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Important traits for the selection of honey bee (*Apis mellifera* L.) colonies

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Abstract
This present experiment was carried out in Apiary, Modern Bee Garden Research and Training Centre, Department of Entomology, G.B.P.U A & T, Pantnagar, Uttarakhand during August 2013 to May 2014. This study aimed at determining selection of better performing colonies on the basis of following important criteria *viz.* bee strength (weight and number of bees in the selected frames), disease incidence, queen performance, brooding pattern (smooth or erratic), and comb area measurement (honey cells, pollen cells, eggs cells, open broods/larvae and sealed broods). This investigation was performed on ten colonies which were selected randomly in the apiary. Maximum bee strength was observed in C_9 colony, where the weight of bees and number of bees were recorded 1.18 kg and 19668 respectively. All the selected colonies were free from disease incidence which indicates that colonies possess disease resistance traits. Excellent queen performance (egg laying pattern and egg laying efficiency) was recorded in colonies C_9, C_5 and C_2. In the case of comb area measurement, maximum area of honey cells (1912.30 cm^2), Pollen cells (468.00 cm^2), eggs cells (516.00 cm^2), open brood/larvae (725.60 cm^2) and sealed broods (945.00 cm^2) were recorded in colony C_9. The colonies C_9, C_5 and C_3 with all these desirable traits were selected in the breeding yard in apiary for quality queen rearing for stock improvement.

Keywords: *Apis mellifera*, desirable traits, bees strength, queen performance, comb cells area measurement

1. Introduction
For a successful beekeeper, beekeeping production depends on the selection of better performing honey bee colonies. Thus, selection aims and criteria are important tools in bee breeding programme for a beekeeper in an apiary. Colonies in an apiary could be selected on the basis of some of the of most important measurable characteristics *viz.* spring colony development, gentleness and a tendency to remain calm on the comb, over wintering ability, honey production and resistance against diseases (Gregorc and Vzreja, 2005) [8]. In honeybees as social insect, the colony is the level of selection, but most of the functions are performed by individual workers in the colony (Fewell and Page Jr, 2000) [6]. The various production activities of colonies are greatly influenced by the population of adult bees that forms each bee colony. Colonies with larger populations usually perform better than those with smaller populations. Hence, strength of bees in a colony affects productivity because of high level of correlation between hive strength and honey production. There are some of the important factors which affect colony strength *viz.* egg laying rate, viability rate, brood care, brood development time and life span (Gregorc and Lokar, 2010) [9]. Although, the worker population of each honey bee colony also depends on food availability (nectar and pollen), oviposition capacity is very important for the generation of populous hives (Moeller, 1958) [12]. The effective defence mechanism against disease is one of the most important functions of the worker bees in a colony. The individual bee's immune system functions in a similar way to that of vertebrate animals, although the most effective defense mechanism that can lead to self-healing of the bee colony is the social behavior of removing as many pathogen agents or parasites as possible from the bee colony. This behavioral defence (entrance reduction and/or stinging) prevents parasites from penetrating the bee colonies, or their killing or removal. Disease resistance is known to correlate with the "hygienic behavior" of worker bees. This is the ability of workers to recognize dead brood and then remove infected or damaged brood. This characteristic has been found to be regulated by two pairs of recessive genes. The queen honey bee is an important member to a colony's survival and functions.

She is the only member of the family capable of producing more female offspring to keep the colony going and is the repository of a colony's heritable genetic traits. The longevity of a queen in a colony depends on its reproductive potential, and its permanence in the colony is related to its oviposition capacity, which affects colony viability and vitality. The queen is naturally replaced when the spermatozoa stored in its spermetheca are depleted (Severson and Erickson, 1989) [18]. Egg-laying capability "is not the only measure of a queen's performance. Queens produce pheromones that greatly affect the activities, especially foraging activity of workers. Pheromone production diminishes in quality and quantity as queen age. In peak season, a queen laid about 2000 eggs (Gary, 2010) [7]. A high-producing colony must be headed by a queen that can lay 1,500 or more eggs a day (Farrar, 1980) [5]. Brood solidness is also an important trait of a colony. Brooding pattern/solidness of a colony could be erratic or solid. Brood solidness of a comb is expressed by the percentage of empty worker cells in a brood patch of a given area. Whether, an acceptable level of empty cells in a comb should be usually less than 10% (Delaplane *et al*., 2013) [3].

In the light of above facts regarding the importance of selection of better performing colonies, those colonies having all these important traits could be selected in breeding yard for further breeding programmed for improvement of the stock.

2. Materials and method

The present investigation on "Evaluating some Criteria for Selection of Better Performing Colonies of Honey bee (*Apis mellifera* L.). Colonies" was carried out in the Model Bee Garden for Research and Training, Department of Entomology, G. B. Pant University of Agriculture and Technology, Pantnagar (Udham Singh Nagar) Uttarakhand, India during August 2013 to May 2014. Bee strength is calculated in terms of weight of bees per colony. For this experiment, eight frames were selected from each of the colony. All eight frames were weighed with bees and without bees (Kg). The differences of these frames precipitated the weight of bees in given frame (Kg). In a frame, number of bees was calculated by dividing the weight of bees present in a frame (Kg) to the weight of a single bee (60 mg, Unit Kg was converted into mg). Then, total numbers of bees in a colony was calculated by the summation of numbers of bees present in eight frames. Total weight of bees (Kg) in a colony was calculated by summation of the weight of bees present in selected frames. Same methodology was used for calculating weight of bees with frame (Kg) and weight of bees without frame (Kg) in various selected colonies. The disease free colonies were selected to ensure the less incidence of disease for production of quality queens. Disease incidence of the colonies was measured as per two or three point system given by Gregorc and Lokar (2010) [9], where: 1= Present and 2= Absent. The queen performance of selected colonies was observed on the basis of egg laying capacity and egg laying pattern. Egg laying capacity and egg laying pattern were scored according to a three point system where: 3= Excellent; 2= Good; and 1= Poor. The bee colony selected having incessant (smooth type) brooding pattern and was scored as two point system where: 1= Smooth and 2= Erratic. Colony scores for the individual observed characteristics summarized as a final Colony Performance Factors (CPF) with a maximum possible scores of 10. Colonies with the highest 7% of scores for CPF were selected for further breeding. For calculating the areas of cells containing honey, pollen, sealed brood, open brood and eggs in various ten colonies with seven frames were selected. For the calculation of honey area in the frame the wire grid (10 in^2) was placed over the honey cells and honey area was recorded. This was done both sides of the frame. Then, honey area was recorded in different frames present in a colony. Total honey area of a colony was calculated by summation of honey areas of all selected seven frames. The area was recorded in inch square, and then converted the unit into centimeter square. Same methodology was used for calculating the pollen, sealed brood, open brood and eggs area in various selected colonies.

3. Result and discussion

3.1 Bees strength: It is pretty clear from data embodied in Table 1. that maximum weight of bees was recorded in colony C_9 (1.18 Kg) followed by C_2, (1.10 kg) and C_5 (1.08 Kg), while, minimum weight of bees was in the colony C_6 (0.53 Kg). Maximum bee weight indicates that these bees are healthy and well fed genetically. Schaffer *et al.* (1979) [16] stated that forage activity of a colony was affected by bee strength. The statement was given by Mayack and Naug (2009) [11] that maximum weight of bees in a colony is due to presence of healthy bees, and due to foraging activity of worker bees the colony weight increases. On the other hand the highest number of bees was observed in colony C_9 (19668) followed by colony C_2 (18331) and colony C_5 (17999), whether the lowest number was recorded in colony C_6 (8831). Hence, the present finding are in confirmation with those of Kauffeld (1975) [10] who found the figures of 1900 presented as the number of adult bees on a deep comb, where the comb is covered on the both sides by a single layer of bees. Whether, Simpson (1969) [19] found that a standard Langstroth deep frame possesses an average of 1,400 adult bees. While, according to Burgett and Burikam (1985) [1] that bees strength affect the queen cell rearing in cell raising colonies. They reared the queen cells in colonies containing 6-8 comb fully occupied by bees (10,000- 12,000). Burgett *et al.* (1985) [1] reported a quantification of the number of adult worker of *Apis mellifera* L. which found on combs of standard sizes at full holding capacity and this holding capacity of combs can assist in evaluating honey-bee colonies for pollination capabilities and also for honey-production potentials

3.2 Disease incidence: The data presented in Table 2 clears that all the ten selected colonies were free from disease incidence. Hence, these colonies have scored 2 marks as per 1-2 scale vividly implies that these colonies posses disease resistance traits. Result indicates that workers hygienic bees have good hygienic behavior, cleaned or removed the dead broods or infected or damaged broods from the cells of combs of all the colonies. Therefore, it would be considered as one of the important reason for selection of the colonies. Hence, the present finding are in confirmation with those of Rothenbuhler (1964) [15] who stated that disease resistance is known to correlate with the "hygienic behaviour" of worker bees. This is the ability of workers bees to recognize dead brood and then remove infected or damaged brood from cells. At the first stage bees remove the capping of the brood cell, and then remove the dead larvae or pupae, and characteristic has been found to be regulated by two pairs of recessive genes and according to Seeley *et al*. (2007) [17] the resistance in honey bees to disease is due to polyandry.

3.3 Queen performance- it is clear from the data embodied in table 2, egg laying pattern of queen in four colonies C_1, C_5, C_8, C_9 were scored (3) which indicated that queen performance was excellent than other five colonies, C_2, C_4, C_3, C_7, and C_{10} where score was given (2), it shown the average performance of queens and only one colony C_8 was scored (1) revealed that poor performance. While egg laying capacity was maximum scored in the eight colonies (3) except C_8 and C_{10} colonies have scored (1), show poor performance. Colonies with excellent queen performance indicates that queens have laid egg singly in each cell in a perfect manner in selected colonies. Therefore, colonies with excellent and average performance were selected for breeding yard, while poor performing colonies were rejected. So, it is clear from the above finding that queens have shown excellent performance were healthy and young and laid single eggs in a cell and queens were not supersedure. The present finding seconded by the finding reported by Farrar (1980) [5] the high-producing colony must be headed by a queen that can lay 1,500 or more eggs a day. The queen's physical development, as well as her genetic constitution, determines her capacity to produce eggs. Whether, Root and Root (1980) [14] found that a well mated and well fed queen can lay 2000 eggs per day in a colony.

3.4 Brooding pattern: According to the data presented in the table 2, brooding pattern was found smooth type all the ten colonies and scored were given (2), indicates that more number of brood cells found Therefore the colonies have maximum score can be selected for breeding programme for stock improvement. Delaplane *et al*. (2013) [3] stated on the basis of their finding that brood solidness is expressed by the percentage of empty worker cells in a brood patch of a given area. An acceptable level of empty cells is usually less than 10%.

3.5 Comb area measurement: it was pretty clear from the data embodied in the table 3, maximum honey area was found in the colony C_9 (1921.00 cm2) followed by C_8 (1612.00 cm^2) and C_2 (1393.00 cm^2). While minimum honey area (693.00 cm^2) was occupied in the colony C_6. Sealed brood area (cm^2) was found higher in C_2 (993.00 cm^2) followed by C_9 (945.00 cm^2). However the colony C_1 (254.70 cm^2) occupied minimum area of sealed brood. However, Rana and Goyal (1994) [13] reported that brood area of *Apis mellifera* was highest (7572 cm^2) in May followed by October (4717 cm^2), and it was lower in January (969 cm^2).The data embodied in table 3 reveles that maximum pollen area was recorded in C_1 (1184.38 cm^2) followed by C_{10} (590.17) colonies. The colonies C_1 (150.00 cm^2) and C_2 (140.62 cm^2) had minimum eggs area and it was assumed that these colonies had poor egg laying queen. Emsen (2006) [4] measured brood area that contained eggs, larvae, pupae, pollen and honey on the combs in each bee colony by using 1x1 inch wire grid. The wire grid placed over the brood comb to estimate the total sq. inches for each side of the comb Honey and pollen collection depends on gene pool of foragers bees, internal and external environment of colony.

The results obtained during course of investigation, the better performing colonies were selected on the basis of following criteria such as: bees strength, queen performance, content of frame (honey and pollen), and brooding pattern. These all characteristics primarily important for selection of honey bees colonies.

4. Conclusion

It may be concluded from the present study that the different traits of colonies were tested for the selection of better performing colonies, where maximum bees strength of the colony associated with the performance of colonies and affect productivity of the high level of correlation between hive strength and honey production, pollen collection, egg laying rate, egg viability rate, brood care, brood development time and other factors. In the case of disease incidence, all the selected colonies were free from disease. So, all the selected colonies (stocks) were associated with the disease resistance traits. Maximum queen performance of colonies indicates that queens are younger, healthy and not supersedure than the other colonies, if queen performance is not excellent then requeen the colonies. Brooding pattern or solidness of all colonies were smooth or solid which indicates that broods are healthy and well fed with pollen and royal jelly, free from disease incidence and colonies are strong. Maximum frame contents area in terms of honey area, pollen area were selected for breeding yard which have ample food for larvae, while solid brood area in colonies indicated that broods are healthy and disease free. Moreover, eggs area and open brood area recorded maximum in colonies can be correlated with queen performance and brood rearing by nurse bees. Hence, for the selection of better performing colonies in an apiary these important traits should be considered by beekeepers.

Table 1: Bee strength of various selected colonies

Colonies no.	Weight of frames with bees (Kg)	Weight of frames without bees (Kg)	Weight of bees (Kg)	No. of bees
C_1	7.30	6.26	1.04	17331
C_2	7.78	6.64	1.10	18331
C_3	7.18	6.18	1.00	16667
C_4	7.29	6.42	0.87	14500
C_5	7.34	6.26	1.08	17999
C_6	6.48	5.93	0.53	8831
C_7	10.42	9.49	0.93	15500
C_8	8.56	7.77	0.79	13166
C_9	8.75	7.57	1.18	19668
C_{10}	7.76	6.77	0.96	16499

Table 2: Score (rating) of colonies on the basis of various desirable traits

Colony no.	Disease incidence (1-2 scale)	Queen performance		Brooding pattern (1-2 scale)	CPF Max. 10
		ELP (1-3 scale)	ELC (1-3 scale)		
C_1	2	3	3	2	10
C_2	2	2	3	2	9
C_3	2	3	3	2	**10**
C_4	2	2	3	2	9
C_5	2	3	3	2	**10**
C_6	2	2	3	2	9
C_7	2	2	2	2	8
C_8	2	1	1	2	6
C_9	2	3	3	3	**10**
C_{10}	2	2	1	2	7

ELC: Egg laying capacity, ELP: Egg laying pattern, CPF: Colony Performance Factors

Table 3: Area of cells containing honey, sealed brood, pollen, eggs and open brood in various colonies

Colony No.	Honey area (cm^2)	Sealed brood (cm^2)	Pollen area (cm^2)	Eggs area (cm^2)	Larvae area (cm^2)
C_1	256.25	254.70	1184.38	150.00	100.00
C_2	1393.00	993.75	73.12	140.62	406.35
C_3	1040.00	843.00	184.00	203.12	518..80
C_4	1065.70	734.38	406.25	290.20	600.00
C_5	2741.20	274.12	219.30	483.30	419.25
C_6	693.37	883.65	306.38	532.12	574.05
C_7	886.90	741.80	209.70	338.70	525.68
C_8	1612.50	822.38	387.90	290.25	574.05
C_9	1912.30	945.00	468.00	516.00	725.70
C_{10}	1177.12	661.22	590.17	387.00	661.12

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References:

1. Burgett M, Burikam I. Number of adult honey bees (Hymenoptera: Apidae) occupying a comb: a standard for estimating colony populations. J Econ. Entomol. 1985**;** 78:1154-1156.
2. Burgett M, Fisher GC, Mayer OF, Johansen CA. Evaluating honey bee colonies for pollination. Pac. Northwest Ext. Bull, 1985, 245.
3. Delaplane KS, Van der steen J, Guzman E. Standard methods for estimating strength parameters of *Apis mellifera* colonies. In *V Dietemann;* J D Ellis; P Neumann (Eds) The COLOSS BEEBOOK, Volume I: standard methods for *Apis mellifera* research. Journal of Apicultural Research, 2013; 52 :1.
4. Emsen B. Semi- automatic measuring capped brood areas of honey bee colony. J Anim. Vet. Adv., 2006; 5(12):1229-1232.
5. Farrar CL. More honey from bees. Yearbook of agriculture, 1980, 680- 685.
6. Fewell JH, Page Jr. RE. Colony-level selection effects on individual and colony foraging task performance in honeybees, *Apis mellifera* L. Behav. Ecol. Sociobiol. 2000; 48:173-181.
7. Gary. Bee My Valentine. Honey bee hobbyist: The care and keeping of bees (Hobby Farm). 2010, 177.
8. Gregorc A, Vzreja. čebeljih matic (*Apis mellifera* carnica). Žirovnica – Čebelarska zveza Zgornje Gorenjske; 2005, 48.
9. Gregorc A, Lokar V. Selection criteria in an apiary of carniolan honey bee (*Apis mellifera* Carnica) colonies for queen rearing. Journal of Central European Agriculture. 2010; 11(4):401-408.
10. Kauffeld N. Overwintering of colonies of honeybees with restricted and unrestricted brood rearing in Louisiana. Am. Bee J. 1975; 115:480-481, 490.
11. Mayack C, Naug D. Energetic stress in the honeybee *Apis mellifera* from *Nosema ceranae* infection. Journal of Invertebrate Pathology. 2009; 100:185-188.
12. Moeller FE. Relation between egg-laying capacity of queen bees and population and honey production of their colonies. Am. Bee J. 1958; 98:401-402.
13. Rana BS, Goyal NP. Comparative brood rearing activity of *Apis mellifera* and *Apis cerana indica* at Nauni Solan, mid hill of Himachal Pradesh. Indian Bee Journal. 1994; 56: 24-28.
14. Root AI, Root ER. The ABC and XYZ of Bee Culture. Medina, Ohio: The A.I. Root Company, USA, 1980.
15. Rothenbuhler WC. Behaviour genetics of nest cleaning in honey bees responses of four inbred lines to disease-killed brood. Anim. Behav. 1964; 12:578-584.
16. Schaffer WM, Jensen DB, Hobbs DE, Gurevitch J, Todd JR, Schaffer MV. Competition, foraging energetics, and the cost of sociality in three species of bees. Ecology. 1979; 60(5):976 987.
17. Seeley TD, Tarpy DR. Queen promiscuity lowers disease within honeybee colonies. Proc. R. Soc. B. 2007; 274:67-72.
18. Severson DW, Erickson EH. Seasonal constraints on mating and insemination of queen honey bees in a continental climate. Apidologie. 1989; 20(1):21-27.
19. Simpson, J. The amounts of hive-space needed by colonies of European *Apis mellifera.* Journal of Apicultural Research. 1969; 8:3-8.