Review Article

Utilization of bumblebee in crop pollination

ABSTRACT

Bumblebees play a vital role in pollination of plants due to being large, very hairy and so are ideal for picking up and transferring pollen. Bumble bees have ability to vibrate ('buzz') flowers and have no communication system. Bumblebees are non-swarming and less aggressive than honeybees. Bumblebees work better in tunnels as they have a better sense of direction. They are 400 times more efficient than honeybees at any pollination chore, capable of visiting 30 to 50 flowers per minute. Bumblebee generally forages during early morning (0530-0800h) and evening (1700-1900h) time Bumblebees are better pollinators than honeybees in greenhouses and glass house and it have a great potentiality to serve as a supplemental pollinator in cultivation of crops such as tomato, eggplant, cucumber, melon, strawberry, pumpkin, cherry, sweet pepper *etc*. It increases yield and number of fruit and seed, fruit diameter, fruit length, fruit weight as well as improves the quality of the fruit. In India, efforts are being made at Solan to mass rear bumble bee and utilized them in pollination. Some private companies are trying to introduce species of bumble bees in India. In a present era population of bumblebees is decline at global level due to injudicious use of pesticides, loss of natural colony and mechanization in agriculture and climatic changes.

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Keywords: Bumblebees, pollinator and foraging behavior

INTRODUCTION

Bumblebees are social insect, belonging to order Hymenoptera, tribe Bombini and genus Bombus in the family Apidae. There are over 250 known species of bumblebee in the worldexisting primarily in the Northern Hemisphere although they also occur in South America. They have been introduced to New Zealand and the Australian state of Tasmania. In India, *Bombushaemorrhoidalis* is reported fromSolan. Bumblebees live in organized colonies in nests typically built in a small hole in the ground or under a clump of grass. The three castes of bumblebees are the queen, female workers and males. Bumblebees have an annual life cycle; Bumblebees pass through four stages (egg, larva, pupa and adult) during their life span. Bumblebee colonies infested by pests and diseases like mite, moth, conopid flies, nematode and *Nosema*spp. They are robust, hairy and black with yellow bands and make a buzzing sound while flying. However, some species have orange or red on their bodies or may be entirely black. A rarity, bumblebee

is a warm-blooded insect, by "shivering" her massive flight muscles; she can create heat in her thorax. Then, by contracting her muscles, she circulates the warmth into her abdomen. Bumblebees require pollen as a protein source for feeding their larvae and nectar as a sugar (carbohydrate) source - a fuel for the adults' flight and to produced wax to build their nest. There are about 400 species of bumblebees worldwide (Heinrich, 1979). There are six species of bumblebee found commonly *viz.*,Buff-tailed bumblebee, *Bombusterrestris;* White-tailed Bumblebee,*Bombuslucorum;* Garden Bumblebee, *Bombus hortorum;* Red-tailed Bumblebee, *Bombus lapidaries;* Early Bumblebee, *Bombuspratorum*and Common Carder Bee, *Bombuspascuorum.* In India, *Bombushaemorrhoidalis* is reported by Chauhan *et al.*, (2013)[b]at Solan.

Bumblebees live in organized colonies in nests typically built in a small hole in the ground or under a clump of grass. The size of queen cells are 16.56-20.57 mm in length and 12.55-15.20 mm width, size of worker cells are 13.16-14.24 mm in length and 10.01-10.95 mm in width. Honey pots are 15.31-20.35 mm in length and 12.91-16.32 mm in width. The three castes of bumblebees are the queen, female workers and males. The length of queen is 20-25 mm, worker is 18-25 mm and that of male is14 -16 mm. Bumblebees have an annual life cycle; Bumblebees pass through four stages (egg, larva, pupa and adult) during their life span. The queen lays eggs in batches of 5-20on the ball of pollen in the pots, seals this with wax and incubates the eggs to keep them warm. Eggs hatched in 2.6 days (mean) after laying and the larval period are 17.2 days while the average pupal stage remained for 8.6 days. The average total period from egg to adult is 28.4 days. Bumblebee colonies infested by pests and diseases like mite, moth, conopid flies, nematode and *Nosema*spp. Bumblebee forages on all kinds of flowers and covers about 8-12 flowers in one minute and it spent 4-8 sec/flower for the collection of pollen and nectar on a single flower (Chauhan *et al.*, 2013[a]).

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Role of Bumblebee as a Pollinator:

Bumblebees play a vital role in pollination of plants due to being large, very hairy and so are ideal for picking up and transferring pollen. Bumblebees are active at temperatures near 5°C and on cloudy, foggy and rainy days. It will fly in winds of up to 40 mph (70 km/hr). Ability to vibrate ('buzz') flowers and have no communication system. Bumblebees are non-swarming and less aggressive than honeybees. Bumblebees work better in tunnels as they have a better sense of direction. They are 400 times more efficient than honeybees at any pollination chore, capable of visiting 30 to 50 flowers per minute. Bumblebee generally forages during early morning (0530-0800h) and evening (1700-1900h) time (Chauhan *et al.*, 2013[b]). Bumblebees are better pollinators than honeybees in greenhouses and poly house and are of great economic importance in greenhouse cultivation of such as tomato, brinjal, strawberry, cucumber, melon, sweet pepper, cherry and pumpkin.

Bumblebee in crop pollination:

Abak*et al.* (1995) observed that the bumblebee pollinated plants of eggplant and tomato recorded significantly higher fruit yield (23% in eggplant and 17% in tomato), number of fruits per m^2 and number of seeds per fruit. However, there was no significant difference observed in fruit quality parameters like total soluble solids content, pH of fruit juice, titretable acidity, fruit diameter and fruit length in both crops as compared to control. In case of pepper, Abak*et al.* (1997) reported that average yield, weight of fruit, diameter of fruit and the numbers of seeds increased 4.0%, 10.0%, 6.0% and 12.5%, respectively in the bumblebee pollination as compared to control in greenhouse.

Dogterom*et al.* (1998) reported that the tomato flowers pollinated by *B. vosnesenskii*produced larger fruit than manually pollinated flowers as evidenced by significant increases ($P < 0.05$) in fruit weight, height, diameter and seed count. Overall, bumblebee treatments (bumblebees and bumblebees plus manual) resulted in significantly greater ($P < 0.05$) fruit weight, seed count, fruit diameter and fruit height compared with non-bee treatments (manual and no-pollination). In contrast, fruit roundness did not differ between treatments ($P < 0.05$).

Stanghellini *et al.* (1998) stated that bumblebee visited flowers recorded significantly lower abortion rates and higher seed sets in the cucumber and watermelon then honeybee visited flowers.

Bumblebee pollination in eggplant yielded higher (25%) than vibration treatment. Fruit size (14% in weight and 7% in length) and number of seeds per fruit were higher (4 times) in bumblebee pollinated fruits than vibration treatments (Abak*et al.*, 2000).

Dasgan *et al.* (2004) reported significantly higher tomato yield (4.12 kg m^{-2}) in bumblebee pollinated plants ($P<0.01$) with an increased yield of 89.9% and 60.9% over vibration treatment and growth regulator application ($P>0.05$) and also significantly improve the quality of tomato like numbers of fruit, number of seeds per fruit, volume of fruits and number of carpels.

Serrano and Jose (2006) studied the sweet pepper flowers visited by bumblebee and noticed that the bumblebee visited flower produced larger and heavier fruits then non-visited flower and significantly produced higher yield as compared to control (self - pollination).

Dimou*et al.* (2008) found that the total number of the marketable fruit as well as its total weight was significantly higher in the row that was pollinated by the bumblebees compared to the control and fruit produced in the control row 30% was deformed because of ineffective pollination in strawberry.

Nault *et al.* (2011) recorded that bumblebee supplemented fields produced higher yield (16.5 lbs/plant), followed by honey bee supplemented fields (15.2 lbs/plant) and then non-supplemented fields(13.1 lbs/plant) of pumpkin in New York.

Vergara and Buendia (2012) observed the number of seeds per fruit was higher in bumblebee pollinated tomato plants as compared to plants pollinated mechanically or not pollinated. Maturation time

was significantly longer and sugar content, fresh weight and seed count were significantly higher in bumblebee pollinated flowers than in flowers pollinated manually or with no supplemental pollination, but did not differ with flowers pollinated mechanically.

Whitehorn*et al*. (2012) reported that the neonicotinoid (imidacloprid) treated colonies had a significantly reduced growth rate and suffered an 85% reduction in production of new queens as compared to control colonies and they suggest that they may be having a considerable negative impact on wild bumblebee populations across the developed world.

Thakur (2018) noted that the bumblebees increase the number of fruits per plant (3.77%), fruit weight (g) (24.60%), fruit length (cm) (13.51%), fruit breadth (cm) (21.52%), healthy fruits (23.84%), seed number (113.64%), 1000 seed weight (g) (5.44%) and fruit yield per m2 (kg) (89.42%) in bell pepper over control.

Conclusion:

Pollination is one of the most important ecological processes on the planet. Among pollinators, bumblebees has gained importance as an efficient pollinator due to its large size and very hairy makes them more ideal for picking up and transferring pollen of many commercial crops grown under greenhouse, glasshouse, poly houses and open field. Bumblebees are better pollinators than honeybees in greenhouses and glass house and it have a great potentiality to serve as a supplemental pollinator in cultivation of crops such as tomato, eggplant, cucumber, melon, strawberry, pumpkin, cherry, sweet pepper *etc*. It give higher yield and increase the number of fruit and seed, fruit diameter, fruit length, fruit weight and also improve the quality of the fruit.

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