were available in the vicinity of the experimental site. The cultural operations were done as and when required. The plots were kept unsprayed throughout the crop season. The observations on number of different insects foraging for nectar or pollen at different hours of the day starting from 06 00 to 18 00 h were recorded at weekly interval with the initiation of flowering in coriander crop from open pollinated plot. The abundance of different insect visitors was recorded by counting their numbers on flowers in 1 m² area per 5 minutes at different hours of the day. The observations on foraging activity of *A. cerana* in caged condition were also recorded at hive entrance at an interval of one

hour starting from confinement of bee hive till removal of hive at weekly interval.

To study the effect of bee pollination on yield parameters of coriander at harvest, ten blocks each of 1 x 1 m² area were selected randomly from each treatment. In each block, ten plants were selected randomly and the observation on number of filled seeds per umbel, per cent seed set, yield of 1 m² area and weight of 1000 seeds were recorded. The yield recorded from 1 m² area was converted to q/ha. The observations on the germination percentage of seeds in different treatments were recorded by putting 50 seeds in petri dishes with wet blotting paper. The data collected on various aspects were analyzed statistically.

RESULTS AND DISCUSSION

The coriander flowers were visited by three species of honeybee *viz.*, *A. florea*, *A. dorsata* and *A. cerana*, stingless bees, dipteran flies including *Syrphid* flies, two species of butterflies, aphids and small beetles (Table 1)

The data on the activity of different insect visitors at different hours of the day (irrespective of day of observation *i.e.* mean of five observations) in 1 m² area for the period of five minutes presented in Table 1 indicated that among different flower visitors, honeybees constituted 82.15 per cent of total flower visitors. The predominance of honeybee was also reported by Hussein and Abdel-Aal (1982) who reported that honeybees constituted 67.7 per cent of the total number of visitors in *C. sativum* in Egypt. Among different bee species, *A. florea* was the predominant one with 5.32 bees/ m²/5 minute followed by *A. dorsata* (4.72 bees/ m²/ 5 minute) and *A. cerana* (0.37 bees / m² / 5 minute) (Table 1.) This constituted 41.98, 37.25 and 2.92 per cent of the total visitors of the coriander flower, respectively. Predominance of *A. florea* as visitors of coriander flower was also reported by Shelar and Suryanarayana (1981); Baswana (1984); Sethi (1999); Anonymous (2010) and Singh *et al.* (2010) which confirms the present findings.

Apart from honeybees, the activity of stingless bees, butterflies, dipterans, small beetles, aphids and syrphid flies was reported to be 0.75, 0.36, 0.43, 0.27, 0.30 and 0.15 m²/5 minute which constituted 5.92, 2.84, 3.39, 2.13, 2.37 and 1.18 per cent of the total visitors, respectively (Table 1).

Further, the perusal of data presented in Table 1 revealed that the mean activity of flower visitors were

more at 11 00 h (33.80 visitors/m²/5 minute) followed by at 10 00 h (32.50 visitors /m²/5 minute) and at 12 00 h (18.00 visitors/ m²/5 minute). Sethi (1999) reported the highest activity of flower visitors at 10 00 h to 11 00 h while Khalid *et al.* (2008) reported it between 10 00 h to 12 00 h which is in confirmation to present findings.

Among different bee species, the activity of *A. florea* commenced from 09 00 h and found throughout the day. The maximum foraging activity *A. florea* was recorded at 15 00 h (12.40 bees/m² / 5 minute) followed by at 16 00 h (10.80 bees/m² / 5 minute), at 14 00 h (10.60 bees/m² / 5 minute) and at 10 00 h (10.10 bees/

m² / 5 minute). The activity of *A. dorsata* started from 09 00 h and continued throughout the day. The maximum activity was recorded at 11 00 h (20.20 bees/m² / 5 minute) followed by at 12 00 h (15.80 bees/m² / 5 minute) and at 10 00 h (13.80 bees/m² / 5 minute). The activity of *A. cerana* was low in open filed condition. The maximum foraging activity of *A. florea* in coriander was recorded during 13 00 h to 15 00 h at Bhubaneshwer (Sethi, 1999) and at 16 00 h at Hissar (Anonymous,2010). The difference in foraging activity may be due difference in climatic condition of the area.

The data on activity of different insect visitors at

Table 1 : Mean population of different flower visitors of coriander at different hours of the day during Rabi 2010-11

Hour	Mean number of visitors/m ² /5 minutes*									
	<i>A. florea</i>	<i>A. dorsata</i>	<i>A. cerana</i>	Stinless bees	Butterflies	Dipterans	Beetles	Aphids	Syrphids	Total
06 00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07 00	00.00	00.00	0.00	0.00	0.20	0.00	0.00	00.20	00.00	01.00
08 00	00.00	00.00	0.40	0.80	0.40	1.20	0.60	0.80	0.20	04.40
09 00	05.20	03.60	0.60	1.00	0.40	1.20	1.20	1.00	0.20	14.40
10 00	10.10	13.80	2.00	1.40	0.80	1.80	1.00	1.00	0.60	32.50
11 00	09.20	20.20	0.40	1.60	0.20	0.40	0.60	0.40	0.80	33.80
12 00	00.20	15.80	0.00	2.00	0.00	0.00	0.00	0.00	0.00	18.00
13 00	01.40	02.00	0.00	0.00	1.20	0.00	0.00	0.00	0.00	04.60
14 00	10.60	00.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	11.60
15 00	12.40	07.60	0.00	0.40	0.00	0.40	0.20	0.60	0.20	21.80
16 00	10.80	04.20	1.00	0.60	0.40	0.00	0.00	0.00	0.00	17.00
17 00	05.40	01.00	0.40	1.20	0.20	0.00	0.00	0.00	0.00	08.20
18 00	03.80	0.20	0.00	0.80	0.00	0.00	0.00	0.00	0.00	04.80
Mean	5.32	4.72	0.37	0.75	0.36	0.43	0.27	0.30	0.15	12.67
Per cent	41.98	37.25	2.92	5.92	2.84	3.39	2.13	2.37	1.18	--

* Mean of five observations taken during flowering period of coriander

Table 2 : Mean population of different flower visitors of coriander flower at different dates of observations during Rabi 2010 -11

Date	Mean number of visitors/m ² /5 minutes*									
	<i>A. florea</i>	<i>A. dorsata</i>	<i>A. cerana</i>	Stingless bees	Butterflies	Dipterans	Beetles	Aphids	Syrphids	Total
20-1-2011	4.60*	4.16	0.37	0.96	0.40	0.25	0.21	0.27	0.1	
	(40.64)**	(36.75)	(3.27)	(8.48)	(3.53)	(2.21)	(1.86)	(2.39)	(0.88)	11.32
27-1-2011	6.00	5.10	0.29	0.84	0.32	0.54	0.23	0.23	0.2	
	(43.64)	(37.09)	(2.11)	(6.11)	(2.33)	(3.93)	(1.67)	(1.67)	(1.45)	13.75
3-2-2011	6.80	7.12	0.55	0.78	0.49	0.60	0.38	0.43	0.2	
	(35.37)	(41.23)	(3.18)	(4.52)	(2.84)	(3.47)	(2.20)	(2.49)	(1.16)	17.27
10-2-2011	5.20	4.05	0.38	0.60	0.41	0.48	0.32	0.32	0.1	
	(43.84)	(34.15)	(3.20)	(5.06)	(3.46)	(4.05)	(2.70)	(2.70)	(0.84)	11.86
17-2-2011	4.00	3.07	0.30	0.56	0.27	0.28	0.23	0.25	0.1	
	(44.15)	(33.88)	(3.31)	(6.18)	(2.98)	(3.09)	(2.53)	(2.76)	(1.10)	9.06
Mean	5.32	4.72	0.37	0.75	0.36	0.43	0.27	0.30	0.15	12.67
	(41.98)	(37.25)	(2.92)	(5.92)	(2.84)	(3.39)	(2.13)	(2.37)	(1.18)	

* Mean of observations taken during different hours of the day from m² for 5 minute .

** Figures in the parentheses indicate percentage of total visitors.

different dates of observation (irrespective of the hour of the day) presented in Table 2 revealed that the maximum activity was observed on 3-2-2011 *i.e.* in third week of flowering (17.27 visitors/m²/5 minute) followed by 27-1-2011 *i.e.* on second week of flowering (13.75 visitors/m²/5 minute). The minimum activity of visitors was recorded towards the maturity stage of the crop (9.06 visitors/m²/5 minute). The activity of honey bee species was found to be maximum in middle of flowering and minimum during the maturity stage of coriander at Pusa in Bihar (Anonymous, 2010) which is in corroboration with present finding.

The observations recorded at hive entrance on activity of *A. cerana* in cage condition revealed that the number of *A. cerana* bees incoming with pollen load was commenced from 09 15 h and continued throughout the day. Its maximum activity was observed at 10 15 h (47.60 bees/5 minute) followed by at 11 15 (43.80 bees / 5 minute) (Table 3). The activity of non -pollen foragers was observed from 07 15 h and continued throughout the day. Their maximum activity was observed at 10 15 h (41.21 bees / 5 minute) followed by at 09 15 h (36 00 bees/5minute). Minimum activity of non pollen foragers observed at 18 15 h.

Significantly higher number of filled seeds / umbel was recorded in the treatment of bee pollination by *A. cerana* in caged condition (54.03 seeds/umbel) followed by open pollination treatment (49.62 seeds/umbel) as compared to pollination without insects which recorded only 27.40 seeds/umbel (Table 4). The number of filled seeds/umbel was highest in open pollination (51.60) followed by bee pollination with *A. mellifera* (43.50) and lowest in pollinators excluded (22.72) at Pusa in Bihar (Anonymous, 2010) which differed from present results might be due to variation in population of natural pollinators or variation in bee species in cage condition at Pusa.

Significantly higher per cent seed set was also

Table 3 : Foraging activity of workers of *A. cerana* in caged condition

Hour	Mean number bees return to hive*	
	Pollen foragers	Non-pollen foragers
06 15	0.00	0.00
07 15	0.00	0.60
08 15	0.00	20.00
09 15	13.60	36.80
10 15	47.60	41.20
11 15	43.80	24.80
12 15	23.60	20.40
13 15	7.20	8.00
14 15	8.80	4.60
15 15	8.40	5.40
16 15	17.20	15.00
17 15	13.40	19.00
18 15	1.00	1.60

* Mean of observations taken during different hours of the day for period 5 minute at hive entrance

recorded in the treatment of bee pollination by *A. cerana* in caged condition (69.51 %) followed by open pollination treatments (62.21 %) and minimum (54.89 %) in pollination without insects (Table 4). Glukhov (1955) reported 63.3 per cent seed setting when bees were excluded, while it was 68.3 per cent in presence of bees in coriander crop. At Pusa in Bihar, the per cent seed set in coriander crop was maximum (70.14 %) in open pollination followed by bee pollination with *A. mellifera* (66.74 %), while it was minimum (53.30%) in the crop where pollinators were excluded (Anonymous, 2010). The variation in seed setting on coriander crop as reported above might be due to variation in population of natural pollinators at different locations or variation in bee species in cage condition.

The data on coriander seed yield per hectare presented in the Table 4 revealed that the significantly higher yield (14.57 q/ha) was recorded in the bee pollination treatment with the *A. cerana* which was at

Table 4 : Effect of honey bee pollination on yield and quality parameter of coriander

Tr. No.	Treatments	Mean no. of filled seed/umbel	Per cent seed set	Yield (q /ha)	1000 seed weight (g)	Seed germination (%)
T ₁	Bee pollination with <i>A. cerana</i>	54.03	69.51	14.57	5.68	75.91
T ₂	Open pollination	49.62	62.21	14.25	5.28	73.09
T ₃	Pollination without insects (PWI)	27.40	54.89	11.66	4.09	62.76
	S.E (±) T	0.96	0.93	2.58	0.18	0.48
	C.D. (P=0.05) T	2.86	4.86	7.66	0.53	1.42
	CV %	6.97	7.66	6.04	11.45	2.14

par with the treatments of the open pollination (14.25 q/ha) but significantly higher than that recorded in pollination without insects (11.66 q/ha). According to Baswana (1984), the seed yield of coriander in open condition ranged from 13 to 14.4 q/ha as compared to 8 to 9.2 q/ha in caged condition. Sethi (1999) reported that pollination resulted in 5.72q/ha seed yield as compared to 3.82 q/ha without insect pollination, thus accounting 49.86 per cent increase in yield. Khalid *et al.* (2008) reported that the honeybee pollination increased the yield of coriander by 45 per cent at Hadhramout University in Yemen. The highest yield of seeds was obtained in open pollination (14.21 q/ha) followed by bee pollination with *A. mellifera* (13.54 q/ha) and lowest when pollinators were excluded (7.62/ha) in coriander at Pusha in Bihar (Anonymous, 2010).

The treatment of bee pollination with the *A. cerana* recorded highest 1000 seed weight (5.68 g) which was statistically at par with the treatment of open pollination (5.28 g) but differed significantly from pollination without insect (4.09 g). Similar results are also obtained at Pusa in Bihar, where in 1000 seed weight was highest in open pollination (6.41 g) followed by bee pollination with *A. mellifera* (5.32 g) and without pollinators (4.08) (Anonymous, 2010).

Significantly higher germination of seeds was observed in the treatment of pollination with *A. cerana* (75.91%) followed by open pollination (73.09 %) and without insect pollinators (62.76%). The germination per cent of seed was reported to be highest in open pollination (81.75%) followed by bee pollination with *A. mellifera* (71.60%) and lowest in pollinators excluded (54.50 %) (Anonymous, 2010).

REFERENCES

- Anonymous (2010). Annual report of the All India Co-ordinated Research Project on honey bees and pollinators, *Rajendra Agricultural University, Pusa* pp. 55-67.
- Baswana, K.S. (1984).** Role of insect pollination on seed production in coriander and funnel. *J. Indian Hort.*, **31** (2): 117-118.
- Glukhov, M.M. (1955).** Honey plants. *Izd-vo-Selkhoz Lit-ry.* 512 pp.
- Hussain, M.H. and Abdel-Aal, S.A. (1982).** Wild and honeybees as pollinators of 10 plant species in Assiut area. *J. Appl. Ento.*, **93** (4) : 342-346
- Khalid, A., Tamin, A. and Mohammed, S.K. (2008).** Study the role of honeybee pollination of *Coriandrum sativum*. *J. Apic. Res.*, **4**: 72-74.
- Nemeth, E. and Szekely, G. (2000).** Floral biology of medicinal plants. *Apiaceae Sp. Internat. J. Hort. Sci.*, **6** (3): 133-136.
- Ramanujam, S., Joshi, B.S. and Saxena, M.V.L. (1964).** Extent and randomness of cross pollination in some umbelliferous spices of India. *Indian J. Genetics*, **24**: 62-67.
- Sethi, R.K. (1999).** Effect of honeybee (*Apis* sp.) pollination on the yield of coriander. Thesis submitted to Department of Entomology, College of Agriculture, Orissa University of Agriculture and Technology, Bhubaneswar, ORISSA (INDIA).
- Shelar, D.G. and Suryanarayana, M.C. (1981).** Preliminary studies on pollination of coriander. *Indian Bee J.*, **43**(4) :110-111.
- Singh, H., Swaminathan, R. and Hussain, T. (2010).** Plant products on pollinators of coriander. *J. Biopesticides*, **3** : 208-211.