International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2013): 6.14 | Impact Factor (2015): 6.391

Diversity and Relative Abundance of Solitary Bees on *Jatropha Curcas* Crop in Sirmour and Solan Hills of Himachal Pradesh, India

Vinod K. Mattu[1], Arun Kumar[2]

Sociobiology and Behavioural Ecology Research Lab, Deptt. of Biosciences, Himachal Pradesh University, Shimla (H.P.)-171005. India

Abstract: ***Studies on diversity and relative abundance of solitary bee visitors to Jatropha curcas crop was made by collecting the flower visitors in different sites located at Nahan (933 m) of Sirmour hills and Arki (1104 m) of Solan hills of Himachal Pradesh, during the years from 2012-2016. Insect diversity studies showed that Jatropha flowers were visited by 16 species of bees belonging to 4 families of order Hymenoptera of class Insecta. Of these, 7 species belonged to Apidae, 5 to Halictidae, 3 to Megachilidae and 1 to Andrenidae family. Analyses of data on relative abundance of different solitory bee visitors revealed that Xylocopa fenestrata was the most abundant bee visitor to Jatropha flowers in the two experimental sites i.e. Nahan (25.85%) and Arki (24.84%). Other important bees pollinators at Nahan and Arki were Ceratina gigantica (21.44% and 21.04%), Megachile flaviceps (9.81% and 9.41%), Halictus sp. (9.61%,and 9.21%) and Andrena sp. (3.20 % and 5.21%).***

Keywords: Solitary bees, Relative abundance, *Jatropha curcas*, Sirmour and Solan Hills

1. Introduction

The Himalaya is a store house of large array of diversity in food, fodder, vegetables and medicinal plants which are grown in valleys, hilly terraces and exposed flat mountain tops. One of the richest sources of biological diversity in the world, the Indian Himalayan region, is having a wide range of medicinal and aromatic plants. Of 17,500 flowering plants known to occur in India, about 3000 are recognized for medicinal uses (Sharma and Mudgal, 1997). *Jatropha curcas* (Euphorbiaceae) is a widely cultivated crop in Africa, Central and South America, India and Southeast Asia (Katembo and Gray, 2007; Maes *et al*., 2009). *Jatropha* is one of the crops cultivated in Himachal Pradesh for its medicinal and environmental importance. However, there are inadequate information on the bee pollinator status in terms of diversity and relative abundance on *Jatropha* in Himachal Pradesh despite the awareness of its environmental and economic importance. Pollination is essential stage in the reproduction of flowering plants and involves the transfer of pollen grains from male to female part of flower with the help of abiotic and biotic pollen dispersal agents. Wind, water and gravity are the important abiotic agents, whereas, insects, birds, bats and small mammals are the primary biotic agents (Free, 1993). Various insect groups which are of prime significance in pollination of agricultural and horticultural crops are Hymenoptera, Diptera, Lepidoptera, Coleoptera and Thysanoptera (Michener, 1974). Of these, Hymenopterans are the most important insect pollinators because of their high energy requirements and tendency for collecting food for their brood in the form of pollen and nectar. Pollinators are extremely diverse, with more than 16,000 pollinator bee species have been described worldwide (Michener, 2000; Kevan, 2003). Insect pollination mostly bees is necessary for the pollination of 75% of all crops that are used directly for human food worldwide (Khan and Khan, 2004). Many investigators have studied the diversity and relative abundance of different agricultural crops in relation to non-*Apis* solitary bees pollination in Europe, North America, South America and Australia (McGregor, 1976; Goodman and Fisher, 1991; Gary, 1992; Free, 1993; Morse and Calderone, 2000). But, only a few studies have been conducted regarding the role of solitary bees in pollinating various mountain crops (Mishra *et al*., 1976; Mattu, 2008, 2010). Therefore, present investigation was conducted on the diversity and relative abundance of different bee species visiting *Jatropha* crop in Sirmour and Solan hills of Himachal Pradesh.

2. Material and Methods

Solitary bees pollination studies have been conducted on *Jatropha curcas* crop located at Nahan (latitude 30° 33′ N, longitude 77° 17′ E and altitude 933 m) in Sirmour hills and Arki (latitude 31° 09′ N, longitude 76° 57′E and altitude 1104 m) in Solan hills of Himachal Pradesh, during the months of July and August of the years 2012-2016, when these crop were in full bloom. Studies on diversity and relative abundance of various bee visitors to *Jatropha* flowers have been made by selecting trees at random, on the basis of their size, flowering state and number of branches. The experimental branches selected had nearly same size with respect to their spread, phase of flowering and height above the ground. The observations were started 2 to 3 days after the flowering commenced and continued under good climatic conditions till petal fall. Relative abundance, of different bee visitors was determined in terms of their visits per 500 flowers/10 minutes (Verma and Chauhan, 1985). The observations were recorded from 0800 to 1700 hours of a day and average counts at these hours gave abundance of a bee pollinator for that particular day. All bee visitors on *Jatropha* flowers were collected, killed and identified. Identification of different insect specimens was done with the help of standard keys.

3. Results and Discussion

Solitary bee diversity studies showed that *Jatropha* flowers were visited by 16 species of bees belonging to 4 families of

order Hymenoptera of class Insecta. Of these, 7 species belonged to Apidae, 5 to Halictidae, 3 to Megachilidae, and 1 to Andrenidae family. These results corroborate the earlier findings of pollinators were selective in their floral visits and are shown to choose flowers which best meet their energetic requirements (Abrol, 1989). Burkill (1909) started that *Xylocopa* spp. was the most important flower visiting insects in India more active than *Apis florea* on many cultivated crops. Popov (1936), Mavromoustakis (1938, 1951), Michener (1966, 1994), Peters (1972) and Gupta (1987, 2003a) have described several species of wild solitary bees from different areas of this country. Apidae were represented by species like *Xylocopa fenestrata*, *Trigona iridipenis*, *Ceratina gigantica*, *Ceratina* sp., *Anthophora* sp., *Amegilla* sp. and *Thyreus* sp.etc. Of the family Halictidae, species like *Halictus himalayensis*, *Halictus simlaenis*, *Halictus* sp., *Nomia himalayana* and *Nomia elliotii* etc. Family Megachilidae was represented by *Megachile flaviceps*, *Megachile lanata* and *Megachile* sp. In addition, a single species of *Andrena* belonging to family Andrenidae was also recorded as pollinator of *Jatropha* crop in Himachal Pradesh (Table 1). Analyses of data on relative abundance of different bee visitors revealed that *Xylocopa fenestrata* was the most abundant bee visitor to *Jatropha* flowers in the two experimental sites i.e. Nahan (12.9±2.3, 25.85%) and Arki (12.4±2.2, 24.84%). Other important solitary bee pollinators at Nahan and Arki were *Ceratina gigantica* (10.7±1.5, 21.44% and 10.5±1.6, 21.04%), *Trigona iridipenis* (3.8±0.9, 7.61% and 3.5±0.8, 7.01%), *Anthophora* sp. (2.6±0.7, 5.21% and 2.7±0.4, 5.41%), *Amegilla* sp.(2.4±0.4, 4.80% and 2.5±0.6, 5.01%), *Megachile flaviceps* (4.9±1.5, 9.81% and 4.7±0.5, 9.41%), *Halictus himalayensis* (4.8±0.8, 9.61% and 4.6±1.6, 9.21%), *Halictus* sp. (2.1±0.9, 4.20% and 1.8±0.7, 3.60%), *Nomia elliotii* (3.4±0.5, 6.81% and 3.8±0.5, 7.61%), *Megachile* sp. (0.7±0.3, 1.40% and 0.8±0.3, 1.60%) and *Andrena* sp. (1.6±0.4, 3.20% and 2.6±0.7, 5.21%) respectively (Table 2-3, figure 1-2). Therefore, present results suggest that family Apidae and Halictidae were the most abundant bee pollinators of *Jatropha* at Nahan (64.92%, 20.64%) and Arki (63.32%, 20.44 %) site (Tables 2-3). The higher population of *Xylocopa fenestrata* in experimental sites may be due to its being native species and thus having better adaptability to local environmental conditions. These results are in conformity with the earlier observations of bees in India have been reviewed by Atwal (1970), Batra (1977) and Kapil (1986). Recently, Raju and Ezradanam, 2002; Muthuraman and Saravanan, 2004; Ashoke *et al*., 2005 reported that *Xylocopa* spp., *Ceratina* sp., *Anthophora* sp., stingless bee, *Trigona iridipennis* (Apidae); *Halictus* sp. (Halictidae) and *Megachile* sp. (Megachilidae) as the prominent bee visitors to this crop.

Table 1: Solitary bee species visiting *Jatropha curcas* flowers wih their taxonomic status

Family: Apidae	**Family: Halictidae**	**Family: Megachilidae**	**Family: Andrenidae**
1. Xylocopa fenestrata	8. *Halictus himalayensis*	13. *Megachile flaviceps*	16. *Andrena* sp.
2. *Trigona iridipenis*	9. *Halictus simlaenis*	14. *Megachile lanata*	
3. *Ceratina gigantica*	10. *Halictus* sp.	15. *Megachile* sp.	
4. *Ceratina* sp.	11. *Nomia himalayana*		
5. *Anthophora* sp.	12. *Nomia elliotii*		
6. *Amegilla* sp.			
7. *Thyreus* sp.			

Table 2: Relative abundance of different solitary bees pollinators visiting *Jatropha curcas* bloom at Nahan. No. of bees/500 flowers/10 minutes

Family	**Genus/Species**	**Mean±S.E.**	**Percentage Population**	**Family Percentage**
Apidae	*Xylocopa fenestrate*	12.9*±2.3	25.85	64.92
	Trigona iridipenis	3.8±0.9	7.61	
	Ceratina gigantic	10.7±1.5	21.44	
	Anthophora sp.	2.6±0.7	5.21	
	Amegilla sp.	2.4±0.4	4.80	
Halictidae	*Halictus himalayensis*	4.8±0.8	9.61	20.64
	Halictus sp.	2.1±0.9	4.20	
	Nomia elliotii	3.4±0.5	6.81	
Megachilidae	*Megachile flaviceps*	4.9±1.5	9.81	11.22
	Megachile sp.	0.7±0.3	1.40	
Andrenidae	*Andrena* sp.	1.6±0.4	3.20	3.20

*Each value is an overall average for bee species
S.E. = Standard error about mean

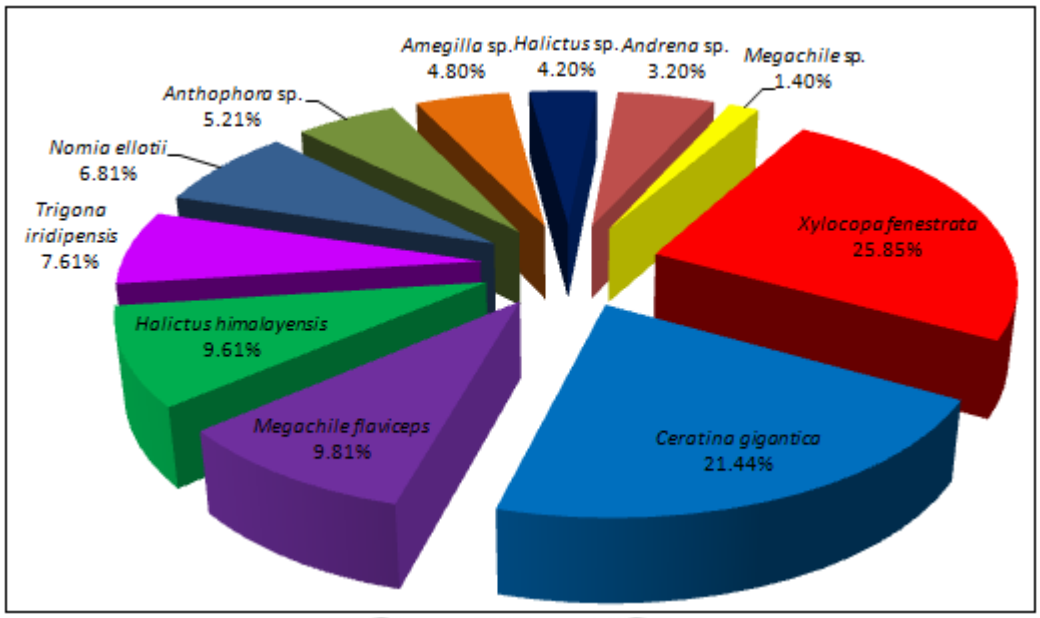

Figure 1: Relative abundance of different solitary bee pollinators visiting *Jatropha curcas* flowers at Nahan of Sirmour hills

Table 3: Relative abundance of different solitary bees pollinators visiting *Jatropha curcas* bloom at Arki. No. of bees/500 flowers/10 minutes

Family	*Genus/Species*	*Mean±S.E.*	*Percentage Population*	*Family Percentage*
Apidae	*Xylocopa fenestrate*	12.4±2.2	24.84	63.32
	Trigona iridipenis	3.5±0.8	7.01	
	Ceratina gigantic	10.5±1.6	21.04	
	Anthophora sp.	2.7±0.4	5.41	
	Amegilla sp.	2.5±0.6	5.01	
Halictidae	*Halictus himalayensis*	4.6±1.6	9.21	20.44
	Halictus sp.	1.8±0.7	3.60	
	Nomia elliotii	3.8±0.5	7.61	
Megachilidae	*Megachile flaviceps*	4.7±0.5	9.41	11.02
	Megachile sp.	0.8±0.3	1.60	
Andrenidae	*Andrena* sp.	2.6±0.7	5.21	5.21

*Each value is an overall average for bee species
S.E. = Standard error about mean

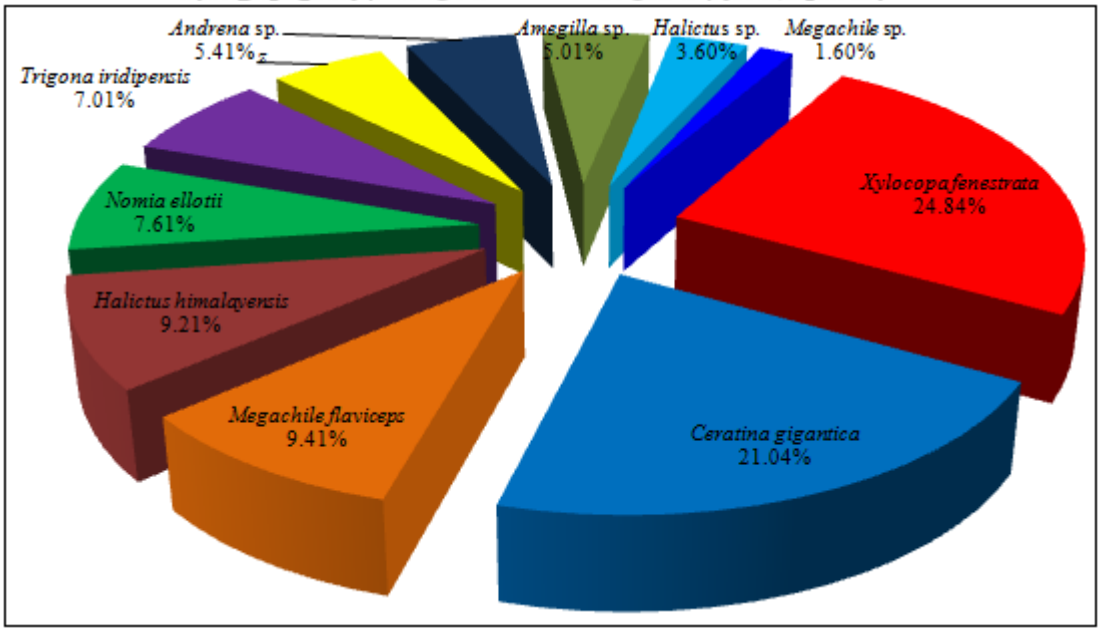

Figure 2: Relative abundance of different solitary bee pollinators visiting *Jatropha curcas* flowers at Arki of Solan hills.

4. Acknowledgements

The authors are thankful to the Chairperson, Department of Biosciences, Himachal Pradesh University, Shimla for

providing the necessary facilities and for encouragements. Thanks are also due to the University Grant Commission (UGC), New Delhi for providing the financial assistance in the form of UGC-BSR (NET).

References

[1] Abrol, D.P. 1989. Studies on ecology and behaviour of insect pollinators frequenting strawberry blossoms and their impact on yield and fruit quality. *Tropical Ecology* **30: 96-100**.
[2] Ashoke, B., Kalyani, D. and Subodh, K. D. 2005. Floral biology, floral resource constraints and pollination limitation in *Jatropha curcas* L. Pak. J. Biol. Sci. 8(3): **456–460**.
[3] Atwal, A.S. 1970. *Insect pollinators of crops*. Punjab Agricultural University Press,Ludhiana. **116 p**.
[4] Batra, S.W.T. 1977. Bees of India, their behaviour, management and a key to the genera. *Oriental Insects* **11** (3/4): 289-324.
[5] Burkill, I.H. 1909. Insects and flowers in India. In: Maxwell-Lefroy, H. and Howlett, F. M. (eds.), Indian insect life. Agriculture Research Institute, Pusa. Govt. of India Publication. **222-223pp**.
[6] Free, J.B. 1993. Insect pollination of crops. Academic Press, London, **786 pp**.
[7] Gary, N.E. 1992. Activities and behaviour of honeybees. *In*: The hive and honeybee (eds.: Dadant and sons). Dadant and sons, Hamilton, Illinois, USA.
[8] Goodman, L.J. and Fisher, R.C. 1991. The behaviour and physiology of bee. CAB International Walling Ford, U.K.
[9] Gupta, R.K. 1987. On a new subgenus *Orientoheriades* and two new species of genus *Heriades* Spinola from India. *Reichenbachia* **25(15)**: **67-71**.
[10] Gupta, R.K. 2003a. The diversity of bees (Hymenoptera: Apoidea) in India. *In*: Gupta, R. K. (ed.), *Advancements in insect biodiversity*. AgroBios (India). **53-78pp**.
[11] Kapil, R.P. 1986. *Pollination Biology-An Analysis*. Inter-India publ., New Delhi, **1-300**.
[12] Katembo, B. I. and Gray , P. S. 2007. Africa, seed and biofuel. J. MultiDiscipl. Res. **1**:**1–6**.
[13] Kevan, P.G. 2003. Pollination for the 21st century: integrating pollinator and plant inter dependence. In: K. Strickler and J.H. Cane [eds] For Nonnative Crops, Whence Pollinators of the Future. Thomas Say Publication of the Entomological Society of America, Lanham.
[14] Khan, M. R. and Khan, M. R. 2004. The role of honey bees *Apis mellifera* L. (Hymenoptera: Apidae) in pollination of apple. Pak. J. Biol. Sci **7**: **359-362**.
[15] Maes, W. H., Trabucco, A., Achten, W. M. J. and Muys, B. 2009. Climatic growingconditions of Jatropha curcas L. Biomass Bioenerg. **33**:**1481–1485**.
[16] Mattu, V.K. 2008. Conservation of bee pollinators for crop pollination. *Proc. 2nd Int. Bee. Cong.* Bhutan.
[17] Mattu, V.K. 2010. Implication of climate change on the pollinator: Some issues and challenges. Proc. *Nat. Sym. Persp. Challng. Integ. Pest Manag. Sustain. Agric. Solan*, **122-123**.
[18] Mavromoustakis, G.A. 1938. Some new Asiatic bees of subfamily Anthidiinae. *Annals and Magazine of Natural History* (10) **9**: **151-157**.
[19] Mavromoustakis, G.A. 1951. Further contributions to our knowledge of the Ethiopian Anthidiinae (Hymenoptera: Apoidea) and their classification. *Annals and Magazine of Natural History* (12) **4**: **962-981**.
[20] McGregor, S.F. 1976. Insect pollination of cultivated crop plants. U.S. Dept. Agric. Handbook, **411 pp**.
[21] Michener, C.D. 1966. A new species of *Anthocopa* fron India (Hymenoptera: Megachilidae). *Entomologis*t **99**: **146-150**.
[22] Michener, C.D. 1974. *The social behaviour of the bees-A comparative study*. Harvard University Press, Cambridge, Massachusetts. **XII+404 pp**.
[23] Michener, C.D. 1994. Native bees in seventeenth centuary Latin America. *Melissa* **8**: **9**.
[24] Micnener, C.D. 2000. The bees of the world. The John Hopkins University Press, Baltimore and London, **XIV+1-913 pp**.
[25] Mishra, R.C., Dogra, G.S. and Gupta, P.R. 1976. Some observations on insect pollinators of apple. *Indian Bee J*.**38**: **20-22**.
[26] Morse, R.A. and Calderone, N.W. 2000. *The value of Honeybees as Pollinators of US Crops in 2000* (http://bee.airoot.com/beeculture/pollinatio 2000).
[27] Muthuraman, M. and Saravanan, P. A. 2004. Utilization of stingless bees for crop pollination. Indian Bee J. 66:(1-2): **58–64**.
[28] Peters, D.S. 1972. Drei neue Arten der Megachilidae aus Mexico. *Senckenbergiana Biologica* **53**: **373-382**.
[29] Popov, V.B. 1936. A new bee of the genus *Ctenoplectra* Sm. Proceedings of the Royal Entomological Society of London (B) **5**: **78-80**.
[30] Raju, A.J.S. and Ezradanam, V. 2002. Pollination ecology and fruiting behavior in a monoecious species, *Jatropha curcas* L.(Euphorbiaceae). Current Science **83**: **1395- 1398**.
[31] Sharma, J.R. and Mudgal, V. 1997. Floristic Diversity and Conservation Strategies in India. *In*: Botanical survey in India (eds.: V. Mudgal and P.K. Hajra). Ministry of Environment and Forests, **5.**
[32] Verma, L.R. and Chauhan, P. 1985. Distribution, abundance and diversity of insect pollinators in apple orchards of Shimla hills. **Indian J. Ecol. 12: 286-292**.