

# Effect of Colony Strength and Stimulant Sugar-feeding on *Apis mellifera*

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Brood-rearing in honeybee colonies starts in September in Hisar and Kurukshetra districts. At this stage, pollen sources such as *Zizyphus mauritiana*, *Tridax* spp., etc. are available. However, availability of nectar is poor. With the idea that providing artificial sugar syrup may stimulate brood-rearing and affect subsequent development, the present studies were conducted.

## Materials and Methods

Thirty-two *Apis mellifera* colonies with bee strengths of four, five, six and seven frames each were selected in September in both Hisar and Kurukshetra districts. Colony parameters – unsealed brood, sealed brood, pollen and honey stores – were the same for each bee-strength group of eight colonies. Queens in all 32 colonies were of the same age. Normal colony management practices were followed. Fifty per cent sugar syrup was prepared and fed to four colonies of each bee-strength group. The other four colonies of same strength each were not fed (control). Two feedings were given: the first in the third week of September and the second 20 days later. Each feeding consisted of 400 g of

sugar for four-frame colonies, 500g for five-frame colonies, 600 g for six-frame colonies and 700 g for seven-frame colonies. Bee strength (frames), unsealed and sealed (worker and drone) brood (cm<sup>2</sup>), pollen (cm<sup>2</sup>) and honey stores (g) were recorded at intervals of 21 days from September 1995 to February 1996. Initiation and cessation of bee activity was recorded on three continuous sunny days in a month and then an average taken.

## Results and Discussion

Observations on colony build-up and stores in colonies fed with sugar and control colonies are presented in Table 1. Results reveal that feeding sugar syrup increased egg-laying and subsequent colony development at both locations. Sheesley and Poduska (1988) noticed that colonies that received driver sugar plus 1% pollen started laying on the day the supplement was given, whereas control queens started when natural pollen became available eight days later.

Data recorded in the second week of October, 21 days after feeding sugar syrup, show that at Hisar total brood-rearing in colonies fed with sugar syrup increased over the control by 277.50

Table 1: Colony build up and stores in *A. mellifera* with different strengths, with and without sugar feeding at two locations in India

Starting strength (no. of frames)	Bee strength (no. of frames)		Strength increase due to sugar feeding (%)	Total brood cm <sup>2</sup>		Total brood increase due to sugar feeding (%)	Pollen stores (cm <sup>2</sup> )		Pollen increase due to sugar feeding	Honey stores (g)		Honey increase due to sugar feeding (%)	
	SF	UF		SF	UF		SF	UF		SF	UF		
	<b>Sept., 95 (Starting)</b>												
4	L <sub>1</sub>	-	-	-	1272.50	1270.00	-	98.75	101.25	-	200.00	197.50	-
	L <sub>2</sub>	-	-	-	1275.00	1269.75	-	101.25	102.50	-	200.00	193.75	-
5	L <sub>1</sub>	-	-	-	1580.00	1591.25	-	172.50	173.75	-	257.50	255.00	-
	L <sub>2</sub>	-	-	-	1582.50	1591.25	-	173.75	173.75	-	255.0	255.0	-
6	L <sub>1</sub>	-	-	-	1898.75	1898.75	-	166.25	150.00	-	307.50	312.50	-
	L <sub>2</sub>	-	-	-	1896.25	1897.50	-	151.25	151.25	-	307.50	306.25	-
7	L <sub>1</sub>	-	-	-	2192.50	2193.75	-	172.50	175.00	-	332.50	335.00	-
	L <sub>2</sub>	-	-	-	2191.25	2195.00	-	173.75	176.25	-	337.50	337.50	-
<b>Oct., 95</b>													
4	L <sub>1</sub>	4.88	4.38	12.50	3401.25	2856.25	42.38	263.75	217.50	52.28	572.50	409.25	79.04
	L <sub>2</sub>	4.49	4.25	6.00	2897.50	2620.00	20.75	142.50	117.50	26.11	493.75	393.75	43.65
5	L <sub>1</sub>	5.70	5.55	3.00	4770.00	4428.75	23.58	320.00	242.50	45.94	773.75	612.50	60.29
	L <sub>2</sub>	5.50	5.25	5.00	3400.00	2845.00	36.06	202.50	178.75	13.67	733.75	648.75	33.33
6	L <sub>1</sub>	6.65	6.38	4.50	6025.00	5408.75	32.45	345.00	295.00	10.85	815.00	618.75	67.04
	L <sub>2</sub>	6.50	6.25	4.16	4800.00	4445.00	18.88	278.75	187.50	60.33	775.00	593.75	58.16
7	L <sub>1</sub>	8.08	7.38	10.00	6386.25	5901.25	22.28	376.25	312.50	39.58	228.50	618.75	64.47
	L <sub>2</sub>	7.55	7.25	4.29	6145.00	5238.75	41.47	310.00	263.75	28.77	881.25	776.25	31.11
<b>CD (P±. 05)</b>		<b>(0.15)</b>			<b>(109.75)</b>			<b>(13.67)</b>			<b>(32.52)</b>		
<b>Feb., 96</b>													
4	L <sub>1</sub>	15.75	14.12	40.75	5312.50	5093.75	16.40	981.25	917.50	87.50	7962.50	7062.50	405.31
	L <sub>2</sub>	16.13	15.13	25.00	7463.75	6621.25	63.75	3090.00	2957.50	166.49	5568.75	5068.75	168.24
5	L <sub>1</sub>	19.44	17.38	41.20	5651.25	5367.50	20.36	982.50	925.00	37.19	9641.25	8050.00	587.31
	L <sub>2</sub>	19.88	18.06	36.40	8147.50	7756.25	27.42	3110.00	2897.50	122.31	6573.75	5620.00	374.02
6	L <sub>1</sub>	19.38	18.50	14.67	6032.50	5701.25	17.45	1040.00	948.75	-6.94	12225.00	11212.50	387.61
	L <sub>2</sub>	20.38	18.38	33.34	8171.25	8031.25	7.67	2895.00	2957.50	-41.32	7337.50	6025.00	418.83
7	L <sub>1</sub>	23.19	21.38	25.86	6572.50	6156.25	19.14	1008.00	981.25	24.28	13475.00	11437.50	638.45
	L <sub>2</sub>	23.31	21.79	21.72	8285.00	7881.25	19.04	3017.50	2770.00	167.27	9700.00	8331.25	1405.55
<b>CD (P± 0.05)</b>		<b>(0.23)</b>			<b>(95.14)</b>			<b>(63.23)</b>			<b>(235.78)</b>		

L<sub>1</sub> - Kurukshetra L<sub>2</sub> - Hisar SF - Sugarfed colonies UF - Unfed/control colonies

cm<sup>2</sup> (21 %) for four-frame colonies, 555.00 cm<sup>2</sup> (36 %) for five-frame colonies, 355.00 cm<sup>2</sup> (19 %) for six-frame colonies, 906.25 cm<sup>2</sup> (41 %) for seven-frame colonies and at Kurukshetra by 545.00 cm<sup>2</sup> (42 %) for four-frame colonies, 341.25 cm<sup>2</sup> (24 %) for five-frame colonies, 616.25 cm<sup>2</sup> (32 %) for six-frame colonies and 485.00 cm<sup>2</sup> (22 %) for seven-frame colonies. Bee strength at

Hisar was up by 0.24 (6 %), 0.25 (5 %), 0.25 (4 %), 0.30 (4 %), and at Kurukshetra by 0.50 (12.5 %), 0.15 (3 %), 0.27 (4.5 %), 0.70 (10 %). Likewise pollen and honey stores were greater in sugarfed colonies. Increases were at a time when the major bee flora, *Brassica* spp., becomes available allowing strengthened colonies to exploit these sources of pollen and nectar fully. As a result,

colonies fed with sugar syrup had significantly higher strengths, brood-rearing, and pollen and honey stores at the end of experiment in February when *Brassica* spp. are no longer available.

At the end of the experiment in February at Hisar total brood of sugar-fed colonies had increased over the control by 842.50 cm<sup>2</sup> (64 %) for four-frame colonies, 391.25 cm<sup>2</sup> (27 %) for five-frame colonies, 140.00 cm<sup>2</sup> (8 %) for six-frame colonies, and 403.75 cm<sup>2</sup> (19 %) for seven-frame colonies. Pollen stores were increased by 133.00 cm<sup>2</sup> (166 %), 213.00 cm<sup>2</sup> (122 %), -62 cm<sup>2</sup> (-41 %) and 247.50 cm<sup>2</sup> (167 %). Honey stores were increased by 500.00 g (168 %), 953.75 g (374 %), 1312.50 g (419 %) and 1368.75 g (1406 %). Bee strength was up by 1.00 frame (25 %), 1.82 frames (36 %), 2.00 frames (33%) and 1.52 frames (22 %). At Kurukshetra sugar-fed colonies increased by 1.63 frames (41 %), 2.06 frames (41 %), 0.88 frame (15 %) and 1.81 frames (26 %). Total brood increased by 218.75 cm<sup>2</sup> (16 %), 283.75 cm<sup>2</sup> (20 %), 331.25 cm<sup>2</sup> (17 %) and 416.25 cm<sup>2</sup> (19 %). Pollen stores were up by 63.75 cm<sup>2</sup> (87.5 %), 57.50 cm<sup>2</sup> (37 %), 91.25 cm<sup>2</sup> (-7 %) and 26.75 cm<sup>2</sup> (24 %). Honey production was up by 900.00 g (405 %), 1591.25 g (587 %), 1012.50 g

(388 %) and 2037.50 g (638 %). Increased brood-rearing due to sugar-feeding has been reported by Forster (1968) in New Zealand, Musa *et al.* (1988) in Sudan and Singh *et al.* (1992) in India. Likewise increased bee strength and brood have been reported by Crane (1950), Peng *et al.* (1984) and Standifer *et al.* (1970). Free (1965), Free and Spencer-Booth (1961), Goodwin *et al.* (1991) and Herbert and Shimanuki (1979) observed greater pollen stores in sugar-fed colonies. Increased honey production in sugar-fed colonies has been reported by Forster (1968), Musa *et al.* (1988) and Zmarlicki and Marcinkowski (1979). However Zherebkin and Martynov (1977) found that sugar-feeding does not have any effect on honey production.

#### Effect of sugar-feeding on drone brood

Data on drone brood are presented in Table 2. Results show that at Hisar drone brood appeared earlier in the sugar-fed five-frame, six-frame and seven-frame strength colonies. At Kurukshetra early appearance of drone brood was not observed. However, drone brood area in sugar-fed colonies was higher than in unfed colonies at both locations. Drone brood area in colonies

**Table 2:** Drone brood in *A. mellifera* colonies with 4, 5, 6 and 7 frames strength, with and without sugar feeding at Kurukshetra and Hisar in India

Month (week)	Location	Drone brood (cm <sup>2</sup> ) in colonies with							
		4-frame strength		5-frame strength		6-frame strength		7-frame strength	
		SF	UF	SF	UF	SF	UF	SF	UF
Nov.,95 (1 <sup>st</sup> week)	L <sub>1</sub>	0.00	0.00	16.25	0.00	162.50	67.50	162.50	132.50
	L <sub>2</sub>	0.00	0.00	0.00	0.00	52.00	3.75	61.25	4.00
Nov.,95 (Last week)	L <sub>1</sub>	31.25	28.75	168.75	142.50	235.00	226.25	231.25	226.25
	L <sub>2</sub>	0.00	0.00	67.50	12.50	250.00	237.50	307.50	221.25
Mid-Dec.,95	L <sub>1</sub>	222.50	197.50	477.50	405.00	632.00	605.00	935.00	871.25
	L <sub>2</sub>	125.00	77.50	190.00	151.25	547.25	455.50	675.00	578.75
Jan.,96 (last week)	L <sub>1</sub>	361.25	325.00	498.75	493.75	846.25	793.75	940.00	886.25
	L <sub>2</sub>	365.00	306.25	576.25	345.00	621.25	425.00	1051.25	255.00
Jan.,96 (Last week)	L <sub>1</sub>	251.25	245.00	287.50	280.00	271.25	245.00	288.75	263.75
	L <sub>2</sub>	617.50	562.50	880.00	810.00	1485.00	830.00	1162.00	1017.50
Feb.,96 (3 <sup>rd</sup> week)	L <sub>1</sub>	121.25	98.75	155.00	146.25	171.25	142.50	196.25	175.00
	L <sub>2</sub>	251.50	188.75	760.00	212.00	232.50	240.00	235.00	216.25

L<sub>1</sub> - Kurukshetra L<sub>2</sub> - Hisar SF - Sugar fed colonies UF - Unfed /control colonies

Table 3: Start and Cessation of activity in *A. mellifera* colonies with different strengths with and without sugar feeding at two locations in India.

Month	Time of start of bee activity in colonies with (hours)															
	4-frame strength				5-frame strength				6-frame strength				7-frame strength			
	L <sub>1</sub>		L <sub>2</sub>		L <sub>1</sub>		L <sub>2</sub>		L <sub>1</sub>		L <sub>2</sub>		L <sub>1</sub>		L <sub>2</sub>	
	SF	UF	SF	UF	SF	UF	SF	UF	SF	UF	SF	UF	SF	UF	SF	UF
Activity Start																
Sept.,95	7.20	7.18	7.18	7.15	7.16	7.20	7.20	7.24	7.24	7.18	7.18	7.21	7.24	7.25	7.24	7.28
Oct.,95	7.15	7.21	7.15	7.18	7.20	7.15	7.20	7.24	7.18	7.16	7.18	7.20	7.25	7.18	7.25	7.17
Nov.,95	8.35	8.32	8.25	8.30	8.30	8.28	8.30	8.34	8.34	8.32	8.38	8.26	8.16	8.20	8.15	8.25
Dec.,95	9.35	9.40	9.41	9.35	9.35	9.41	9.36	9.46	9.20	9.36	9.36	9.48	9.35	9.36	9.39	9.45
Jan.,96	10.20	10.16	10.21	10.18	10.25	10.15	10.31	10.36	10.16	10.27	10.28	10.22	10.30	10.18	10.21	10.30
Feb.,96	9.45	9.41	9.42	9.46	9.40	9.35	9.35	9.44	9.38	9.45	9.40	9.38	9.47	9.50	9.45	9.41
Activity cessation																
Sept.,95	6.15	6.10	6.10	6.14	6.18	6.12	6.12	6.15	6.10	6.10	6.14	6.18	6.15	6.16	6.15	6.18
Oct.,95	6.05	6.00	6.04	6.04	6.04	6.08	6.01	6.08	6.05	6.05	6.00	6.01	6.01	6.04	6.05	6.05
Nov.,95	5.35	5.40	5.40	5.36	5.40	5.42	5.38	5.40	5.35	5.35	5.40	5.40	5.35	5.40	5.40	5.35
Dec.,95	5.26	5.20	5.20	5.22	5.25	5.26	5.21	5.26	5.24	5.21	5.18	5.24	5.22	5.24	5.25	5.21
Jan.,96	5.06	5.00	5.00	5.08	5.05	4.58	5.00	5.00	5.08	5.06	5.05	5.08	5.00	5.08	5.00	5.02
Feb.,96	5.20	5.20	5.25	5.21	5.25	5.30	5.18	5.24	5.28	5.20	5.21	5.27	5.22	5.27	5.10	5.25

L<sub>1</sub> - Kurukshetra L<sub>2</sub> - Hisar SF - Sugarfed colonies UF - Unfed/control colonies

at Kurukshetra was greater than in colonies at Hisar until mid-December; in January and February the situation was reversed. This pattern may be because at Kurukshetra *Brassica campestris* var. Toria becomes available earlier than Hisar and the area under cultivation is greater; after mid-December bee flora *B. juncea* remains plentiful at Hisar but not at Kurukshetra. Singh et al. (1992) in Punjab, India, concluded that drone brood area increased significantly with increase in colony size.

#### Effect of sugar-feeding on initiation and cessation of activity

Data on initiation and cessation of bee activity is presented in Table 3. Results reveal that initiation and cessation of bee activity occurred almost at the same time in sugar-fed and unfed colonies at both locations. Initiation of activity ranged from 7:15 h to 10:31 h in sugar-fed colonies and 7:15 h to 10:36 h in control colonies. Cessation of activity at Hisar ranged from 17:00 h to 18:15 h in sugar-fed and 17:08 h to 18:18 h in unfed colonies,

and at Kurukshetra from 17:00 h to 18:18 h in sugar-fed and 17:00 h to 18:15 h in unfed colonies. Variation in initiation and cessation of bee activity may be attributed to ambient temperature. Abady (1975), Oh and Choi (1986) and Singh (1962) stated that bee foraging is temperature dependent.

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