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Effect of sprays of bee attractants on qualitative and quantitative yield parameters on seed onion crop (*Allium cepa* L.)

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Abstract
A field experiment was conducted to study the effect of sprays of indigenous bee attractants on qualitative and quantitative parameters of N-2-4-1 variety of seed onion crop (*Allium cepa* L.). Among different treatments, sprays of bee attractants Jaggery solution (10%) was found to be the most effective as it recorded significantly highest number of seed per umbel (843.25), increased in seed set over control (31.60%), test weight (4.19 g/1000 seeds), seed yield per plot (753 g), seed yield per hectare (1145.83 Kg), germination (86%) and lowest deformed seed (6.95%). However, the parameter number of umblets per umbel is non-significant to the treatments.

Keywords: Honeybee, seed onion, jaggery solution, *Allium cepa* L., bee attractants

Introduction
Onion (*Allium cepa* L.) monocotyledon in the family Amaryllidaceae or Liliaceae, is one of the important bulb crop known to human beings and consumed as a fresh-cut or processed throughout the year all over the world. As a strongly protandrous cross pollinated requires an external agent or pollinators transfer the pollen to female reproductive parts of flower, thereby enabling fertilization and sexual reproduction. The absence of natural pollinators on onion seed plantation poses a serious problem of reduction in seed number and seed weight per umbel. Also, seeds from free pollination flowers show higher germination capacity than those isolated from insect visitors [1]. Honeybees are most efficient pollinator among various insect pollinators of onion as its foraging activity coincides with stigma receptivity of onion flower, out of which *Apis mellifera* L., *Apis dorsata* Fab., *Apis florea* Fab., *Apis cerana* Fab. and *Trigona* sp. are important one [7]. Most of the farmers using toxic insecticides on foraging activity of pollinators and on onion crop during flowering without paying due attention towards foraging honeybees and their role in onion seed production leads to loss of honeybee colonies and reduction in onion seed yield [4] and potassium content in onion nectar is slightly more than the nectar of other crops and bees prefer a nectar containing low potassium content and high carbohydrate content. Hence, there is need to increase the activity of pollinators artificially in onion seed crop by using bee attractants so the pollination of target crop can be achieved at critical time. In developed countries different type of commercial bee attractants *viz*., bee line, bee here, bee scent, bee scent plus, fruit boost and bee-q are being used to boost the seed production of onion [3]. Most of them are costlier and not readily available to farmers hence need to suggest a better bee attractant which can be easily and locally available and cheaper one.

Material and Methods
A field experiment was conducted at the experimental field of Entomology Section, College of Agriculture, Pune, and Maharashtra. In all there were six treatments replicated four times in Randomized Block Design. The bulbs of variety N-2-4-1 were used for planting on ridges and furrow layout with spacing was 60 cm X 20 cm and plot size was 3 × 2.4 m^2 for each treatment and replication. In this way bulbs were planted with 1.5 m distance in between two treatments and 2.0 m distance between two replications. The experimental plot was kept free from application of any insecticide spray during flowering period. Honeybee colonies of *A. mellifera* were kept in the research plot.

After 20 per cent flowering of onion, the bee attractant was sprayed early in the morning hours to the respective plot of seed onion crop and it was sprayed thrice at a weekly interval. The treatment details have been given in table 1 and table 2. Cultural operations like irrigation, weeding was uniformly carried out to all treatments.

The quantitative yield parameters were recorded as, five umbels from each replication and treatment were selected randomly and the observations for number of umblets per umbel and number of seeds per umbel were recorded. Per cent seed setting increased over absence of pollinator and control were calculated from these values. After maturity, the umbels of each treatment were harvested. The seeds were separated by threshing the umbels and weight was recorded by using weighing balance which expressed in gram/plot, later converted into kg/ha basis. 1000 dried seeds drawn randomly from each treatment and test weight is recorded by using weighing balance.

The normal shape of onion seed was triangular in cross section and colour was glossy black. Deformed seeds, which were discolored and wrinkled were recorded and the ratio of deformed seeds to total number of seeds per five umbels per plot was calculated and expressed as per cent deformed seeds. For recording germination percentage, fifty seeds from all replications of each treatment were sown in a plastic tray fill with soil and after adequate watering the trays were placed in shade for conducting the germination test. Watering is done regularly by using a shower and final germination count was made 12 days after sowing. The statistical analysis was done as per design of the experiment as suggested [6].

Results and Discussion

From the data recorded in Table 1, revealed that the number of umblets per umbel were ranged from 292.85 to 301.30 with no significant difference among the treatments. The treatment T_2 Jaggery solution (10%) was found most effective than rest of the treatments as it recorded its superiority for number of seeds per umbel (843.25 seeds/umbel), per cent seed set increased over control plot *i. e.* onion crop without spray of any bee attractants (31.60%), test weight (4.19 g/1000 seed), seed yield per plot (753 g), seed yield per hectare (1045.83 Kg/ha) and germination (86.00%). Next best treatments were in the order of Jaggery solution 10% > Sugar solution 10% > Molasses 10% > Sugarcane juice 10% > control > crop covered with insect net. Treatment T_5 recorded the highest per cent deformed seed (29.65%) which is inferior to other treatments. The results are presented in table 1, table 2, figure 1, figure 2, figure 3 and figure 4.

The Jaggery solution (10%) were the best bee attractants which attract a greater number of honeybees to the treated seed onion crop leads to enhancement of qualitative and quantitative onion seed parameters due to increased and better pollination [6].

The increase in seed setting may be attributed to increase in foraging activity of honeybees attracted due to pollinators, pollination and fertilization of a greater number of ovaries in onion [1] and similar in radish seed production [2].

(A) Research plot 1 month after planting (B) Research plot at flowering stage

Plate 1: General view of seed onion research plot

Table 1: Effect of bee attractants on quantitative yield parameters on onion seed crop

Sr. No.	Treatment	Umblets per umbel (No.)	Seed per umbel (No.)	Onion seed setting increase over control (%)	1000 seed weight (g)	Seed yield (g/plot)	Seed yield (Kg/ha)
1.	Sugarcane juice 10%	292.85	671.25	13.23 (16.73)*	3.67 (2.04)**	585	812.50
2.	Jaggery 10%	296.50	843.25	30.18 (34.19)	4.19 (2.16)	753	1045.83
3.	Molasses 10%	301.30	733.50	14.97 (20.78)	3.46 (1.99)	534.5	742.36
4.	Sugar solution 10%	295.10	775.50	22.45 (27.67)	4.01 (2.12)	670.5	931.25
5.	Insect net cover	296.30	59.50	-	2.22 (1.65)	163.5	227.08
6.	Control	296.25	640.50	-	3.11 (1.90)	459.5	638.19
	S.E. ±	NS	9.06	1.02	0.01	4.73	6.56
	C.D. at 5%		27.31	3.07	0.03	14.25	19.79
	CV		2.92		1.88	1.79	1.79

*Figures in parenthesis are Arcsine transformed values

****** Figures in parenthesis are $\sqrt{n+0.5}$ transformed values

Table 2: Effect of bee attractants on qualitative yield parameters on onion seed crop

Sr. No.	Treatment	Germination percentage	Percent deformed seed
1.	Sugarcane juice 10%	78.00 (62.40)	10.65 (19.03)
2.	Jaggery 10%	86.00 (68.51)	6.95 (15.27)
3.	Molasses 10%	78.00 (62.09)	10.85 (19.21)
4.	Sugar solution 10%	82.00 (65.31)	8.65 (17.09)
5.	Insect net cover	36.00 (36.84)	29.65 (32.98)
6.	Control	72.00 (58.06)	15.10 (22.85)
	S.E. ±	1.66	0.53
	C.D. at 5%	5.00	1.59
	CV	4.58	5.00

*Figures in parenthesis are Arcsine transformed values

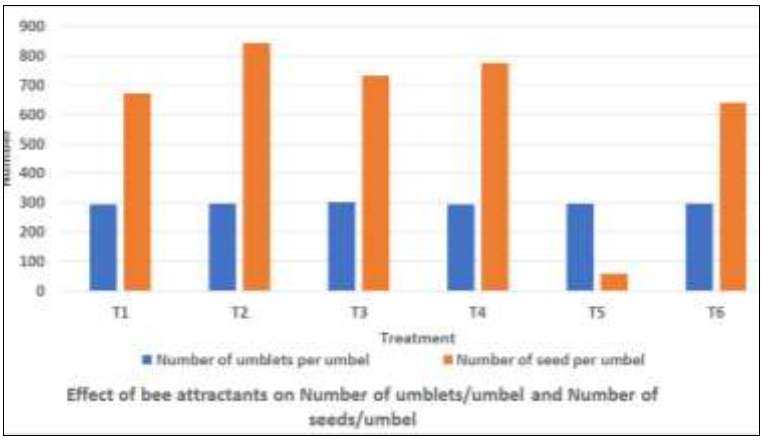

Fig 1: Effect of bee attractants on Number of umblets/umbel and Number of seeds/umbel parameters on onion seed

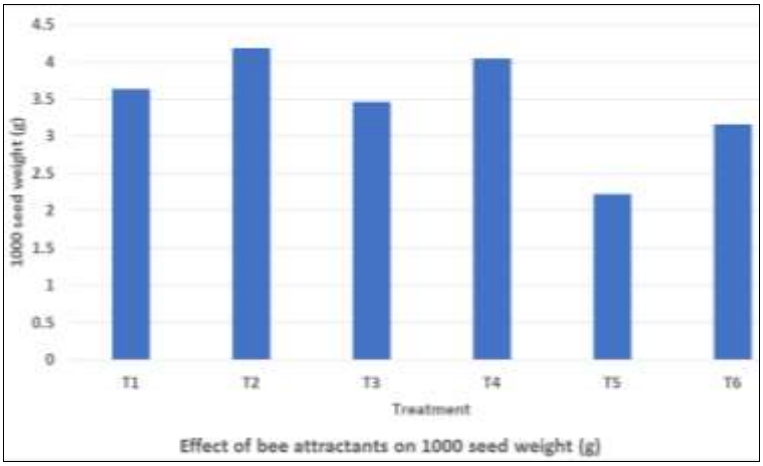

Fig 2: Effect of bee attractants on 1000 seed weight of onion seed

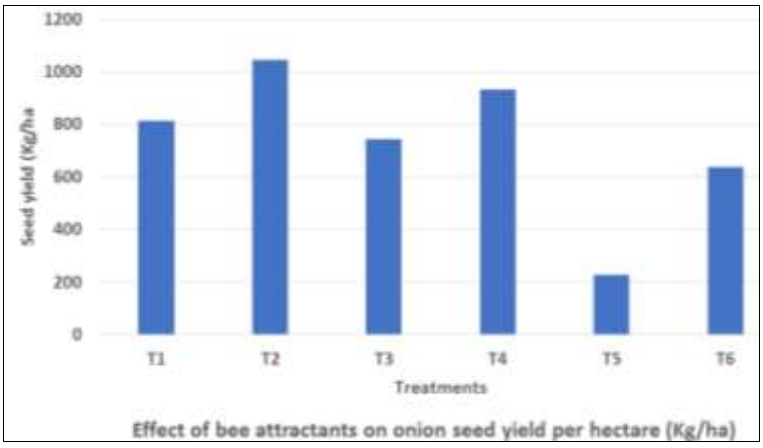

Fig 3: Effect of bee attractants on onion seed yield per hectare (Kg/ha)

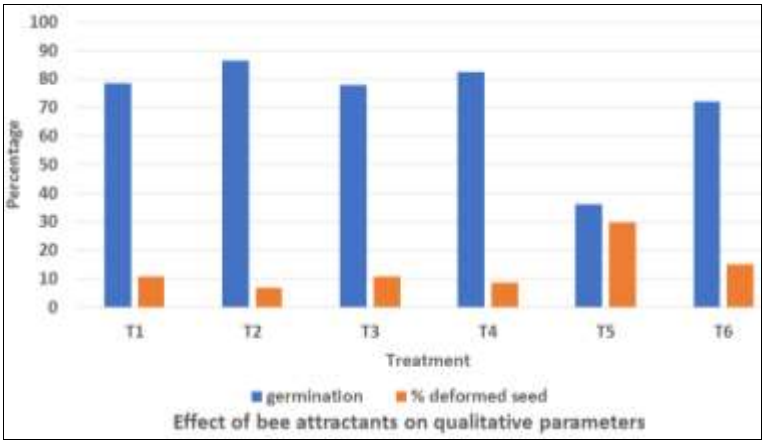

Fig 4: Effect of bee attractants on seed germination and per cent deformed seed.

Conclusions

The results from the present investigation revealed that spraying of Jaggery solution (10%) in seed onion crop as a honey bee and other pollinator attractant was found to be the most beneficial in ameliorating various seed quality and quantity parameters and getting higher seed yield in onion. Thus, it can be concluded that the Jaggery solution (10%) may be incorporated into the spraying schedule of seed onion crop to obtain a sustainable production.

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