

## Original Research Article

# **Augmentation of *Apis mellifera* for fruit yield enhancement in *Capparis decidua*(Forssk.) Edgew(Kair)**

### **Abstract**

*Capparis decidua* (Family, Capparidaceae) is a very nutritious shrub of arid region. Its fruits are utilized in famous Rajasthan Panchkutta and Tricutta vegetable and pickle making. The present paper deals with the effect of *Apis mellifera* beehives augmentation on the fruit setting and quality parameters of its fruit. It was found that the average numbers of fruit setting raceme-1 were found 4.36, 3.77 and 2.2 in natural pollination with augmentation of honey bees, pollination by honey bees only and natural pollination respectively. Germination percentage, TSS%, average fruit weight, Shoot length and Seedling length was higher in case of natural pollination with augmentation of honey bees. Shoot length and seedling length were found to be higher in natural pollination with augmentation of honey bees among all the treatments.

Key words: *Capparis decidua*, pollination, augmentation, fruit setting, Germination, fruit weight

### **Introduction**

There are many food-value plant species in forests that produce edible leaves, fruits, seeds, roots, and rhizomes, among other things. Many of these plants are directly useful to humans. Most foods obtained from forests have excellent nutritional contents, even though the nutritional value of the majority of these items is not precisely recognized. One of the many edible fruit-bearing and food-producing species found in Rajasthan's dry and semi-arid zones is *Capparis decidua*.

Children's nutrition, both in rural and urban places, is significantly influenced by native fruits. The fruit *Capparis decidua* is one of the key components of the well-known Marwari vegetables Panchkuta and Trikuta, which are made from five and three different types of dried fruits or seeds,

respectively. These dishes are considered to be staples of the Marwari diet. 'Kair' is the common name for *Capparis decidua*, a member of the Capparidaceae family. It also goes by the name *Capparis aphylla*. The Capparidaceae family has between 700 and 900 species spread across 40 to 45 genera. Its members exhibit a wide range of fruit and floral characteristics (Pieroni, 2000; Ozer, 2005). It has several branches that are either leafless or have extremely small leaves. It rarely rises higher than five meters. It rarely rises higher than 5 meters. March to April and August to September see the appearance of red, noticeable blossoms, which ripen in May and October. It can withstand moderate frost and is exceptionally drought-resistant (Burdak, 1982). *Capparis decidua* can be utilized in semiarid and desert environments for landscape gardening, afforestation, and reforestation since it helps prevent soil erosion (Kaul, 1963; Ghosh, 1977).

Kair is a caducous plant and found all throughout the desert areas of India and other nations. In general, the species has a wide ecological range, and in India, it is particularly common in arid and semi-arid regions of the states of Gujarat, Punjab, Uttar Pradesh, Madhya Pradesh, and Andhra Pradesh, western Rajasthan and parts of Haryana. Being xerophytic, the plant is typically found in desert regions and is a draught-resistant plant with a long lifespan. It is the perfect plant for preventing soil erosion, notably wind erosion, and stabilizing sand dunes. Also, as *Capparis* contains high levels of nutrients like proteins, carbohydrates, minerals, and vitamins, its fruits are utilized as vegetables and the fruits are used to make pickles (Joseph and Jini 2011). According to Mishra et al. (2007); Singh and Mishra (2010); Verma et al., (2011); Dangi and Mishra (2011), the entire plant, especially its fruit, has therapeutic benefit for treating cough, asthma, heart issues, and many other conditions.

According to Chouhan et al. (1986), mature fruits are very nutrient rich. Also, it was found that the fruits were high in dietary fiber (Agarwal and

Chouhan 1988). The fruits and flower buds produced 14% surface wax (w/w), which was found to consist of a mixture of compounds, primarily straight chain saturated hydrocarbons and ketones with C-28 and C-32 chain length, associated with oils that contained nitrogen and sulphur (Rai 1987a). Additionally, fifteen natural substances have been extracted and identified from Kair fruit (Rai 1987b).

Four bee species, three wasp species, and two species of butterflies have been identified by Latif et al. (2016) visiting the blooms of *C. aphylla*. The most numerous insects that visited the flowers were bees (1035), followed by wasps (354), and butterflies (151). Reviewing the above it was found that record of pollination by *Apis mellifera* and its effect on fruit quality and quantity was missing therefore Present study was conducted deals to evaluated the effects of augmentation of *Apis mellifera* on fruit production and fruit quality of *Capparis decidua* (Forssk.) Edgew(Kair)

## **Methodology**

*Apis mellifera* hives boxes containg eight frames were augmented in *Capparis decidua* under caged condition. Bamboo-Net structures were installed in the *Capparis decidua* field to conduct pollinator exclusion experiment by keeping honey beehives boxes. A Randomized block design (RBD) with 3 treatments was applied and replicated thrice. Three different trees of almost equal size and canopy were selected for pollination by honey bees only. These plants were caged within Bamboo-Net structures (T2). An eight framed hives with *A. mellifera* L. bee colony were placed in each cage. The trees were caged restricting the entry of insects.

Three trees were randomly chosen for natural pollination with the introduction of honey bees (T1), allowing free visits from all pollinators and the placement of a honey bee colony with eight frames of adult bees in the research area (Abrol 2009). Natural pollination(T3)was observed on three randomly selected trees/shrubs tagged for control treatment away from rest of the

experimental area. In each treatment, a sampling unit consisted a set of 10 panicles that had been marked with tags. The average fruit weight was obtained by dividing the total fruit weight by the total number of fruits, and the mean number of fruit per raceme was computed by counting all the fruits in the sampling unit and dividing that number by 10. The data was analysed statistically (Steel *et al.*, 1997). Size of the fruit, fruit weight and total soluble solids (TSS) were also calculated. For germination percentage and vigour index following formula were used.

Percent germination was calculated by using formula:

Germination % =  $\frac{\text{Seeds germinated}}{\text{total seeds}} \times 100$

Vigor index was calculated by using formula:

Vigor index (VI) =  $[\text{seedling length (cm)} \times \text{germination percentage}]$   
(Dezfuliet *al.*, 2008)

## Results

Pollination effect of honey bees (*Apis mellifera* L.) on average number of fruit setting per raceme and quality parameters like average fruit weight (in kg) and size (mm) of *Capparis decidua* are summarized in Table No. 1 & 3; Fig 1 & 3 respectively. Significant differences ( $P > 0.05$ ) were observed among the treatments in terms of average number of fruit panicle-1. The average numbers of fruit setting raceme-1 were 4.36, 3.77 and 2.2 in natural pollination with augmentation of *Apis mellifera*, pollination by *Apis mellifera* only and natural pollination respectively. With the addition of *Apis mellifera* and pollination by *Apis mellifera* alone, there was an increase of 98.18% and 71.36% in the number of fruit raceme-1 over the control, respectively.

Our findings are consistent with those of Sujitratunth (1992), who estimated that *Citrus maxima* fruit percentage was 66.9%, which represented a 274.5% increase in fruit production over the cage without bees. In a different study done by Chaudhry (2008), peach trees that were given access to honey bee colonies produced an optimal harvest of 6.5 peaches per branch.

According to Cayuela et al. (2011), plants that were not pollinated by honey bees (the control) had a much lower number of fruits per panicle than those that were.

The pollination effect of honey bees (*Apis mellifera* L.) on average fruit weight (in gm) is indicated in Table 1. Significant differences ( $P>0.05$ ) were found among the treatments. Average fruit weight was found to be 0.81g and 0.79g in treatments with pollination by *Apis mellifera* alone and natural pollination, respectively. These values were relatively lower than natural pollination with *Apis mellifera* augmentation, i.e. 0.91g. Volz et al. (1996) also reported similar findings stating the maximum apple weight of variety



**Pic 1. *Apis mellifera* augmentation in Kair (*Capparis decidua*)**

**Pic 2. Fruits setting of *C. decidua***



**Pic 3. Fruits of *C. decidua***

'Braeburn' (170g) in trees that had treatment of pollination.

The TSS% was found to be maximum (18.09) in the case of natural pollination *Apis mellifera* augmentation, followed by pollination by honeybees alone (16.04), and least (15.21) in the control.

Germination percentage (Table No. 4; Fig 3) in natural pollination with augmentation of honey bees was 55.33% in comparison to pollination by honey bees (50.33%) and natural pollination (49.33%). Similar results were reported by Sabir *et al.*, (2000) indicating *A. mellifera*, as a good source of pollination of *Brassica campestris* resulting in maximum seed yield (19.9 q/ha), 1000 seed weight (3.8 g) and seed germination (95.8%). In the present study root length (3.03cm), Shoot length (4.05cm) and Seedling length (7.09cm) were found to be highest in natural pollination with augmentation of honey bees among all the treatments. Seedling Vigour index (Table No.2) natural pollination with augmentation of honey bees was higher (392.28) in comparison to pollination by honey bees (332.00) and natural pollination (322.61).

## **Discussion**

Chaturvedi (1965) revealed that insects were the primary pollinators of litchi. According to Free and Nuttall's 1968 research, bee-caged litchi trees produced 25% more fruit than bee-caged plants. The Dehradun cultivar of litchi had the highest yield when pollinated by bees, as opposed to tree which are not pollinated by bees, according to Badiyala and Awasthi (1991). Similar findings were observed by Kumari *et al.*, (2023) stating that percentage fruit set/fruit weight was higher in natural pollination with *A. mellifera* and other pollination modes than without pollination by insect pollinators. Pareek *et al.*, (2007) revealed how important pollination and pollinators are for fruit setting in ber. Insufficient pollination reduces oil tree peony fruit set, according to Zhang *et al.* (2022) research. Augmenting appropriate bee density to the field for pollination is a key tactic to increase fruit yield.

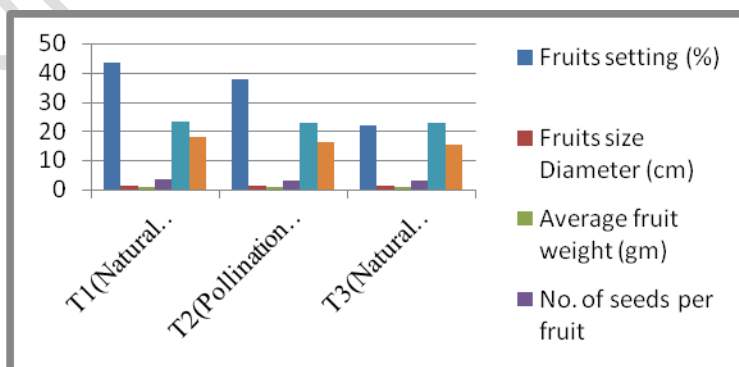
Verma and Dulta, (1987) reported similar findings that there wasn't any fruit set in absence of insect pollinators in self-incompatible apple cultivars like Royal and Red Delicious, and it was 10.12 and 8.27% greater in honeybee-pollinated blooms in comparison to open pollinated flowers. Without any insect pollinators, the fruit loss in Golden Delicious and Red Gold was considerably higher ( $P < 0.01$ ) than in open and honeybee-pollinated flowers. In regards to weight, length, width, volume, and other fruit quality measures, honeybee cross-pollination considerably improved the fruit.

This demonstrates honeybees' capacity for pollination in agricultural settings and their high adaptation to both crops and trees (Nates, 2005). Our results imply that to reduce the danger of pollination deficiencies influencing food production, management measures for managed bees and wild insect populations should be increased. These populations provide pollination services for the development of agro-forestry systems.

**Table1:** Studies on effect of *Apis mellifera* augmentation on fruit setting, fruit dia, average fruit weight, no. of seeds per fruit, seed weight and Total sugar

Treatment	Parameters					
	Fruits setting (%)	Fruits size Diameter (cm)	Average fruit weight (gm)	No. of seeds per fruit	Seed test weight (gm)	Tss content %
T1(Natural pollination+ Augmentation of honey bees)	43.6	1.23	0.91	3.4	23.40	18.09
T2(Pollination by Honey bees)	37.67	1.21	0.81	3.0	23.00	16.04
T3(Natural pollination)	22.0	1.19	0.79	2.96	22.73	15.21
Grand mean	34.42	1.21	0.84	3.13	23.04	16.45
SE	0.61	0.011	0.035	0.112	0.136	0.31
CD @5%	2.39	0.027	0.086	0.274	0.332	3.23
CV	3.06	1.132	5.173	4.386	0.723	1.20
Significance @5%	S					

content in Kair (*Capparis decidua*)



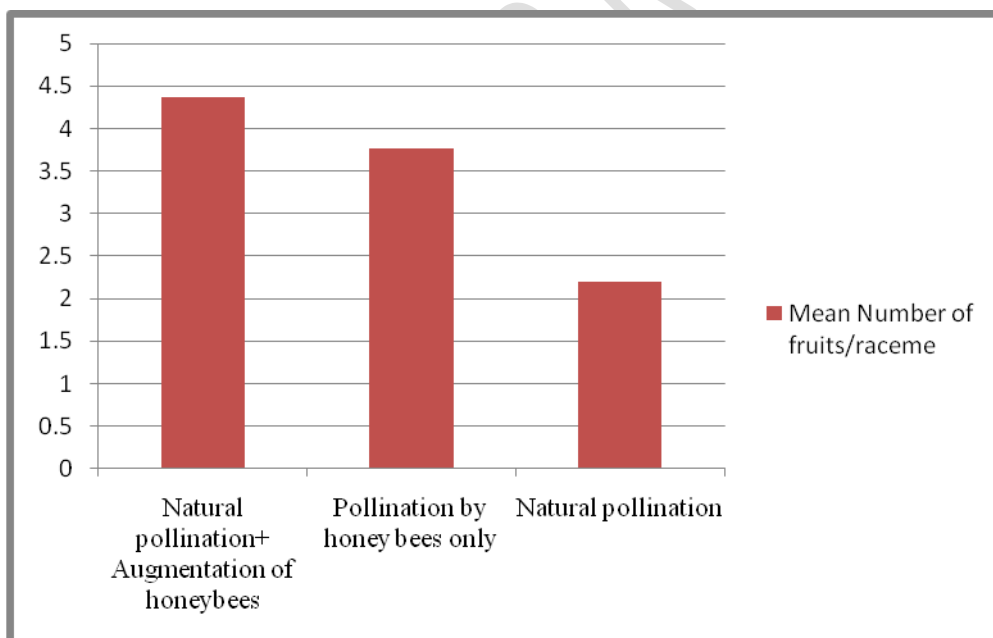
**Fig 1:** Studies on effect of *Apis mellifera* augmentation in Kair

**Table 2: Studies on effect of *Apis mellifera* augmentation on seedling fesh weight, seedling dry weight and seedling vigourin Kair (*Capparis decidua*)**

Treatment	Seedling fresh weight (gm)	Seedling dry weight (gm )	Seedling Vigour index (Mass)	Seedling Vigour index (length)
T1(Natural pollination+ Augmentation of honey bees)	0.56	0.07	3.87	392.28
T2(Pollination by Honey bees only)	0.53	0.06	3.00	332.00
T3 Control (Natural pollination)	0.52	0.06	3.02	322.61
Grand mean	0.54	0.06	3.30	348.96
SE	0.011	0.006	0.190	16.75
CD@5%	0.027	0.014	0.464	40.99
CV	2.55	11.37	6.74	5.88
Significance @5%	S	Ns	S	S

**Table3: Pollination effect of *Apis mellifera* L. augmentation on average number of fruit setting in *Capparis decidua***

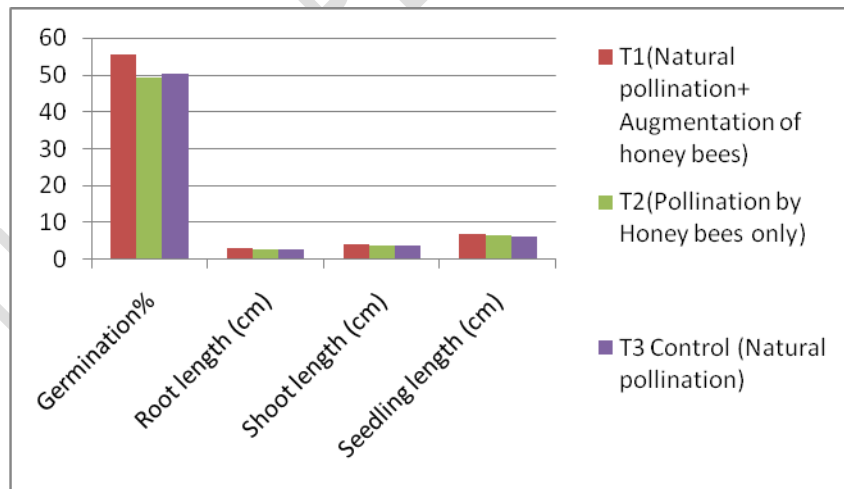
Treatment	Mean number of fruits/raceme	Percentage increase over natural pollination
Natural pollination+ Augmentation of honeybees	4.36	98.18
Pollination by honey bees only	3.77	71.36
Natural pollination	2.2	-



**Fig 2: Pollination effect of *Apis mellifera*L. augmentation on average number of fruit setting in *Capparis decidua***

**Table 4: Studies on effect of *Apis mellifera* augmentation in Kair (*Capparis decidua*)**

Treatment	Germination%	Root length (cm)	Shoot length (cm)	Seedling length (cm)
T1(Natural pollination+ Augmentation of honey bees)	55.33	3.03	4.05	7.09
T2(Pollination by Honey bees only)	50.33	2.84	3.89	6.73
T3 Control (Natural pollination)	49.33	2.68	3.72	6.41
Grand mean	51.66	2.85	3.89	6.74
SE	1.825	0.100	0.103	0.187
CD@5%	4.467	0.246	0.253	0.459
CV	4.327	4.319	3.257	3.412
Significance at 5%	S	S	S	S



**Fig 3: Effect of *Apis mellifera* augmentation in Kair (*Capparis decidua*)**

## Conclusion

In this study, the pollination impact of honey bees *Apis mellifera* L. on fruit weight and development was examined. When natural pollination was supplemented with honeybees (*Apis mellifera* L.), we observed a significant increase in the quantity of fruit/pods panicle-1 and their weight. Therefore, for optimal fruit/pod output, farmers are thus suggested to put in colonies of honeybees in their farms during tree/shrub blossom times. Our research is intended to help raise community knowledge of the value of honeybees in forestry, agro-forestry, and agriculture.

Pollination is an essential ecosystem service that is accountable for better yield in plants. Different trees/shrub species have different requirements for effective pollination. Despite the fact that pollination is an unbound service provided by bees together with several wild bees, they need to be conserved and cosseted. In conclusion, our observation on insect visitors reveals that there is a large and varied assemblage of potential pollinators. However, the irregular arrival and departure of the various insect species portend that most wild pollinators can only be relied upon secondarily. When natural pollination was augmented with honeybees (*Apis mellifera* L.) was observed there is a positive effect on fruit setting and quality parameters of *Capparis decidua*.

## References:

1. Agarwal V. and Chouhan B. M. (1988). A study on composition and hypolipidemic effect of dietary fibre from some plant foods. *Plant Food for Human Nutrition*, 38(2): 189-197.
2. Abdul Latif, Saeed Ahmad Malik, Abid Mahmood Alvi, Qamar Saeed, Shafqat Saeed, Muhammad Atif Shuja, Muhammad Ejaz and Naeem Iqbal (2016). Pollinators' community of *Capparis aphylla* at Dera Ghazi Khan, Punjab, Pakistan. *Journal of Entomology and Zoology Studies*; 5(1): 967-969.
3. Badiyala, S.D. and Awasthi, R.P. (1991). Physico-chemical characteristic of some Litchi chinensis Sonn. cultivars grown in Kangra valley. *Indian Food Packer*, 42-45.
4. Burdak, L.R. (1982). Recent Advances in Desert Afforestation- Dissertation submitted to Shri R.N. Kaul, Director, Forestry Research, F.R.I., Dehra Dun. p.55
5. Chaudhry O. P. (2008). Influence of Different colony placement distances on yield and quality parameters of peach *Prunus persica* (L.). *Korean J. Apic.* 23 (2): 89-95.
6. Cayuela L., Arriaga S. and Ozers C. P. (2011). Honeybees increase fruit set in native plant species important for wildlife conservation. *Environ. Man.* 48: 910-919.
7. Chouhan B.M. Duhan A. and Bhatt CM. (1986). Nutritional value of Ker (*Capparis decidua*) fruit. *Journal of Food Science and Technology* 23(2): 106-108.

8. Dangi K. S., Mishra S. N. (2011). Effect of *Capparis aphylla* stem extract treatment in normal and streptozotocin induced diabetic rats infected with *Candida albicans*. Asian Journal of Experimental Biological Sciences. 2011; 2: 102-107.
9. Dezfuli P. M., Sharif-Zadeh F. and Janmohammadi M. (2008). Influence of priming techniques on seed germination behavior of maize inbred lines (*Zea mays* L.). Journal of Agricultural and Biological Science, 3(3): 22-25.
10. Ghosh, R.C., 1977. Handbook on Afforestation Techniques. Dehra Dun, India.
11. Kaul, R.N., 1963. Need for afforestation in the arid zones of India. La-Yaaran. Vol. 13.
12. Mishra S. N., Tomar P.C. and Lakra N (2007). Medicinal and food value of *Capparis* - a harsh terrain plant. Indian Journal of Traditional Knowledge; 6:230-238.
13. Pieroni (2000). Medicinal plant and food medicines in the folk traditions of the upper Lucca province. J Ethnopharmacol.; 70:253-73
14. Sabir A. M., Suhail A., Hussain A. and Saeed A. (2000). Insecticidal mortality, foraging behaviour and pollination role of honeybee (*Apis mellifera* L.) on Brassica (*Brassica campestris* L.). Pakistan Journal of Zoology. 32:369-372.
15. Singh K., Mishra S.N. (2010). Antimicrobial potency of stem extract of *Capparis aphylla*. Plant Archives, 10: 141-144.
16. Sujitratunth S. (1992). Pollinating management by honeybee, *Apis mellifera* L. on fruit production of pummelo, *Citrus maxima* (J. Burm.) Merr, cv. Tongdee. Ms. Thesis. Kastesart University, Bangkok. 72p.
17. Verma P. D., Dangar R.D., Shah K. N., Gandhi D. M. and Suhagia B. N. (2011). Pharmacognostical Potential of *Capparis decidua* Edgew. Journal of Applied Pharmaceutical Science 01 (10); 2011: 06-11.
18. Volz R. K, Tustin D.S. and Ferguson I. B. (1996). Pollination effects on fruit mineral composition, seeds and cropping characteristics of 'Braeburn' apple trees. Scientia Horticulture. 66:169-180.
19. Chaturvedi, R.B. 1965. Preliminary studies in the sex distribution, pollination and fruit development in Letchi. Allahabad farmer. 39 (2): 49-51.
20. Kumari, Pooja, Shagun Rana, Bhavya Bhargava, and S. G. Eswara Reddy. 2023. "Diversity, Abundance and Impact of Insect Visitors in *Litchi chinensis* Production" *Agronomy* 13, no. 2: 298.
21. Pareek, S., Mukherjee, S., Paliwal, R., 2007. Floral biology of ber—A Review. Agricultural Reviews 28(4), 277–282.
22. Verma, L.R. and P.C. Dulta. 1987. Role of insect pollinators on yield and quality of apple fruit. Indian Journal of Horticulture 44:274-279.
23. Özer, D., 2005. Caper plant (*Capparis* spp.) 'S cultivation, use and trade areas A.Ü.Z.F. Field Department of Crops. Diploma Thesis. 33 p., Ankara
24. Joseph B, Jini D (2011) A medicinal potency of *Capparis decidua*-a harsh terrain plant. Res J Phytochem 5(1): 1-13.
25. Rai S. (1987a). Oils and fats in arid plants with particular reference to *Capparis decidua*. Transactions the Indian Society of Desert technology, 12(2): 99-105.
26. Rai S. (1987b). Chemical examination of edible plants in Rajasthan with special reference to Capparidaceae. Current AgricultureII (1-2): 15-23.
27. Zhang K, Li Y, Sun K, Bao J, He C, Hou X (2022) Supplementary honey bee (*Apis mellifera* L.) pollination enhances fruit growth rate and fruit yield in *Paeonia ostii* (family: Paeoniaceae). PLoS ONE 17(8): e0272921.

28. Nates Parra G. Abejas silvestres y polinización. Manejo Integrado De Plagas Y Agroecología. (*Costa Rica*), 2005; 75: 7–20.

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