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## Colony strength and food reserves of *Apis mellifera* L. under stationary and migratory beekeeping in Himachal Pradesh India

**Amritpal Singh Brar, Harish Kumar Sharma and Kiran Rana**

### Abstract

Experiments were conducted during July 2015 to June 2016 on *Apis mellifera* L. colonies maintained at Nauni, Solan, in Himachal Pradesh India. With the onset of spring experimental colonies gained strength during February (4.2 bee frames/ colony) and March (4.6 bee frames/ colony) when build up flora was in bloom at Nauni, Solan. Thereafter, colonies increased in their average strength to 6.2 and 6.6 bee frames/ colony during June and May 2016, respectively. Average brood area was significantly higher during May, 2016 (3143.6cm<sup>2</sup>) followed by the average brood area in June (2497.6) and April, 2016. Maximum pollen area (160 cm<sup>2</sup>) was recorded in the month of April, 2016. Average honey stores in *A. mellifera* kept at Nauni remained poor during the year. Whereas under migratory conditions, the average colony strength (8 bee frames), brood area (5399.2cm<sup>2</sup>) and pollen area (520 cm<sup>2</sup>) increased in March 2016 when honey bees were foraging for nectar and pollen on the *Brassica juncea* crop at Hisar. To overcome, the status of stationary beekeeping with respect to parameters like bee strength and brood area was obtained as upsurge whereas pollen area and honey store remained poor but looking towards opposite side whereas, migratory beekeeping is more lucrative in terms of food reserves.

**Keywords:** Colony strength, brood area, pollen area, honey store, stationary and migratory beekeeping

### Introduction

Honey bees are susceptible to a variety of diseases and environmental threats. While it is impossible to identify a single factor which on its own account for all colony losses in all regions of the world. It is clear that several biological and environmental factors acting alone or in combination have the potential to cause premature colony mortality by adversely affecting colony health and lifespan. Colony parameters play a significant role in stationary and migratory beekeeping. Among these factors are mainly, honey bee diseases and parasites that have been shown to play a remarkable role to increase honey bee colony mortality and colony losses (Genersch, 2010) [4]. Migratory beekeeping helps in increasing the honey production through exploitation of different bee flora (Sharma and Raj, 1985) [18] thereby providing opportunity for overcoming unfavorable climatic conditions as well as attack of local bee enemies (Singh *et al.* 1983; Phadke, 1987) [21, 14]. As per as colony parameters are concerned, Rana and Goyal (1994) [15] reported that the maximum pollen and brood area during the summer season while colony strength was found to be maximum in autumn season. The amount of pollen in the colonies reflects its status and can be used to expect the honey yield produced at the end of the season Stronger colonies produced more honey (10.50 kg/colony) than weak (7.17 kg/colony) ones. The largest brood rearing was obtained during the summer both in strong and weak ones. Several investigators have proved positive correlation between stored pollen, brood production, colony strength and honey yield (Kolmes and Sam, 1990; Shower *et al.* 2003) [10, 20]. Chandran *et al.* (1995) [1] reported that during December to February colonies of *A. mellifera* had 5 frames of brood. The colony strength was at its maximum during April – May and September i.e. 11 bee frames/ colony in Tamilnadu. The amount of brood rearing depends upon collection of food (Fathy, 1998; Shower *et al.* 2003) [3, 20] which depends upon the availability of young and foraging worker. The productivity of honeybee colonies was significantly influenced by its population size. Chaudhary *et al.* (1998) [2] reported that colony strength in *A. mellifera* colonies ranged between 8 to 10 frames at Nauni, Solan. Rana and Kumar (2011) [17] recorded the performance of *A. mellifera* colonies in high hills of Himachal Pradesh and observed increase in bee strength from 8 to 11 frames during February-May owing to flowering of the temperate fruits.

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The bee strength reduced to 6 frames in January. In February the brood area was 3600 cm<sup>2</sup> and reached 4260 cm<sup>2</sup>, 5275 cm<sup>2</sup> and 5904 cm<sup>2</sup> in March, April and May, respectively. The study was undertaken to record the colony performance of *A. mellifera* colonies under stationary and migratory conditions.

### Material and methods

Field experiments were conducted during July 2015 to June 2016 in *Apis mellifera* L. colonies maintained at the University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh, (33.3N° latitude, 70.70°E longitude, 1256 asl). Data on colony parameters of experimental colonies under stationary and migratory conditions were recorded monthly for a year (July, 2015 to June, 2016). Colony strength of each selected colony for the experiment was estimated by observing the number of frames covered with bees. Whereas, brood area and pollen area were measured with the help of measuring grid having squares, each square measuring one square inch (6.45 cm<sup>2</sup>). The area was converted into cm<sup>2</sup> by multiplying the number of squares with a factor of 6.45. Honey stores were estimated visually on the assumption that one Langstroth frame sealed with honey yield contains 2 kg.

The data on colony parameters and food reserves were transformed using the square root transformation as per the method described by Gomez and Gomez (1986)<sup>[5]</sup>, subjected to analysis of variance (ANOVA) and means were compared using a least significant difference test. The randomized block design the least significant difference between treatments was calculated taking all the possible combinations of factors. The treatment effects were tested at 5 per cent level of significance.

### Results and Discussion

The observations on the colony records in *A. mellifera* colonies under stationary (Nauni, Solan) as well as migratory (Hisar, Haryana) conditions have been recorded at monthly interval during July 2015 to June 2016. Twelve experimental colonies of equal strength of *A. mellifera* in the stationary conditions were kept at Nauni, Solan during the study period. Colonies of almost equal strength were selected for taking observations under migratory conditions. These colonies were migrated to Hisar, Haryana for five months (November, 2015 to March, 2016).

#### Under stationary conditions

The data on colony records of *A. mellifera* under stationary conditions during July, 2015 to June, 2016 presented in Table 1 revealed that the average colony strength was 5.2 bee frames/colony in July, 2015 which reduced in August (4), September (4.4) and October (4). The minimum average colony strength was 2.8 to 3.8 bee frames/colony during November to January when the temperature was low. With the onset of spring experimental colonies gained strength during February (4.2 bee frames/colony) and March (4.6 bee frames/colony) when build up flora was in bloom at Nauni, Solan. Thereafter, colonies increased in their average strength to 6.2 and 6.6 bee frames/colony during June and May 2016, respectively. The observations on colony records of *A. mellifera* at Nauni revealed that the average brood area was significantly higher during May, 2016 (3143.6 cm<sup>2</sup>) followed by the average brood area in June, 2016 (2497.6 cm<sup>2</sup>) and April (2013.8 cm<sup>2</sup>). The data further revealed that the average brood area was significantly low during winter months i.e. November 2015 (525.8 cm<sup>2</sup>), December (410.4 cm<sup>2</sup>) and January 2016

(436 cm<sup>2</sup>). The average brood area in experimental colonies varied from 844 cm<sup>2</sup> (October, 2015) to 1732 cm<sup>2</sup> (July, 2015) during the rest of the period under observations.

The observations recorded at Nauni on the average pollen area revealed that the maximum pollen area (160 cm<sup>2</sup>) was recorded in the month of April, 2016 which was statistically same with the pollen area in May (140). The minimum average pollen area was observed in November (26 cm<sup>2</sup>) and December 2015 (24 cm<sup>2</sup>). Perusal of data on Table 1 showed that average honey stores in *A. mellifera* kept at Nauni remained poor during the year being maximum in September (480g), followed by August (450g), and July (350g), values being statistically different from each other. The lowest average honey stores were found in January (80g) and February (75g) and bees were fed with sugar syrup during these months and other lean months on a regular basis.

The present findings on colony records at Nauni are in line with the earlier observations of Rana (2009)<sup>[16]</sup>, who have also reported maximum colony strength (9 bee frames/colony) in May and the minimum in the month of December (2.50). The studies conducted at Nauni, Solan (Sharma, 2010)<sup>[19]</sup> and at Reckong Peo (Rana and Kumar, 2011)<sup>[17]</sup> also indicated a similar trend in bee strength, brood area, pollen stores and honey stores. His studies also indicated minimum brood area (84.6 cm<sup>2</sup>) during December and maximum (3898 cm<sup>2</sup>) during May. According to them colony strength decreased from August to January, whereas from February onwards it increased regularly due to presence of bee floral sources and reached its maximum strength in May. The colonies of *A. mellifera* were reported to have brood area (2098.67 to 4459.67 cm<sup>2</sup>), pollen stores (10.00 to 21.33 cm<sup>2</sup>) and honey store (676.66 to 866.67 g) during winters at Nauni (Sharma, 2010)<sup>[19]</sup>. Kumar and Kashyap (1996)<sup>[11]</sup> conducted studies at sub-temperate, sub-humid mid hills and wet temperate high hills and found that sugar feeding is necessary during different seasons for maintaining *A. mellifera* as stationary beekeeping.

#### Under migratory conditions

Colony records of *A. mellifera* colonies under migratory conditions presented in Table 2. Average colony strength for *A. mellifera* colonies under migratory conditions is shown on Table 2 from 4.2 to 5.8 bee frames in winter months (November to January). The average colony strength increased in February (7 bee frames) and March, 2016 (8 bee frames) when honey bees were foraging for nectar and pollen on the *B. juncea* crop at Hisar. During December, 2015 at Hisar, average colony strength was 4.80 bee frames which were statistically same with average colony strength when colonies were at Nauni during July (4.6) and September (4.4). The observations on colony records of *A. mellifera* under migratory conditions further revealed that the maximum average brood area (5399.2 cm<sup>2</sup>) was recorded during March, 2016 followed by brood area in February (3209.8), January (2253) and December, 2015 (1694.4).

The observations recorded on average pollen area revealed that the maximum average pollen area (520 cm<sup>2</sup>) was recorded in the month of February, 2016. The minimum average pollen area (36 cm<sup>2</sup>) was observed in September, 2015. The data in Table 2 showed that maximum average honey stores was recorded in spring season under migratory conditions i.e. February (1190g) followed by honey stores in March (750g) and January, 2016 (680g).

The average colony strength, brood area, pollen area and honey stores were higher in colonies migrated to Hisar. These colonies were divided in the month of December when they gained strength while foraging on mustard crop. The divided colonies gained strength in the month of February and also collected surplus amount of honey in March. Migrated colonies got set back after poisoning during back migration period at Kadasan and Naryangarh (Haryana). There was a loss of colony strength from average 7 bee frames to 2.60 bee frames within three days. The average honey production was 10 Kg from migrated colonies. The commercial *A. mellifera* beekeepers from Himachal Pradesh have been adopting definite migratory routes to avail honey flow during winters for making beekeeping as profitable venture (Goyal and Rana, 1992) [6]. The colonies are reported to grow in strength continuously during migration on mustard crop with 1-2 extractions till the end of February (Mishra 1998) [12].

These observations are in conformity to the present studies which also indicated gain in strength and brood area with 2 honey extractions on mustard crop. The studies carried out in Uttar Pradesh (India) and Saudi Arabia showed the increase in

colony strength and brood area when colonies are migrated to floral rich belts during winters (Chandran *et al.* 1995 and Taha and Kahtani, 2013) [1, 22]. The colonies were migrated in March to Narayangarh (Haryana) for availing surplus honey flow from *Eucalyptus*. However, honey flow from *Eucalyptus* could not be availed due to bee poisoning which resulted into mass mortality of about average 5 bee frames. Mass mortality of honeybees due to pesticidal poisoning has been also reported by different workers in different places (Gupta, 1988; Johansen, 1979; Mayer *et al.* 1980 and Johansen *et al.* 1981) [7, 9, 13, 8] of colony strength from average 7 bee frames to 2.60 bee frames within three days. The average honey production was 10 Kg from migrated colonies.

The commercial *A. mellifera* beekeepers from Himachal Pradesh have been adopting definite migratory routes to avail honey flow during winters for making beekeeping as profitable venture (Goyal and Rana, 1992) [6]. The colonies are reported to grow in strength continuously during migration on mustard crop with 1-2 extractions till the end of February (Mishra 1998) [12].

**Table 1:** Colony strength and food reserves of *A. mellifera* under stationary conditions (Nauni, Himachal Pradesh) during July, 2015 to June, 2016

Period	Colony parameters			
	Bee frame	Brood area (cm <sup>2</sup> )	Pollen area (cm <sup>2</sup> )	Honey store (g)
July, 2015	5.20	1732.00 (41.56)*	92.20 (9.63)	350.00 (18.73)
August	4.00	876.00 (29.45)	48.20 (6.95)	450.00 (21.17)
September	4.40	989.60 (31.35)	36.00 (6.05)	480.00 (21.90)
October	4.00	844.00 (28.53)	70.00 (8.38)	250.00 (15.84)
November	3.80	525.80 (22.81)	26.00 (5.13)	170.00 (12.93)
December	3.00	410.40 (19.28)	24.00 (4.96)	120.00 (10.94)
January, 2016	2.80	436.00 (20.83)	40.00 (6.32)	80.00 (8.94)
February	4.20	973.20 (30.44)	90.00 (9.48)	75.00 (8.47)
March	4.60	1031.80 (32.01)	120.00 (10.98)	150.00 (12.22)
April	5.60	2013.80 (44.85)	160.00 (12.68)	220.00 (14.84)
May	6.60	3143.60 (55.84)	140.00 (11.86)	270.00 (16.44)
June	6.20	2497.60 (49.71)	100.00 (9.92)	250.00 (15.72)
CD <sub>0.05</sub>	0.82	5.71	1.23	1.81

\*Numbers or numerals in parentheses are square root (x+1) transformed values

**Table 2:** Colony strength and food reserves of *A. mellifera* under migratory (Hisar, Haryana) and stationary (Nauni, Himachal Pradesh) conditions during July, 2015 to June, 2016

Period	Colony parameters			
	Colony strength (bee frame)	Brood area (cm <sup>2</sup> )	Pollen area (cm <sup>2</sup> )	Honey store (g)
July, 2015	4.60	1674.00 (40.88)*	160.00 (12.59)	360.00 (18.99)
August	4.00	815.60 (28.52)	90.00 (9.33)	460.00 (21.42)
September	4.40	1009.60 (31.57)	36.00 (5.93)	490.00 (22.10)
October	4.00	804.20 (27.85)	70.00 (8.40)	200.00 (14.17)
November**	4.20	989.60 (31.31)	90.00 (9.46)	300.00 (17.32)
December**	4.80	1694.40 (41.01)	150.00 (12.22)	500.00 (22.36)
January, 2016**	5.80	2253.00 (47.46)	380.00 (19.51)	680.00 (26.09)
February**	7.00	3209.80 (55.76)	520.00 (22.82)	1190.00 (34.50)
March**	8.60	5399.20 (73.39)	450.00 (21.23)	750.00 (27.39)
April	3.20	323.20 (17.83)	180.00 (13.43)	410.00 (20.17)
May	3.60	720.40 (26.82)	160.00 (12.68)	200.00 (14.13)
June	4.40	1128.60 (33.56)	100.00 (10.02)	350.00 (18.71)
CD <sub>0.05</sub>	0.72	3.92	1.55	1.37

\*Figures in parentheses are square root (x+1) transformed values

\*\* Months of migration period of colonies to Haryana

## Conclusion

Under stationary conditions, with the onset of spring experimental colonies gained strength during February (4.2 bee frames/ colony) and March (4.6 bee frames/ colony) when build up flora was in bloom at Nauni, Solan. Thereafter,

colonies increased in their average strength to 6.2 and 6.6 bee frames/ colony during June and May 2016, respectively. Average brood area was significantly higher during May, 2016 (3143.6cm<sup>2</sup>) followed by the average brood area in June (2497.6) and April, 2016. Maximum pollen area (160 cm<sup>2</sup>)

was recorded in the month of April, 2016 which was statistically same with the pollen area in May (140). Average honey stores in *A. mellifera* kept at Nauni remained poor during the year. Whereas under migratory conditions, the average colony strength (8 bee frames), brood area (5399.2cm<sup>2</sup>) and pollen area (520 cm<sup>2</sup>) increased in March 2016 when honey bees were foraging for nectar and pollen on the mustard crop at Hisar. Maximum average honey stores was recorded in spring season under migratory conditions i.e. February (1190g) followed by honey stores in March (750g). *A. mellifera* beekeeping in Himachal Pradesh is profitable under migratory conditions, since colonies gained strength and produced surplus honey and can also be divided when migrated to floral belts.

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