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NECTAR FEEDING AND DEARTH PERIOD MANAGEMENT IN INDIAN HONEY BEE *APIS CERANA* (F)

Bismat UN Nisa[1]*, Muneer Ahmad[2], S S Pathania[1], Humira Mushtaq[1], Ikra Manzoor[3], Mohd Firdoos[1] and Arifa Gulzar[4]

[1]Division of Entomology; [3]Division of Fruit Science, [4]Division of Plant Pathology,
Sher e Kashmir University of Agricultural Sciences and Technology,
Faculty of Horticulture, Shalimar, Jammu & Kashmir, India
[2]Section of Entomology, Dryland Agriculture Research Station, Rangreth, Jammu & Kashmir, India
*Email: darbisma123@gmail.com (corresponding author): ORCID ID 0009-0009-2586-4175

ABSTRACT

There have been many attempts to reduce the loss of Indian honey bee *Apis cerana* (F) colonies during the dearth period by supplementing nectar feeding substitutes. An experiment on development and evaluation of nectar feeding substitutes was conducted at an apiary maintained at the Division of Entomology, SKUAST-K, Shalimar from July to September during 2020-21. Syrup containing apple juice, sugar and mixture of both were evaluated as a diet supplement to develop an efficient feeding substitute. These include: T_1- apple juice and sugar in the ratio of 1:1; T_2- apple juice and sugar in the ratio of 1.5:1; T_3- apple juice alone and T_4- sugar syrup in the ratio of 1:1 and compared with T_5 natural feeding to determine their impact on desirable attributes of colonies. A gradual increase in the colony performance index (CPI), space covered by eggs (sq cm), larvae (sq cm) and pupae (sq cm) was observed, which were maximum with apple juice and sugar in the ratio of 1.5:1 viz; CPI (13.28); space covered by eggs (204.25 sq cm); larvae (296.12 sq cm); pupae (484.41 sq cm). All parameters were found to be least in T_5 (natural feeding). Thus, apple juice and sugar in the ratio of 1.5:1 (T_2) was the best nectar feeding substitute.

Key words: *Apis cerana*, feeding substitutes, apple juice, brood, carbohydrate, sugar, colony performance index, dearth period, egg laying, supplements, egg, larvae, pupae, space coverage

Over the world, almost every place has specific period when there is dearth of floral resources for honey bees (Prakash et al., 2007). Carbohydrates act as a stimulus to expand their colony and to spend active life (Javaheri et al., 2000) and their shortage results in reduction in the brood rearing (Pokhrel et al., 2006; Pande and Karnatak, 2013). Providing colonies with supplementary feeding helps to tide over dearth period (Pernal and Currie, 2001; Kalev et al., 2002; Neupane and Thapa, 2005; Prakash et al., 2007). Optimum population during dearth period ensures colony's early buildup and more foragers during subsequent honey-flow time to produce more honey (Somerville and Collins, 2007; Sihag and Gupta, 2013). It has been reported that rice bran, buckwheat powder, soybean in different forms, germinated pulses powder, sweet pumpkin, turnip, *malus* and temperate fruits are used to feed bees during off-season (Pande et al., 2011; Pande and Karnatak, 2013; Pande and Karnatak, 2014). Feeding bees with fruits, vegetables or cereals rich in carbohydrates, proteins, minerals and fats can be advantageous (Pande and Karnatak, 2013). This study evaluated some nectar substitutes in this regard.

MATERIALS AND METHODS

This study was undertaken at an apiary maintained at the Division of Entomology, Faculty of Horticulture, SKUAST-K, Shalimar from July to September during the year, 2020-21. Twenty honey bee colonies of *Apis cerana* (10 frame strength) were evaluated. The beehives were made of homogenous material and were of same dimensions. Honey bee colonies were provided by the four nectar substitutes viz., T_1; apple juice and sugar in the ratio of 1:1, T_2; apple juice and sugar in the ratio of 1.5:1, T_3; apple juice only and T_4; sugar syrup in the ratio of 1:1. In T_5 (control), no nectar substitute was provided and colonies were allowed to feed naturally. The experiment was conducted in randomized complete block design and each treatment was replicated four times. Feeding substitutes (@ 200 ml/ hive) were provided at an interval of 21 days by placing them inside the hive after filling the syrups in plastic feeders of dimension of (14x 12") with floating dry leaf twigs so that the bees may not get drowned in the syrup. Observations were recorded on colony performance index (CPI) as per the tool proposed by Punchihewa

(1994), space covered by eggs, larvae and pupae (sq cm) before treatment and on 3rd, 5th, 7th, 9th, 15th and 21st day after feeding/ treatment. The space (sq cm) covered by eggs, larvae and pupae in the combs was measured with the help of wire grid device; 8x8cm (Pande et al., 2015). Data were subjected to ANOVA using OP STAT software with means compared at $p \leq 0.05$.

RESULTS AND DISCUSSION

All the feeding supplement treatments reveal profound effect on colony performance index, egg laying and brood rearing (larvae and pupae) thereby, holding the opinion that carbohydrate is an indispensable food. After first feeding supplement, the maximum CPI was recorded in bee colonies provided with nectar feeding substitute, T_2; Apple juice and sugar in the ratio of 1.5:1 (12.09), followed by T_1; Apple juice and sugar in the ratio of 1:1 (10.57). Almost similar trend was found during second feeding. During first feeding, CPI was almost similar at the beginning, but a significant increase was observed after feeding on all the combinations of substitutes. This is supported by the findings of Vergheese and Prasad (1980). Increase in activity of foragers and subsequent increment in brood area in the hive due to addition of feeding substitutes was also reported by Pande and Karnatak (2013), Pande et al. (2014) and Pande et al. (2015). After first bee supplement feeding, maximum egg laying was recorded in colonies provided with nectar feeding substitute, T_2; Apple juice and sugar in the ratio of 1.5:1 (159.25 sq cm), followed by T_1; Apple juice and sugar in the ratio of 1:1 (150.54 sq cm), while the minimum was in T_5; natural feeding (93.75 sq cm) followed by T_3; Apple juice alone (131.95 sq cm) and T_4; Sugar syrup in the ratio of 1:1 (141.75 sq cm). Similar trend was found during second feeding. During first feeding, egg laying was almost similar at the beginning, but a significant increase was observed after feeding on all the combinations of nectar substitutes throughout the trial period (Table 1).

The maximum space covered by larvae was recorded in colonies provided with nectar feeding substitute, T_2; Apple juice and sugar in the ratio of 1.5:1 (250.04 sq cm), followed by T_1; Apple juice and sugar in the ratio of 1:1 (242.79 sq cm). Similar trend was found during second feeding. The maximum space covered by pupae was recorded in colonies provided with nectar feeding substitute, T_2; Apple juice and sugar in the ratio of 1.5:1 (437.58 sq cm), followed by T_1; Apple juice and sugar in the ratio of 1:1 (429.95 sq cm). Similar trend was found during second feeding (Table 1). The reason for the varied increase in egg laying and brood area could be explained by different nutritional status, consistency and flavor of feeding substitutes as advocated by Dodologlu and Emsen (2007). These results are in conformation with Standifer et al. (1978), Abbas et al. (1995) and Pesante et al. (1992). Chhuneja et al. (1993) reported that adequate food supplements initiated healthy colony multiplication and development throughout the dearth period when there was scarcity of natural food supplements. Neupane and Thapa (2005) reported that honey bee colonies when supplemented with banana and pumpkin syrup increased brood cells. Pande and Karnatak (2013) too reported increase in brood area of honey bee colonies when juices of different temperate fruits were utilized for off-season dietary management. Pande et al. (2014) also reported moderate increment in brood area when colonies were supplemented with germinated pulses as a pollen substitute during the dearth period. Pande et al. (2015) reported increase in brood area when bees were supplemented with different fruit syrups.

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AUTHOR CONTRIBUTION STATEMENT

Bismat un Nisa is the main author and completed her research under the guidance and mentorship of Dr. Muneer Ahmad Sofi.

CONFLICT OF INTEREST

No conflict of interest.

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Table 1. Effect of nectar feeding substitutes on the colony performance index (CPI) and brood rearing of *A. cerana* (July- September, 2020)

Treatments	Parameters	Feeding Ist								Feeding 2nd								Pooled mean
		Before treatment	3rd DAT	5th DAT	7th DAT	9th DAT	15th DAT	21st DAT	Mean	Before treatment	3rd DAT	5th DAT	7th DAT	9th DAT	15th DAT	21st DAT	Mean	
T_1 (Apple juice + sugar, 1:1)	Colony performance index (CPI)	3.60	8.83	9.37	10.11	10.85	11.82	12.44	10.57	12.44	12.92	13.15	13.35	13.54	13.65	13.91	13.42	11.99
	Space covered by eggs (cm^2)	110.00	118.00	128.00	141.75	152.75	171.25	191.50	150.54	191.50	198.00	206.25	217.50	227.50	246.50	264.00	226.62	188.58
	Space covered by larvae (cm^2)	205.00	209.50	221.75	234.50	246.00	262.50	282.50	242.79	282.50	291.50	298.00	310.75	320.50	336.25	356.75	318.95	280.87
	Space covered by pupae (cm^2)	405.00	407.50	411.50	417.75	428.00	447.75	467.25	429.95	467.25	476.75	487.00	498.00	509.75	527.50	548.00	507.83	468.89
T_2 (Apple juice + sugar, 1.5:1)	Colony performance index (CPI)	3.63	10.28	11.48	12.15	12.24	12.86	13.54	12.09	13.54	13.90	14.05	14.40	14.64	14.88	14.92	14.47	13.28
	Space covered by eggs (cm^2)	109.00	122.75	134.75	147.50	162.50	183.50	204.50	159.25	204.50	215.50	226.25	238.25	251.50	271.50	292.50	249.25	204.25
	Space covered by larvae (cm^2)	204.00	212.75	225.50	238.50	253.50	272.50	297.50	250.04	297.50	308.75	320.00	331.00	344.00	364.00	385.50	342.20	296.12
	Space covered by pupae (cm^2)	404.00	408.25	415.00	423.50	437.75	458.00	483.00	437.58	483.00	494.25	506.50	519.50	534.00	554.75	578.50	531.25	484.41
T_3 (Apple juice alone)	Colony performance index (CPI)	3.42	6.31	6.64	6.04	6.23	6.91	7.54	6.61	7.54	7.89	8.11	8.37	8.53	8.66	8.92	8.41	7.51
	Space covered by eggs (cm^2)	110.00	113.50	118.50	125.50	132.75	143.00	156.50	131.95	156.50	161.25	166.00	171.75	178.75	188.00	202.50	178.04	154.99
	Space covered by larvae (cm^2)	205.00	206.25	212.50	218.00	226.50	237.00	251.50	225.29	251.50	256.50	261.00	267.50	273.50	283.50	296.50	273.08	249.18
	Space covered by pupae (cm^2)	404.00	405.75	407.75	411.00	419.00	429.50	442.50	419.25	442.50	445.00	450.50	456.75	463.00	473.00	486.00	462.37	440.81
T_4 (Sugar syrup)	Colony performance index (CPI)	3.54	8.15	9.01	9.22	9.44	10.13	10.89	9.47	10.89	11.24	11.37	11.54	11.64	11.94	12.03	11.63	10.55
	Space covered by eggs (cm^2)	110.00	115.50	125.50	133.50	143.50	158.50	174.50	141.75	174.50	181.75	188.00	195.75	205.50	217.50	234.75	203.87	172.81
	Space covered by larvae (cm^2)	204.00	208.00	216.75	226.00	236.00	249.00	267.50	233.87	267.50	273.00	282.50	291.50	301.50	315.50	332.50	299.41	266.64
	Space covered by pupae (cm^2)	405.00	406.25	410.75	416.00	426.50	439.75	457.50	426.29	457.50	463.00	472.00	481.50	491.00	504.75	522.50	489.12	457.70

(contd.)

(contd. Table 1)

	Colony performance index (CPI)	3.72	3.52	3.33	3.25	3.23	3.06	3.04	3.24	3.04	3.07	3.13	3.18	3.25	3.31	4.17	3.35	3.29
T_5 (natural feeding) Control	Space covered by eggs (cm^2)	110.00	105.00	100.75	94.50	91.00	87.50	84.00	93.75	84.00	85.50	87.25	89.25	91.50	95.50	100.00	91.50	92.62
	Space covered by larvae (cm^2)	204.00	200.00	194.00	188.50	183.25	178.00	172.75	186.08	172.75	173.50	174.30	184.00	185.75	190.25	196.50	184.05	185.06
	Space covered by pupae (cm^2)	405.00	400.50	397.00	393.00	389.25	385.50	381.75	391.16	381.75	383.00	385.50	387.50	388.50	392.75	396.00	388.87	390.01
		CD ($p \leq 0.05$)												CD ($p \leq 0.05$)				
Treatment	Colony performance index (CPI)	0.079												0.037				
	Space covered by eggs (cm^2)	0.675												0.680				
	Space covered by larvae (cm^2)	0.609												0.583				
	Space covered by pupae (cm^2)	0.553												0.476				
Time interval	Colony performance index (CPI)	0.087												0.041				
	Space covered by eggs (cm^2)	0.740												0.745				
	Space covered by larvae (cm^2)	0.667												0.638				
	Space covered by pupae (cm^2)	0.606												0.522				

Each value mean of 4 observations; DAT: Days after treatment

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