



E-ISSN: 2320-7078

P-ISSN: 2349-6800

www.entomoljournal.com

JEZS 2020; 8(5): 2545-2548

© 2020 JEZS

Received: 10-08-2020

Accepted: 15-09-2020

Manoj KumarAssistant Professor, Department
of Entomology, RPCAU, Pusa,
Samastipur, Bihar, India**Chandreshwar Prasad Rai**Senior Technical Officer,
Department of Entomology,
SRI, Pusa, Samastipur, Bihar,
India

Pollinator diversity and foraging behaviour of insect visitors on fennel (*Foeniculum vulgare* L.) bloom

Manoj Kumar and Chandreshwar Prasad Rai

Abstract

The pollination diversity and foraging behaviour of insect pollinators on fennel (*Foeniculum vulgare* L.) revealed that the abundance of different insect visitors species showed that the mean population (No. of insect pollinator/m²/minute) of *Apis mellifera* (11.87) was highest followed by *Apis dorsata* (8.53), *Xylocopa fenestrata* (7.07) and the least population of *Apis florea* being 4.87 was recorded among different insect foraging complex on fennel. This might be due to fact that more number of opened flower density were observed during mid flowering period and lower open flower density during initiation of bloom and near maturity of crop. The maximum population of insect visitors on fennel was observed at 1100-h (5.8) which decreased as the day progressed being 4.9 at 1300-h, 3.8 at 1500-h and minimum at 0700-h being 3.0. The foraging rate of *Apis florea* was maximum being 7.27 umbel/min followed by *Apis mellifera* (4.87), *Xylocopa* (4.67) and minimum in case of *Apis dorsata* (4.13). The minimum foraging rate was recorded during middle of flowering being 4.17umbel/min. The foraging speed of *Apis dorsata* was maximum being 15.74 seconds followed by *Xylocopa* (13.67), *Apis mellifera* (12.93) while minimum in case of *Apis florea* (8.74). The minimum foraging speed was recorded near the maturity of crop (9.42 seconds) indicating that less floral rewards were available to bees and thus insect pollinators spent less time to collect floral rewards to fulfil their food requirement.

Keywords: Pollinator diversity, foraging behaviour, *Apis* spp., fennel

Introduction

Fennel (*Foeniculum vulgare* L.) is an important Umbelliferous spice crop grown widely in India. Although seed yield of this crop has been shown to improve considerably by adopting proper cultural practices but insect pollinators have also been reported to play an important role in seed production of fennel crop. This is because most of the Umbelliferous crops are cross-pollinated mainly by insects. The importance of beekeeping has been in practice since long back mainly for honey production and a little has been given to the primary biological and economic role played by bees in the pollination of cultivated and wild plants. Honeybees have helped mankind in maintaining biological diversity through inducing hybrid vigour by cross-pollination and saved a number of botanical sources from extinction by providing free ecosystem services in the form of cross-pollination and propagation of many cultivated and wild plants. It has been reported that fennel (*Foeniculum vulgare* L.), coriander (*Coriandrum sativum* L.) and carrot (*Daucus carota* L.) flowers are favourably visited by honeybees more for nectar but also to obtain pollen in the absence of better flora from February to March (Mishra, 1995) ^[10]. The exploitation of insects for pollination is one of the strategies for enhancing crop production. It is estimated that one third of the total world food production is received from cross-pollinated crops mostly visited by the bees for obtaining pollen, nectar or both (Gatoria *et al.* 1996) ^[3]. However, little efforts have so far been made in utilizing insect pollinators for seed production in fennel crop. Hence the present experiment was carried out and the result so obtained was presented here.

Materials and Methods

To study the relative abundance and diurnal foraging pattern of insect pollinators on fennel (*Foeniculum vulgare* L.) the field experiments were conducted at the University Apiary, Dr. Rajendra Prasad Central Agricultural University Pusa, Samastipur (Bihar) during the *Rabi* season of 2018-2019. The crop was grown as per recommended package of practices except insecticidal application.

Corresponding Author:**Manoj Kumar**Assistant Professor, Department
of Entomology, RPCAU, Pusa,
Samastipur, Bihar, India

The crop was grown in RBD with three replications and the observations were recorded on the insect pollinators visiting fennel umbel. The number of different insect pollinator species visiting fennel umbels was counted in an area of one square meter per minute which were randomly marked in the experimental plots. The number of foragers was recorded dated from 05.02.2019 to 05.03.2019 at different time intervals, i.e. 0700, 0900, 1100, 1300 and 1500 and 1700 hours of the day at weekly intervals on five different dates and time during the flowering period. The average temperature and relative humidity were also recorded at different time and on different dates, simultaneously at the time of observation with the help of thermo-hygrometer. The pollination diversity and foraging activity of insect pollinators was correlated with temperature and relative humidity to know the influence of weather parameters on insect pollinators.

Results and Discussion

Relative abundance of insect pollinators on fennel

The relative abundance of insect pollinators on fennel observations was recorded on the insect pollinators visiting fennel umbel. The number of different insect pollinator species visiting fennel umbels was counted in an area of one square meter per minute which were randomly marked in the experimental plots. The average temperature and relative humidity were also recorded at different time and on different dates, simultaneously at the time of observation with the help of thermo-hygrometer. The recorded data have been presented in Table -1.

Table 1: Relative abundance of insect pollinators (No. of insect pollinator /m²/minute) on fennel on different dates.

Date of observation	<i>Apis mellifera</i>	<i>Apis dorsata</i>	<i>Apis florea</i>	<i>Xylocopa fenestrata</i>	Mean	Av. Temp	Av. RH
05.02.2019	11.00	6.67	3.67	7.33	7.17	15.10	64.0
12.02.2019	13.67	10.33	4.67	7.00	8.92	16.65	65.5
19.02.2019	16.00	11.67	6.67	9.33	10.92	17.25	69.0
26.02.2019	11.33	8.33	5.33	7.00	7.99	20.50	84.5
05.03.2019	7.33	5.67	4.00	4.67	5.42	19.50	68.5
Mean	11.87	8.53	4.87	7.07	8.08	-	-
Factors	S Em (±)		CD (=0.05)		CV(%)		
Date	0.22		0.70		9.12		
Species	0.29		0.84		9.12		
Date × Species	0.27		0.81				

The abundance of different insect visitors species revealed that the mean population (No. of insect pollinator/m²/ minute) of *Apis mellifera* (11.87) was highest followed by *Apis dorsata* (8.53), *Xylocopa fenestrata* (7.07) and the least population of *Apis florea* being 4.87 was recorded among different insect foraging complex on fennel. This might be due to fact that more number of opened flower density were observed during mid flowering period and lower open flower density during initiation of bloom and near maturity of crop. Therefore, the insect pollinator species were getting maximum floral rewards during mid flowering period showing abundance of insect pollinators. With the increase in temperature the foraging activity of pollinators increases while the relative humidity suppress the foraging activity of pollinators.

Diurnal foraging pattern of insect pollinators on fennel

The diurnal foraging pattern of insect pollinators on fennel observations were recorded on the insect pollinators visiting fennel umbel. The numbers of foragers were recorded at

0700, 0900, 1100, 1300, 1500 and 1700 hours of the day at weekly interval on five different dates and time during the flowering period. The recorded data have been presented in Table -2.

Table 2: Diurnal foraging pattern (No. of insect pollinator /m²/minute) of insect pollinators on fennel at different hours.

Time of Observation	<i>Apis mellifera</i>	<i>Apis dorsata</i>	<i>Apis florea</i>	<i>Xylocopa fenestrata</i>	Mean
0700	4.8	3.2	1.6	2.4	3.0
0900	5.4	3.0	2.0	3.4	3.45
1100	11.0	4.8	3.2	4.2	5.8
1300	10.6	3.6	2.8	2.6	4.9
1500	6.0	3.0	2.8	3.4	3.8
1700	5.6	2.6	2.2	3.8	3.55
Mean	7.23	3.37	2.43	3.3	4.08
Factors	S.Em (±)		CD(P=0.05)		CV(%)
Species	0.15		0.52		9.62
Hour	0.19		0.56		
Species × Hour	0.16		0.49		

The abundance (No. of insect/m²/minute) of insect pollinator species viz. *Apis mellifera*, *Apis dorsata*, *Apis florea* and *Xylocopa fenestrata* at different hours of the day showed variations in abundance over time. The maximum population of insect visitors on fennel was observed at 1100-h (5.8) which decreased as the day progressed being 4.9 at 1300-h, 3.8 at 1500-h and minimum at 0700-h being 3.0. The abundance of insect pollinators showed that *Apis mellifera* was the most abundant insect species visiting fennel with a mean population of 7.23/m²/minute followed by *Apis dorsata* (3.37) and *Xylocopa fenestrata* (3.3) and least abundant species was *Apis florea* (2.43). There were significant differences among the species at different hours of the day.

Foraging rate of insect pollinators in fennel

The foraging rate (the number of umbel visited per minute) by insect pollinators on fennel on different dates, the observation were recorded on five dates at 7-days intervals during the flowering period. The data recorded have been depicted in Table -3.

Table 3: Foraging rate of insect pollinators (No. of umbel visited per minute) on fennel on different dates.

Date of observation	<i>Apis mellifera</i>	<i>Apis dorsata</i>	<i>Apis florea</i>	<i>Xylocopa fenestrata</i>	Mean
05.02.2019	5.00	4.00	7.67	4.67	5.34
12.02.2019	4.67	3.67	8.00	4.00	5.09
19.02.2019	4.67	3.00	5.67	3.33	4.17
26.02.2019	4.00	4.33	6.00	5.33	4.92
05.03.2019	6.00	5.67	9.00	6.00	6.67
Mean	4.87	4.13	7.27	4.67	5.24
Factors	S.Em (±)		CD (P=0.05)		CV(%)
Species	0.21		0.53		8.56
Hour	0.28		0.69		
Species × Hour	0.26		0.81		

The result indicated that the insect pollinators showed varied foraging rate on different dates. The foraging rate of *Apis florea* was maximum being 7.27 umbel/min followed by *Apis mellifera* (4.87), *Xylocopa* (4.67) and minimum in case of *Apis dorsata* (4.13). The minimum foraging rate was recorded during middle of flowering being 4.17umbel/min. The maximum mean value of foraging rate was observed 6.67umbel/min. near the maturity of crop indicating that less

floral rewards were available to bees and thus requires more flowers to fulfil their food requirement. The factors date and time and their interactions were found significant.

Foraging speed of insect pollinators on fennel

The foraging speed (Time spent on per umbel) by insect pollinators on fennel on different dates, the observations were recorded on five dates at 7-days intervals during the flowering period. The data recorded have been depicted in Table-4.

Table 4: Foraging speed of insect pollinators (Time spent on per umbel) on fennel on different dates.

Date of observation	<i>Apis mellifera</i>	<i>Apis dorsata</i>	<i>Apis florea</i>	<i>Xylocopa fenestrata</i>	Mean
05.02.2019	12.33	15.67	8.33	13.00	12.33
12.02.2019	13.00	16.67	8.00	15.67	13.34
19.02.2019	13.33	21.67	10.67	18.33	16.00
26.02.2019	15.67	14.00	10.00	11.33	12.75
05.03.2019	10.33	10.67	6.67	10.00	9.42
Mean	12.93	15.74	8.74	13.67	12.77
Factors	S.Em (±)	CD (P=0.5)	CV(%)		
Species	0.23	0.70	9.13		
Hour	0.29	0.76			
Species × Hour	0.34	0.85			

The result indicated that the insect pollinators showed varied foraging speed on different dates. The foraging speed of *Apis dorsata* was maximum being 15.74 seconds followed by *Xylocopa* (13.67), *Apis mellifera* (12.93) while minimum in case of *Apis florea* (8.74). The minimum foraging speed was recorded near the maturity of crop (9.42 seconds) indicating that less floral rewards were available to bees and thus insect pollinators spent less time to collect floral rewards to fulfil their food requirement. The factors date and time and their interactions were found significant. More or less similar observations on diurnal foraging pattern of insect visitors on different crops have been reported by several workers also. (Kumar *et al.*, 2002) [8] reported that foraging activity of *Apis cerana indica* and *Apis mellifera* on sunflower revealed that honeybees on sunflower were more in early flowering stage than matured flowers. (Kumar, 2003) [6] reported that in diurnal foraging pattern of insect visitors described above, 1000 to 1300 h of day were found to be most favourable for foraging. The foraging behaviour of *Apis mellifera* visiting mustard (*Brassica juncea* L.) revealed that abundance of *A. mellifera* on mustard was more in early flowering stage than matured flowers. (Kumar, 2005) [9] reported that in diurnal foraging pattern of insect visitors, the period between 0600 to 0900 h, was found most congenial for foraging. The observations on foraging speed in different crops had been reported by earlier workers also. Gilbert (1980) [3] reported that foraging speed (time in second spent per flower) and foraging rate (number of flowers visited per minute) depends upon the foraging behaviour of insects and the floral structure of the crop concerned. Kumar *et al.*, (1989) [5] reported that on a plot caged with 4-frame nucleus hive of *Apis cerana* on onion umbels received an average time spent by a bee on a flower were 3.5 and 3.3 second in an open plots, respectively. Sharma and Singh (1999) [11] reported that foraging behaviour of *Apis* species on carrot umbels indicated that *A. florea* spent more time (27.09 sec/umbel) than *A. dorsata* (9.20 sec/umbel) and visited 2.20 and 4.40 umbels/min, respectively. Chaudhary and Kumar (2002) [1] reported that *A. mellifera* spent least time (5.2 sec./flower) to collect pollen whereas, *A. c. indica* spent maximum time (5.5 sec./flower). *A. florea*

spent maximum time to collect pollen (7.2 sec./flower). Kumar *et al.* (2003) [7] reported that the foraging speed (time in seconds spent by a bee per capitulum) revealed that *A. mellifera* spent more time (6.69 seconds/capitulum) compared to *Apis cerana indica* (5.37 seconds/capitulum). The foraging speed of both the species was recorded highest at 2.00 PM and lowest at 10.00 AM. Kumar (2005) [9] reported that the maximum mean time (sec) spent/flower by *Apis mellifera* on bitter gourd, sponge gourd and cucumber was recorded to be 7.43, 6.69, 7.66, respectively and on bottle gourd *Apis cerana indica* (7.15).

Conclusion

Thus, it may be concluded that more number of opened flower density were observed during mid flowering period and lower open flower density during initiation of bloom and near maturity of crop. Therefore, the insect pollinator species were getting maximum floral rewards during mid flowering period showing abundance of insect pollinators. With the increase in temperature the foraging activity of pollinators increases while the relative humidity suppress the foraging activity of pollinators. The abundance of insect pollinators showed that *Apis mellifera* was the most abundant insect species visiting fennel followed by *Apis dorsata* and *Xylocopa fenestrata* and least abundant species was *Apis florea*. There were significant differences among the species at different hours of the day. The minimum foraging rate was recorded during middle of flowering. The maximum mean value of foraging rate was observed near the maturity of crop. The foraging speed of *Apis dorsata* was maximum followed by *Xylocopa*, *Apis mellifera* while minimum in case of *Apis florea*. The minimum foraging speed was recorded near the maturity of crop indicating that less floral rewards were available to bees and thus insect pollinators spent less time to collect floral rewards to fulfil their food requirement.

Acknowledgements

The authors are grateful to acknowledge the help extended by Professor and Head, Department of Entomology, Dr. Rajendra Prasad Central Agricultural University, Pusa, Samastipur (Bihar) for providing necessary facilities for research work.

References

1. Chaudhary OP, Kumar R. Honeybee foraging behaviour and pollination studies on niger (*Guizotia abyssinica* Cass.) J oilseeds Res 2002;19(2):257-258.
2. Gatoria G, Baldev Singh, Jhaji HS. Need to revise or separately fix the standards for *mellifera* apiary honey. Facts based on some case studies. National Beekeeping experience exchange conference. 29-31, May1995, Punjab Agriculture University, Ludhiana 1996.
3. Gilbert FS. Flowers visiting by hover flies (Syrphidae). Ann. Rev. Ecol. and Syst 1980;6:139-170.
4. Goyal NP, Singh Manjit, Kandoria JL. Role of insect pollination in seed production of carrot, *Daucus carota* L. Indian Bee J 1989;51(3):89-93.
5. Kumar J, Mishra RC, Gupta JK. Effect of honeybee pollination on onion (*Allium cepa* L.) seed production. Indian Bee J1989;51(1):3-5.
6. Kumar M. Role of insect pollination of some *citrus* spp. Published M.Sc.(Ag.) Thesis, R.A.U., Pusa, Bihar 2003.
7. Kumar M, Singh R, Chand H. Foraging rate and foraging speed of *Apis cerana indica* Fab. and *Apis mellifera* L. in sunflower (*Helianthus annuus* L.) *Shashpa*,

2003;10(1):27-32.

8. Kumar M, Singh R, Chand H. Foraging activity of *Apis cerana indica* Fab. and *Apis mellifera* L. visiting sunflower (*Helianthus annuus* L.) Shashpa 2002;9(1):31-34.
9. Kumar R. Foraging activity of honeybees on summer cucurbits. Published M.Sc. (Ag.) Thesis, R.A.U., Pusa, Bihar 2005.
10. Mishra RC. Honeybees and their management in India. ICAR Publ. New Delhi, 1995, 146-168 p.
11. Sharma SK, Singh JR. Pollinating efficiency of *Apis dorsata* and *A. florea* on carrot (*Daucus carota*). Indian Bee J 1999;61(1-4):75-78.