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VARIATION IN FLOWERING BEHAVIOUR AND HONEY BEE VISITATION ON *EUCALYPTUS* CLONES

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ABSTRACT

With the adoption of clonal forestry by the farmers on large tracts in north-western India, the reports of negligible flowering in *Eucalyptus* clonal plantations need to be analysed. This study reports the results from the experimental trial involving 14 clones replicated thrice in randomized block design with plot size of 5 trees. Floral buds appeared from June and continued up to July. Profuse flowering was recorded only on three clones i.e., PE-7, PE-8 and PE-9. On the other hand, no floral buds could be seen on C-72, C-413, PE-12 and PE-14. All the four honey bee species i.e., *Apis mellifera* L. (Italian honey bee), *A. dorsata* F. (rock bee), *A. cerana indica* F. (Indian honey bee) and *A. florea* (little bee) visited the flowers. The frequency of their visit was maximum (7.3/ 2 min) during the afternoon (1 pm) and the lowest (4.9) in the evening. The maximum honey bee visitation was observed on clone PE-9.

Key words: Apiculture, *Eucalyptus*, clonal plantations, agroforestry, diurnal variation, flowering span, *Apis mellifera*, *A. dorsata*, *A.cerana indica*, *A. florea*, flower visitors, frequency, duration

Punjab is one of India's major contributors towards central pool for grains, milk, other dairy products. The highly intensive cropping pattern based on high yielding crops has led to reduced floral diversity. The honey production in Punjab during 2018-19 was 16500 mt, constituting 13.8% (www.indiaagristat.com). *Apis mellifera* L., beekeeping is mainly dependent on agricultural crops. Apart from field and fruit crops, several forest and avenue trees are also good source of the nectar or pollen. In Punjab 19 tree species show relative utility for apiculture, and studies on bee flora reveal that honey bees visit about 172 species. Out of these 27 plant species are source of nectar, 25 of pollen and 120 are source of both nectar and pollen. The agricultural crops are seasonal and provide bee forage for limited periods. Bee colonies cannot be sustained unless an integrated intensive agriculture, agroforestry and social forestry is adopted. In commercial beekeeping, to bridge the gap periods between the crops, the bee colonies have to be moved to other areas having bee flora in bloom.

Eucalyptus flowers produce profuse quantity of pollen and nectar which attract a wide range of pollinators such as *Apis dorsata, A. mellifera* etc. The foraging activity of these depends upon the floral structure of the tree. *Eucalyptus* spp., show high variation in the flowering time (Blakely, 1965). *Eucalyptus* is considered as one of the major tree species for apiculture in many parts of India, especially in the plantation forestry regions (Datta et al., 2008; Chauhan et al., 2017). In Australia, 70 to 80% honey is derived from *Eucalyptus* trees (Somerville, 2000). Many timber producing species like *E. camaldulensis, E. melliodora, E. delegatensis, E. tereticornis, E. saligna, E. globulus* and *Corymbia citriodora* are also known for pollen availability and honey production. On the other hand, trees of *E. paniculata, E. caleyi* and *E. polyanthermos* are not logged for wood but retained only for honey production (Moncur and Kleinschmidt, 1992; Somerville, 1998). *Eucalyptus* is an excellent source of good quality nectar having TSS of 66% (Singh, 1979). In general, the trees do not bear flowers until they are 5-6 years old. Therefore, early flowering has been considered as a valuable trait in *Eucalyptus* breeding programmes (Chambers et al., 1997; Wiltshire et al., 1998). With the adoption of clonal *Eucalyptus*, the farmers in Punjab and adjoining states shifted to the monoculture of few fast growing clones like C-413, C-72, C-2045 and C-288. Punjab State Horticulture Department had given feedback that trees of clonal *Eucalyptus* adversely affecti apiculture. Keeping in view the concerns of beekeepers, this study conducted an experiment raising newly developed and commercial clones in a common garden under field conditions. The aim was to determine the variability among the

Eucalyptus clones for flowering time and intensity of flowering; and to find out flower visitors and honey bee behaviour on these.

MATERIALS AND METHODS

The study was carried out at experimental area, Department of Forestry and Natural Resources, Punjab Agricultural University, Ludhiana (30°90' N, 75°81'E, 247 masl), which represents the central agro-climatic zone of the Punjab region. Fourteen clones were planted with the spacing of 4x 3 m following randomized block design with 3 replications and plot size having five trees in each block. Five commercial clones (C-2135, F-316, C-413, C-72 and C-407) and nine PAU clones (PE-5, PE-6, PE-7, PE-8, PE-9, PE-11, PE-12, PE-13 and PE-14) were used. Based on weekly survey of the plantation, the time (week and month) of bud initiation and time of flowering were recorded from randomly selected two trees/ plot. The methodology used was similar to that of Dhillon and Khajuria (1994). Intensity of flowering was recorded on the basis of floral bud appearance on number of branches/ twigs. Intensity was grouped into 3 categories: low= floral buds appear on <4 twigs; medium= floral buds appear on 4-8 twigs and high= floral buds appear on >8 twigs. Flower visitor diversity was recorded by manual counting i.e. number of insects visited blossomed or fully opened flowers of clones-PE-7, PE-8, PE-9, for collecting nectar, pollen or other foraging activities. Further this, counts of *A. mellifera*/ 2 min visiting on one branch of each clone of bloomed *Eucalyptus* at morning (10 am), afternoon (1 pm) and evening (4 pm) during December 2018 to February 2019 at weekly intervals. The data on flower visits were subjected to ANOVA and means were compared LSD (p=0.05) under completely randomized block design (CRBD) following the CPCS statistical software developed by Punjab Agricultural University, Ludhiana.

RESULTS AND DISCUSSION

Flowering time: Variation was observed in the flowering behaviour among clones of *Eucalyptus* w.r.t. bud initiation (first floral bud appearance) and month of blossoming (opening) of floral buds. No emergence of floral buds was recorded in three clones i.e. C-72, PE-14 and PE-12. The first bud emergence was observed on clone C-2135 in the 2nd week of June, followed on the clone PE-8 and PE-9 in the last week of June. Further, bud appearance was followed on clone PE-7 in the 1st week of July then floral buds emerged on two clones PE-5 and PE-13 in the 2nd week of July. After this, the floral buds commenced on clone F-316, PE-11 and C-407and later on clone C-413 in the 3rd week of August. These buds bloomed within three to four months but no blooming of floral buds was observed in two clones viz C-413 and C-407 (Table 1). The maximum bloomed buds were on the clones PE-7, PE-8 and PE-9 and it commenced from last week of October and continued up to February. These results on variation in the flowering commencement are in accordance with reports of Ashton (1975) that since the floral buds were protected by a capsular sheath for 4 to 6 months, the period of flowering was prolonged to about three months. Hodgson (1976) reported that floral buds reached anthesis stage after three to four months. Keatley et al. (1999) found high variation in the flowering behaviour among *Eucalyptus* spp. Cremer et al. (1978) reported the flowering time of *Eucalyptus* spp. from few days to two months. Similarly, in *Grewia optiva,* Pant et al. (1997) reported floral bud appearance during March-April to end June. Friedel et al. (1993) reported that flowering time was associated with seasonal patterns of rainfall and temperature and intensity of solar radiation. Flowering time is reported to be under genetic control in general in *Eucalypts* (House, 1997) and in *E. globulus* (Chambers et al., 1997; Jones et al., 2011).

Table 1. Variations in flowering behaviour among *Eucalyptus* clones

Clone	Bud initiation	Blossoming initiation	Intensity of flowering
C-2135	2nd week of June	4th week of October	Medium
F-316	3rd week of July	2nd week of December	Low
C-413	3rd week of August	Nil	Nil
PE-6	2nd week of July	2nd week of December	Medium
C-72	Nil	Nil	Nil
PE-14	Nil	Nil	Nil
PE-7	1st week of July	4th week of November	High
PE-5	2nd week of July	3rd week of December	Medium
PE-11	3rd week of July	1st week of November	Low
PE-13	2nd week of July	3rd week of December	Low
PE-8	4th week of June	4th week of November	High
C-407	3rd week of July	No blossoming	Nil
PE-12	Nil	Nil	Nil
PE-9	4th week of June	3rd week of November	High

Flowering intensity: Profuse flowering was observed on the clones PE-7, PE-8 and PE-9 (Table 1); medium intensity of flowering was observed on PE-5 and PE-6; and nil flowering with C-72, PE-12 and PE-14. Though bud initiation was seen on clone C-413 (3rd week of August) and C-407 (3rd week of July), no flowering was seen later on. The lack of flowering of commercial clones had been reported by Ghosh (2019). Keatley et al. (1999) also found that many *Eucalyptus* spp. did not bloom; variation among the genotypes may be exploited to maximise the wood productivity along with apiculture (Dhillon and Sangha, 2018). Moreover, *Eucalyptus* is reported to be having nectar equivalent to 11 kg of honey/ tree (Jhajj et al., 1996).

Diversity and visitation of flower visitors: Flower visitors on of *Eucalyptus* clones were observed during December 2018 to February 2019 on the fully bloomed flowers. It was observed that all the honey bee species found in Punjab were noticed. These were *A.mellifera*, *A. cerana indica*, *Apis dorsata* and *Apis florea*. Yellow wasp (*Ropalidia marginata*) and potter wasp (*Eumeninae flavopictus*) were also noticed roaming around the flowers. These insects visit for nectar and pollen and help in pollination; and *Eucalyptus* rewards these providing nectar. *Eucalyptus* is considered as a major bee flora in the floral calendar of foraging sources in Punjab conditions (Singh et al., 2020). It is established fact that large number of insects visit *Eucalyptus* for pollen and nectar (Pryor, 1976; Hingston and Potts, 1998) and pollinate the plants (Hodgson, 1976).

The preference of honey bee visitation was significantly influenced by the clone (Fig. 1); the pooled counts of *A. mellifera* at three timings/ day were maximum on clone PE-9 (7.1) and followed by PE-8 (5.6), which was statistically at par with those on clone PE-7 (5.2); clone PE-9 was found to be the most attractive, may be due to its flower structure or may provide more reward to visitors. Seeley and Levien (1987) opined that the density of flower visitor insects on bloomed flowers was related with the nectar potential, the flower structure of the tree and intensity of flowers on the tree. The mean honey bee visits/ 2 min varied significantly with the time of the day (Fig. 2). The maximum visits occurred at 1.00 pm (7.3), followed by morning time (5.3) and closely followed during evening time (4.9). The maximum visitation found during afternoon period may be due to higher temperature in the afternoon which enhances the metabolic processes in the insects (Free, 1993) or the better visibility and favourable weather conditions (Seeley and Levien, 1987).

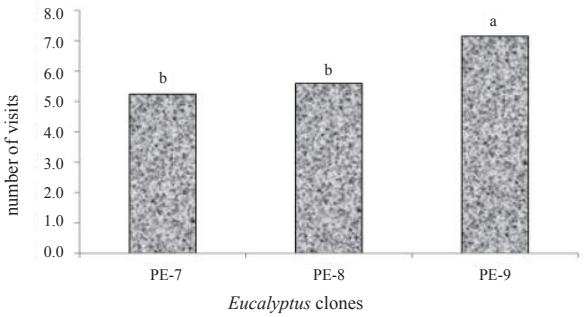

Fig. 1. Honey bee visitation on *Eucalyptus* clones (number of visit / 2 min)

Thus, the results from this study indicate that the

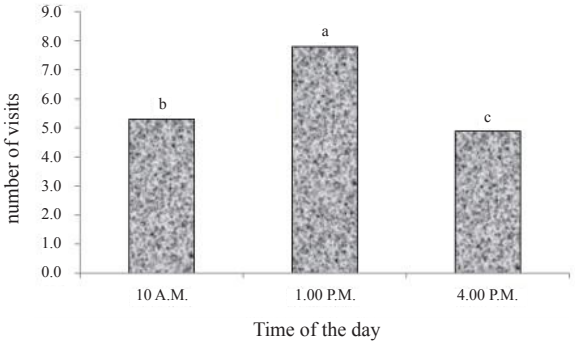

Fig. 2. Diurnal variation in honey bee visits on *Eucalyptus* flowers (No./ 2 min)

enough clonal variation exists in the flowering potential of *Eucalyptus* clones. Many commercial clones had nil to low flowering, while three clones i.e. PE-7, PE-8 and PE-9 had high intensity of flowering. Four honey bee species visited the flowers with high frequency on clone PE-9 and during afternoon.

REFERENCES

Ashton D H. 1975. Studies of the flowering behaviour in *Eucalyptus regnans* F. Muell. Australian Journal of Botany 23: 399-411.

Blakely W F. 1965. A key to the eucalypts. 2nd edition, Forestry and Timber Bureau, Canberra.

Chambers P G S, Potts B M, Tilyard P A. 1997. The genetic control of flowering precocity in Eucalyptus globulus ssp. *globulus*. Silvae Genetica 46: 207-214.

Chauhan M S, Farooqui A, Trivedi A. 2017. Plants foraged by bees for honey production in northern India: The diverse flora of India and its implications for apiculture. Acta Palaeobotanica 57: 119-132.

Cremer K W, Cromer R N, Florence R G. 1978. Stand Establishment. HIllis W E, Brown A G (eds.) Eucalypts for wood production. CSIRO, Melbourne.

Datta K, Verma P C and Chatterjee A. 2008. Mapping of key bee flora of upper Gangetic region of India – a palynological assessment through regional honeys. Grana 47: 159-170.

Dhillon G P S, H N Khajuria. 1994. Floral biology of *Acacia nilotica* ssp. *indica* under subtropical conditions. Journal of Research

Punjab Agricultural University (Agricultural Research Journal) 31: 421-426.

Dhillon G P S, Sangha K S. 2018. Exploiting variation in *Eucalyptus* for apiculture. Proceedings. International Agroforestry Congress (IAC). Kathmandu Nepal, April 27-29, 2018.

Free JB. 1993. Insect pollination of crops. 2nd edition, Academic Press, London.

Friedel M H, Nelson D J, Sparrow A D, Kinloch J E, Maconochie J R. 1993. What induces central Australian arid zone trees and shrubs to flower and fruit? Australian Journal of Botany 41: 307-319.

Ghosh S. 2019. A floral calendar for bee conservation. Mongabay Series: Conserving agrobiodiversity, Environment and Her. June 25, 2019.

Hingston A B, Potts B M. 1998. Floral visitors of *Eucalyptus globulus* ssp. *globulus* in eastern Tasmania. Tasforests 10: 125-137.

Hodgson L M. 1976. Some aspects of flowering and reproductive behaviour in *Eucalyptus grandis.* South African Forestry Journal 97: 18-28.

House S M. 1997. Reproductive biology of Eucalypts. Williams J, Woinarski J (eds.). Eucalypt ecology individuals to ecosystems. Cambridge University Press, Cambridge. 30-55 pp.

Jhajj H S, Gatoria G S, Bakhetia D R C. 1996. Three decades of beekeeping research in the Punjab. Punjab Agricultural University, Ludhiana. 59 pp.

Jones R C, Vaillancourt R E, Gore P L, Potts B M. 2011. Genetic control of flowering time in *Eucalyptus globulus* ssp. *globulus.* Tree Genetics and Genomics 7: 1209-1218.

Keatley M R, Hudson I L, Fletcher T D. 1999. The use of long-term records for describing flowering behaviour; a case-study in Victorian Box Ironbark forests. Australia's Everchanging Forests. DNRE, Victoria.

Moncur M W, Kleinschmidt G J. 1992. A role for honey bees (*Apis mellifera*) in eucalypt plantations. Iufro-Afocel (ed.). Mass production technology for genetically improved fast growing forest tree species. Proceedings. Conference. September 14-18, Bordeaux. 107-115 pp.

Pant K S, Sehgal R N, Sharma S S. 1997. Floral biology and breeding system in *Grewia optiva* Drummond. Indian Journal of Forestry 20: 309-313.

Pryor L D. 1976. The Biology of Eucalypts. Edward Arnold, London.

Seeley T D, Levien R A. 1987. Social foraging by honeybees: how a colony tracks rich sources of nectar. Menzel R, Mercer A (eds). Neurobiology and behaviour of honey bees. Springer, Berlin, Heidelberg.

Singh B. 1979. Phytosociological studies of *Apis mellifera* L. and *Apis cerana indica* F. on bee flora in Punjab. M Sc Thesis, Punjab Agricultural University, Ludhiana. 58 pp.

Singh J, Chhunneja P K, Chauhan S. 2020. Important bee flora and its utility to honey bees. Progressive Farming 56 (2): 11-12.

Somerville D C. 1998. State forests- a valuable beekeeping resource. Australian Beekeeper 100: 96-101.

Somerville D C. 2000. *Eucalyptus* in Asia: A Beekeeping Resource. Matsuka M (ed.). Proceedings. Asian bees and beekeeping: progress of research and development. Asian Apicultural Association. pp. 218-222.

Wiltshire R J E, Reid J B, Potts B M. 1998. Genetic control of reproductive and vegetative phase change in the Eucalyptus risdonii–E. tenuiramis complex. Australian Journal of Botany 46: 45-63.

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