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MASS REARING OF QUEEN BEES, *APIS MELLIFERA* L. (HYM: APIDAE) FOR BEE COLONY DEVELOPMENT RAISED UNDER THE TEMPERATE CONDITIONS OF KASHMIR

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ABSTRACT
This experiment was carried out to determine the differences in terms of raising queens by different rearing methods i.e. queenright and queenless colonies. The larval acceptance rates among rearing groups were found highly significant in the month of May and June ($p < 0.01$) and significant in July ($p < 0.05$). The graft acceptance rate in queenright colonies and queenless colonies was 83 and 79% respectively. The mean pupal weight of the queen pupae in the queenright colony was not significantly different from the mean pupal weight of the queenless colony ($t = 1.13$, $p > 0.05$). The mean length of sealed queen cell was found 26.60 ± 0.16 mm in queenright colonies, while the same values were measured as 31.00 ± 0.13 mm in queenless colonies ($t = 8.24$, $p < 0.001$). Mean mating rates of queen bees in queenright and queenless colonies were found to be 90.77 and 87.77% respectively. The pre-oviposition period in both queenright and queenless colonies had no significant difference among the two methods, howver, the emergence weight was 202.19 ± 8.25 mg in queenright colonies and 197.34 ± 7.44 mg in queenless colonies.

INTRODUCTION

Queen rearing is one of the major objects of apiaries especially for the commercial beekeepers, and it is a main factor for successful in beekeeping (Morse, 1994). Rearing honeybee queens occurs when the colony is in the process of swarming, supersedure or when the queen has been accidentally lost or killed (Seeley, 1985). Although the rearing of queen bees can be performed in the presence of the queen in a nurse colony however a higher effectiveness can be achieved in queenless colonies (Morse, 1994; Crailsheim, *et al.,* 2013) and in the absence of emergency queen cells (Free *et al*., 1987). In all these cases, adult workers rear new queens from worker larvae that are less than 48 hrs old (Haydak, 1943). For successful managing and rearing of queen bees, it is imperative to adapt beekeeping measures for colony development. Under temperate conditions, the colony brood rearing cycle is characterized by complete cessation of brood rearing in the late fall and reduction of colony size during the winter (Avitabile, 1978). Limited brood rearing is initiated already during winter months and brood rearing leading to colony expansion is often initiated before nectar and pollen become available (Seeley, 1978). The highest number of queen cells is achieved by using royal jelly in July and August (Genc *et al.,* 2005). Queen bees can be reared from
the end of March to September, but better quality of queens is obtained from the end of March until the end of April, (Koc and Ka-racaoglu, 2004). The acceptance and the ratio of queen emergence is highest using royal jelly as the grafting substrate (El-Din, 1999). At present, grafting is the most convenient and economical method of queen rearing.

In tropical or subtropical climates, where honey bees are able to rear brood continuously throughout the year, data on colony development is readily available. Compared to honey bees in temperate climates, colonies may respond more rapidly with increased brood rearing when foraging conditions become favourable (Rinderer and Hellmich, 1991). At Doolittle (1888) devolved a method of transferring very young larvae from worker cells to specially prepared queen cell cups. Several improvements have been made in Doolittle's grafting method. This method has been challenged as producing queens of inferior quality to those produced from the egg. Researchers have produced queens from eggs; however, no convenient and economical method has been developed. Consequently, the aim of the present work was to investigate population dynamic measurements in honey bee colonies (*Apis mellifera*) in Kashmir region on queen cell acceptance after grafting throughout the year with the objective to collect data on colony development and queen rearing possibilities in temperate region.

MATERIALS AND METHODS

The experiment was carried out in the apiary of Division of Entomology, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir from 2007 to 2009. The grafted larvae raised with Doolittle method were introduced into queenless and queenright colonies. Larvae less than 24 h old

were transferred into cell cups filled with royal jelly that was diluted with water in proportion of 1:1 (Wilkinson and Brown, 2002). During the experiment, queen rearing colonies were fed with sugar syrup (1:1). Queen bees were reared in *A. mellifera* colonies with 3 brood and 2 storage frames. Rearing frames with 1 day old grafted larvae were placed in the centre of the colony. When capped queen cells were moved into incubators, the next series of grafted frames were placed into rearing colonies. Each nurse colony was provided with the brood comb taken from support colonies every 10 days of rearing period. In this experiment, differences between rearing methods were determined by evaluating the rate of larvae acceptance, acceptance rate of queens, weight of queen pupae, length of queen cell, emergence rate, mating rate and pre-oviposition period. Data on larval acceptance rates and mating rates were subjected to Z-test. The mean heights of queen cell and emergence weight values were analyzed with t-test. Pre-oviposition periods of queen bees were compared with one way analysis of variance (Cengiz *et al.*, 2009).

RESULTS AND DISCUSSION

The larval acceptance in starter colony for each group for different periods is given in Table-1. The differences in the rate of accepted larvae among queenright and queenless rearing groups were found significant ($p < 0.01$). The larval acceptance rates in both groups were found as 79 and 96.33% in June, respectively, which are higher than that observed in other months (May and July). The bees of queenless colonies showed more interest to the grafted larvae. The higher acceptance rate bestowed by queenless colonies is assumed to be depending on the absence of queen. The higher larvae acceptance rate in queenless colonies obtained in present studies draw their support from the findings of Dodologlu and Emsen (2007) and Cengiz *et al.* (2009) who reported 93.33 and 95% larval acceptance rate for queenright and queenless colonies respectively. Similarly, Sahinler and Kaftanoglu, (2005), in another study obtained an average acceptance rate of 75.1, 70.9 and 68.3% in queenright colonies in June, July and August respectively which is by and large in agreement with the present findings.

The graft acceptance rate (Table 2 and 3) of 83 % was achieved in the queenright colonies and 79% in queenless colonies out of the total larval grafts of 4176 and 3919 larval for queenright colonies and queenless colonies respectively. Colony number 45 and 127 (from queenright) and 40 and 70 (from queenless), however, consistently gave lower acceptance rates and their use as queen rearers was discontinued. The present findings draw their support from the works of Wilkinson and Brown (2002) who reported average graft acceptance rate of 81% in queenright colonies. However, Brother Adam (1975) was convinced that although queens of the highest quality could be raised using the queenright method, but was reported that an average acceptance rate of about 90% with the queenless method.

Table 1: Rate of larvae acceptance raised in different methods of queen rearing

Groups	No. of grafted larvae	No. of accepted larvae(**)	Larvae acceptance rate May (%) (**)	June (%) (**)	July (%) (*)
Queenright colony	150	115	75.33	79.00	75.66
Queenless colony	150	132	81.66	96.33	86.33
Total	300	247	75.66	88.50	82.83

Significant, ** ($p < 0.01$), *($p < 0.05$)

The weight of the queen pupae and lengths of the queen cells reared under the two different methods of queen rearing are listed in Table-4. The mean pupal weight (0.2575g) of the queen pupae reared in the queenright colonies was not significantly different from the mean weight (0.2436g) of the queenless colonies ($t = 1.13$, $p > 0.05$). The mean length of sealed queen cell was found 26.60 ± 0.16 mm in queenright colonies, while the same values were measured as 31.00 ± 0.13 mm in queenless colonies. The mean length of the queen cells reared in the queenless colonies was significantly greater than the mean length in the queenright colonies ($t = 8.24$, $p < 0.001$). These results show that queenless colonies build longer cells compared to queenright colonies. Wilkinson and Brown (2002) reported the length of queen cell in queenless and queenright colonies as 30.82 and 26.70 mm, respectively, which are in agreement with the present findings. Emsen *et al.* (2003) found that the height of sealed queen cell was 25.20 ± 0.04 mm in queenless colonies which is lower to the result in the present study.

In general, it was noticed that all the cells in both groups had surplus royal jelly in the cell base. It was also noticed that all the queen cells reared in the queenless colonies had very obvious outer wall sculpturing with dimples and ridges, whereas all the cells reared in the queenright rearer had smooth outer walls. The finding that the queen cells raised in the queenless colony were longer and more sculptured than those raised in the queenright one is intriguing. It may have been the result of small genetic differences in the colonies used, or due to a different distribution of the cell building bees. Queen cell length is only likely to have an effect on the quality of the queen developing inside if the queen cell is so short that the pupal development is physically restricted. Taber (1983) reported that rearing of queens in queenless colonies are particularly difficult in queenless, *Apis mellifera capensis* colonies due to the development of laying workers which produce worker brood (thelytokous reproduction) and the workers fight each other, causing much colony disruption.

A total of 175 queen bees were evaluated with the total mating rates of 89.27% (Table-5). The rate of mating in queenright colonies and queenless colonies in the month of May (92.33, 85.33), June (95.66, 94.33) and July (84.33, 83.66) respectively. No significant differences were observed between two groups. According to Genc *et al.* (2005), the mating rates of queen bees reared in June July and August did not show any significant difference. Similar results obtained by Cengiz *et al.* (2009) support the present findings.

On the other hand, the longest pre-oviposition period in both queenright and queenless colonies was (12.54 ± 0.54) and (12.59 ± 0.50) respectively in the month of June, while the shortest pre-oviposition period was found in May (10.49 ± 0.60 and 10.78 ± 0.63) respectively. (Table - 6). However, no significant difference were observed in both rearing groups with regard to pre-oviposition period was found. The present

Table 2: Acceptance rates of queens in queenright colonies.

Year	Colony number	Number of graft batches	Total grafts given	Total grafts accepted	Percent acceptance(%)
2007	45	5	300	195	65
2007	35	25	870	696	80
2007	26	30	950	817	86
2008	47	27	650	533	82
2008	110	22	770	693	90
2008	127	18	456	342	75
2008	126	3	45	36	80
2009	23	3	60	51	85
2009	34	1	25	19	76
2009	17	1	25	25	100
2009	70	1	25	24	96
Total		136	4176	3431	83

Table 3: Acceptance rates of queens in queenless colonies.

Year	Colony number	Number of graft batches	Total grafts given	Total grafts accepted	Percent acceptance(%)
2007	40	8	350	217	62
2007	32	20	880	660	75
2007	16	26	850	697	82
2008	37	22	550	440	80
2008	60	28	750	645	86
2008	77	19	350	245	70
2008	86	4	65	52	80
2009	53	4	50	40	80
2009	44	2	24	18	75
2009	97	1	25	23	92
2009	22	1	25	22	88
Total		135	3919	3059	79

Table-4: Weight of queen pupae (grams) and length of queen cells (mm) raised in different methods of queen rearing.

	Pupal weight (g)		Queen cell length (mm)	
	Queenright	Queenless	Queenright	Queenless
	0.2620	0.2544	27	32
	0.2565	0.2355	26	31
	0.2567	0.2456	27	32
	0.2612	0.2552	27	30
	0.2376	0.2458	28	30
	0.2604	0.2346	26	31
	0.2456	0.2287	26	32
	0.2566	0.2554	25	30
	0.2712	0.2357	28	32
	0.2677	0.2459	26	30
Average	0.2575	0.2436	26.60	31.00
SD	0.0100	0.0103	0.943	1.095

findings are in agreement with those of Dodologlu and Genc,(1997), who reported pre-oviposition period of 12.15 ± 0.39 days in the controlled reared queen bee and 12.36 ± 0.43 days for the queen bees reared in the natural queen cell cups The rate of queen cell emergence in the present study was 100% in both rearing methods, which is similar to the findings recorded by Dodologlu and Emsen (2007) but higher than those reported by Emsen *et al*. (2003), who reported 70 and 69% queen cell emergence in two methods.. The emergence weight of 202.19 ± 8.25 mg in queenright colonies and 197.34 ± 7.44 mg in queenless colonies was obtained in the present studies (Table-6). These findings were higher than the findings of 206.13 ± 3.20 mg reported for queenright colonies and 178.47 ± 2.05 mg for queenless colonies reported by Dodologlu *et al*. (2004). However, similar findings on the emergence weight were reported by other workers (Emsen, 2004; Genc *et al.,* 2005).

The aim of the present investigation was to rear queens for the purpose of replacement on a regular basis, at least every second year, to maintain young prolific queens and to minimizing the risk of swarming and maximizing productivity. The queenright method has the advantage that the workers are not separated from their queen at any time, except to the extent that the queen excluder may act as a barrier to queen pheromone dispersal. It is therefore possible that the queenright method could be reused for successive batches of queen cells, without causing laying worker problems. The ability to rear queens in temperate conditions of Kashmir valley using queenright method could be a very important tool, particularly because of the short honey flow period. There was no significant difference in terms of queen weight at emergence, mating rate and oviposition period, while the acceptance rate of queen bees raised from different groups were significantly different depending on rearing methods. On the other hand, in spite of the variables of low grafting yield in queenright colonies, queen bees were reared in queen cells and brood activity was continued. According to the results obtained in the present study, we conclude that rearing queen bees in queenright

Table 5: Percent mating rates of queen bees raised in different methods of rearing.

Groups	Number of queen bees	Mating rates (in %) May	June	July	Mean
Queenright colony	90	92.33	95.66	84.33	90.77
Queenless colony	85	85.33	94.33	83.66	87.77
Total	175	88.83	94.99	83.99	89.27

Table 6: Pre-oviposition period and emergence weight of queen bees raised in different methods of rearing.

	Periods	Queenless colony N	Mean ±SE	Queenright colony N	Mean ±SE
Pre-oviposition period	May	27	10.78±0.63	25	10.49±0.60
	June	25	12.54±0.54	24	12.59±0.50
	July	28	11.65±0.48	26	11.45±0.41
Emergence weight (mg)		140	197.34±7.44	140	202.19±8.25

colonies is more advantageous than in queenless colonies.

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REFERENCES

Avitabile, A. 1978. Brood rearing in honeybee colonies from late autumn to early spring. *Journal of Apicultural Research*. **17**: 69-73.

Brother Adam, 1975. Beekeeping at Buckfast Abbey. Geddington Northants, UK: British Bee Publications Ltd.

Cengiz, M., Emsen, B. and Dodologlu, A. 2009. Some characteristics of queen bees (*Apis mellifera* L.) rearing in queenright and queenless colonies. *Journal of Animal and Veterinary Advances*. **8(6)**: 1083-1085.

Crailsheim, K., Brodschneider, R., Aupinel, P., Behrens, D., Genersch, E., Jutta Vollmann, J. and Riessberger-Galle, U. 2013. Standard methods for artificial rearing of Apis mellifera larvae. *Journal of Apicultural Research* **52(1):** 1-16

Dodologlu, A. and Emsen, B. 2007. Effects of larvae transfer conditions on queen bee productivity. *J. Applied Anim. Res.* **31**: 181-182.

Dodologlu, A. and Genc, F. 1997. The effect of rearing and mating methods on some characteristic of queen honeybees (*Apis mellifera* L.). *Turk. J. Vet. Anim. Sci*. **21**: 379-385.

Dodologlu, A., Emsen, B. and Genc, F. 2004. Comparison of some characteristics of queen honey bees (*Apis mellifera* L.) reared by using Doolittle method and natural queen cells. *J. Applied Anim. Res*. **26**: 113-115.

Doolittle, G. M. 1888. Scientific Queen Rearing. Chicago, Illinois, USA: Thomas G. Newman & Son.

El-Din, H. A. E. S. 1999. Biological and ecological studies on rearing honeybee (*Apis mellifera* L.) for commercial queens production. *Honeybee Sci.* **20(3):** 127-130.

Emsen, B., Dodologlu, A. and Genc, F. 2003. Effect of larvae age and grafting on the larvae accepted rate and height of sealed queen cell (*Apis mellifera* L.). *J. Applied Anim. Res.* **24**: 201-206.

Free, J. B. 1987. Pheromones of Social Bees. London, UK: Chapman and Hall.

Genc, F., Emsen, B. and Dodologlu, A. 2005. Effects of rearing period and grafting method on the queen bee rearing. *J. Applied Anim. Res*. **27(1):** 45-48.

Haydak, M. H. 1943. Larval food and development of castes in the honeybee. *J. Econ. Entomol*. **36**: 778-783.

Koc, A. U. and Karacaoglu, M. 2004. Effects of rearing on the quality of queen honeybees (*Apis mellifera* L.) raised under the conditions of Aegean Region. *Mellifera*. **4(7):** 34- 37.

Morse, R. A. 1994. Rearing Queen Honeybees. pp. 64-72. Bd. Wicwas Press; Cheshire, Ct; USA.

Rinderer, T. E. and Hellmich, R. L. 1991. The process of Africanization, in: M. Spivak, D.J. Fletcher, M.D. Breed (Ed.), The "African" honey bee. Westview Press, Boulder, Colorado, USA. pp. 95-117.

Sahinler, N. and Kaftanoglu, O. 2005. The effects of season and honeybee (*Apis mellifera* L.) genotype on acceptance rates and royal jelly production. *Turk. J. Vet. Anim. Sci*. **29:** 499-503.

Seeley, T. D. 1978. Life history strategy of the honey bee, *Apis mellifera*. *Oecologia,* **32:** 109-118.

Seeley, T. D. 1985. Honeybee Ecology. A study of adaptation in social life. In: Krebs J.R. and T. Clutton - Brock (eds.). Monographs in Behavior and Ecology. 201 pp. Princeton Univ., Press, Princeton, NJ.

Taber, S. 1983. Queen rearing with the Cape bee – it's much different. *American Bee Journal,* **123:** 435-437.

Wilkinson, D. and Brown, M. A. 2002. Rearing queen honey bees in a queenright colony. *Apiculture Res.* **11:** 271-274