

Quality of Carrot Seeds Influenced by Insect Pollinators under Field and Controlled Conditions

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Amongst root vegetables, carrot is of prime importance for nutritional security as it is a rich source of carotene, the precursor of vitamin A. This crop is highly cross-pollinated and seed yield and quality is greatly affected by the extent of insect pollinators. *Apis cerana indica* and *A. mellifera* species are widely used by the farmers in Himachal Pradesh for pollination purpose but scanty information is available in the literature regarding the role of these species under open and controlled conditions for enhancing the seed yield and quality. Hence, the present studies were initiated, to judge the effect of these pollinators on yield and quality of carrot.

These studies were carried out at Vegetable Research Farm, Dr. Y.S. Parmar University of Horticulture & Forestry, Nauni, Solan, Himachal Pradesh, during the winter season of 2002-03 and 2003-04, respectively, on a well-drained sandy loam soil having medium available NPK and neutral pH. Four treatments viz. Open Pollination, Caged Plants with *Apis cerana indica*, Caged Plants with *A. mellifera* and Caged Plants without Bee-pollinators were included in this investigation. The experiment was laid out in a Randomized Block Design, which was replicated six times with a plot size of 2.0 x 0.9 m². The seedlings of cv. Pusa Yamdagni were spaced at 45 x 45 cm. and transplanted on 9th of February 2003 and 2004, after thorough selection. For controlled conditions,

cages were prepared with the help of locally available material i.e. woody bamboo sticks and these cages were covered by insect proof nylon nets of 24 mesh size. The nets were put on cages on dates 28th and 25th of March, 2003 and 2004, respectively, when the plants were well established but prior to bolting stage. The nucleus beehives having three frames of insect species *Apis cerana indica* and *A. mellifera* were placed inside these well furnished cages on 26th and 24th of April, 2003 and 2004, respectively, when the plants have attained 10-15% flowering.

These nucleus beehives were kept for one month inside the cage. Every precaution was undertaken for the upkeep of insect species for effective pollination under controlled conditions/environment. The insect species were active inside the cage, however partial mortality was there. The observations were recorded on seed yield per plant, 1000-seed weight of primary and secondary umbels, per cent germination, seedling length and vigour index of mixed umbels. The percentage seed germination was determined as per ISTA Procedure [1].

Data for two years i.e. 2002-03 and 2003-04 (Table 1) clearly indicated that maximum 1000-seed weight of primary umbel was obtained in open pollination having significant differences over Caged Plants with *Apis cerana indica*, Caged Plants

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with *A. mellifera* and Caged Plants without Bee-pollinators. Similarly, 1000-seed weight of secondary umbels was recorded maximum in Open Pollination, which was highly significant than rest of the treatments.

Data pertaining to germination percentage clearly indicated that during both the years of study, open pollination resulted in maximum germination percentage of seed being highly significant over rest of the treatments. Open pollination showed maximum seedling length (Table 1) being statistically at par with Caged Plants with *Apis cerana indica* and Caged Plants with *A. mellifera* but significant over Caged Plants without Bee-pollinators. Further, inquisition of data (Table 1) indicated that open pollination resulted in maximum value of seed vigour index being highly statistically significant over rest of the treatments during both the years of study. The possible reasons for higher values obtained with respect to seed quality characters in open pollination are mainly because of plenty of insects visited carrot flowers for pollen and exposed nectarines for sweetness and then resulted in bold seed of high vigour. Further, earliness related to the respective appearance of primary and secondary umbels and their immediate pollination by visiting insects and selective harvesting for the ripening umbels, allowing embryos to grow with maximum size, might have contributed to the better quality of seed. Our results have been corroborated by earlier workers as well [2, 3].

Data given in Table 1, pointed that during 2002-03 and 2003-04, maximum seed yield per plant was recorded in open pollination as compared to rest of the treatments. The possible reasons for high yield in open pollination may be due to abundance of insects attracted largely towards the exposed nectarines and pollen proportions in abundance present in carrot flowers. Further, higher seed set and number of mature seed per umbel also might have contributed to maximum extent for higher seed yield. Higher seed yield in open pollination have also been reported [4, 5, 6]. Two years study concluded that maximum values with respect to seed yield per plant, 1000-seed weight of primary and secondary umbels, per cent seed germination, seedling length and vigour index were recorded in open pollination as compared to controlled pollination.

Table 1. Quality of carrot seeds as influenced by insect pollinators under field and controlled conditions

Treatments/ observations	1000-seed weight (g)											
	Seed yield per plant(g)		Primary umbels		Secondary umbels		Germination percentage(%)		Total seedling length(cm)		Vigour index	
	2002-03	2003-04	2002-03	2003-04	2002-03	2003-04	2002-03	2003-04	2002-03	2003-04		
Open-Pollination	69.20	74.93	1.50	1.54	0.99	1.12	92.6	92.7	12.4	13.5	1416	1442
Caged plants with <i>Apis cerana indica</i>	36.00	50.74	1.22	1.37	0.87	1.02	88.3	88.5	9.8	11.3	750	904
Caged plants with <i>A. mellifera</i>	50.17	64.82	1.41	1.46	0.89	1.05	89.7	89.4	11.3	11.8	871	971
Caged plants without Bee-pollinators	27.21	30.71	1.14	1.18	0.79	1.01	85.5	87.7	8.2	9.3	702	819
C.D. _{0.05}	9.12	23.88	0.19	0.13	0.08	0.07	2.7	2.6	4.1	3.5	108	128

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