Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

J E Z S Journal of Entomology and Zoology Studies

E-ISSN: 2320-7078
P-ISSN: 2349-6800
JEZS 2019; 7(3): 1062-1065

Received: 22-03-2019
Accepted: 23-04-2019

Navneet Kaur Dhaliwal
Department of Entomology, Punjab Agricultural University, Ludhiana, Punjab, India

Jaspal Singh
Department of Entomology, Punjab Agricultural University, Ludhiana, Punjab, India

Pardeep K Chhuneja
Department of Entomology, Punjab Agricultural University, Ludhiana, Punjab, India

Correspondence
Navneet Kaur Dhaliwal
Department of Entomology, Punjab Agricultural University, Ludhiana, Punjab, India

Comparative evaluation of mass queen bee rearing techniques for *Apis mellifera* (Hymenoptera: Apidae) in autumn season

Navneet Kaur Dhaliwal, Jaspal Singh and Pardeep K Chhuneja

Abstract
Comparative efficiency of Doolittle and novel techniques (Karl Jenter and Cup kit) of queen bee rearing during autumn 2012, revealed that maximum larval acceptance (54.00%), queen cell raising (50.00%), its sealing (46.00%), and emergence of gynes (40.67%) were recorded in Cup kit apparatus. The mean weight of newly emerged gynes was 183.64 mg in case of Cup kit and the maximum from Doolittle method in plastic cell cups (202.57mg). Although mean weight of the gynes produced from Cup kit was less than those produced from plastic cell cups, but considering the better performance of Cup kit in terms of acceptance of larvae and number of emerged gynes, it proved to be the best alternative for queen bee rearing.

Keywords: *Apis mellifera*, cup kit, Doolittle method, karl jenter, mass queen bee rearing

Introduction
The performance of a honey bee (*Apis mellifera* Linnaeus) colony is based on its several traits including the rate of colony growth and nectar hoarding efficiency, longevity, resistance to diseases and enemies, etc. Queen bee is the genetical custodian for transferring all these traits to the colony, truly though it is responsible for half of the genetic make-up of its offspring or colony inmates. Reproductive division of labor is clearly evident in the honey bees, where sterile worker carry out non-reproductive tasks and the queen bee has monopoly over reproduction. Queen bee mates with several drones in a mating flight [1, 3] and on an average lays 1500 eggs daily [4]. However, reproductive physiology of a queen bee is affected by its rearing environment. It has been demonstrated by different workers that the age of the larvae affects the quality of the queen bee reared from it [5, 6]. First instar worker larvae yield good quality robust queen bees which in turn has favorable effect on colony parameters such as pollen and honey stores [6, 9]. Doolittle method is used by commercial queen breeders for mass rearing of quality queen bees [10]. This method requires skill to identify and careful handling of young worker caste larvae and slightest mishandling of the larvae may lead to their rejection for queen rearing by worker bees. However, novel techniques of queen bee rearing i.e. Karl Jenter and Cup kit queen rearing apparatus skip the fabrication of wax cell cups and grafting of larvae. These systems, therefore, avoid any chances of injury to larvae during grafting and make the process of transferring larvae to cell builder colonies simpler, quicker and easier. There have been very few studies on the performance of these apparatuses for mass queen bee rearing [11]. However, no study has been done on comparative performance of Doolittle method and the novel techniques. The present study was undertaken to evaluate the comparative performance of these queen bee rearing techniques.

Materials and methods
Studies on the comparative performance of different mass queen bee rearing techniques in queen less cell builder colonies were conducted during autumn season of 2012-13 at the Campus Apiary of Punjab Agricultural University, Ludhiana (India).

Experimental layout
The apparatuses were installed in the breeder colonies by fitting queen rearing apparatus in a fully raised comb and the queen of the colony was confined into the apparatus to lay eggs. The comb containing the apparatus was kept in the brood chamber of the breeder colony.

The cell cups with larvae of less than 24 h of age were collected for their transfer into 15 bee-frame strength cell builder colonies. All the cell builder colonies used in the experiment were equalized in respect of their bee strength, brood area, pollen and honey stores. Comb arrangement of cell builder colonies was made, after [12].

Treatments

Cell cups from Cup kit apparatus and cell cup bases from Karl Jenter apparatus, containing larvae of less than 24 h age, were collected. These cell cups were then fitted in to the cell cup blocks fixed on the bars of queen rearing frames. Doolittle grafting method was practiced in both bees wax cell cups (9 mm diameter) and plastic queen cell cups. Larval grafting was done by priming queen cell cup with speck of diluted fresh royal jelly (Royal jelly: sterilized water- 1:1) with the help of a camel hair brush. Young larvae of less than 24h age taken from selected breeder colonies were used for grafting. Thirty cell cups for each treatment were given per cell builder colony.

Observations

Acceptance of larvae in the cell cups was recorded 24h after transfer of larvae. Extending queen cell cup walls and nursing of the grafted larva with royal jelly by nurse bees was counted towards accepted. Raising of queen cells was recorded 72h after larval transfer. Successful sealing of queen cells was recorded five days after larval grafting. Per cent raising and sealing of queen cells was worked out on the basis of the total number queen cell cups provided and cell cups accepted.

Three partition hives were used as mating nuclei. Each nucleus was given 2 bee frames with brood and adequate population of nurse bees to attend the queen after its emergence. Sealed gyne cells were removed from the bars of queen rearing frame were fixed in to the brood combs of the nuclei. The emergence of queen bees from sealed cells was recorded on 12th day after larval transfer. The emergence percentage was calculated both in terms of queen cell cups provided as well as on the basis of queen cells accepted.

Statistical analyses

Statistical analyses were done using Analysis of Variance (ANOVA) for Completely Randomized Design (CRD), following various transformations wherever necessary. Least significant difference (L.S.D.) values were worked out to determine the significance of differences among the mean values at 5 per cent level of significance.

Results and discussion

Acceptance of larvae in bees wax cell cups in Doolittle method and plastic cell cups in Doolittle, Cup kit and Karl Jenter methods differed significantly among different techniques and ranged from 37.33 to 54.00% (Table 1). The acceptance in Cup kit apparatus was significantly higher (54.00%) than the other three techniques. Acceptance in Karl Jenter apparatus, plastic cell cups and wax cell cups was at par with respective values being 37.33, 42.00 and 40.00%. Similar results were obtained in case of raising of cell cups, where Cup kit was significantly better (50.00%) than other three techniques, while in case of Karl Jenter apparatus it was significantly lower (32.67%) than other techniques except Doolittle method involving plastic queen cell cups. Acceptance rates during spring breeding season for the rearing techniques ranged from 50.00-66.00% [13], which are higher as compared to the autumn season acceptance rates during the present study. Spring season being a major breeding has abundant bee flora as compared to the autumn season. Several workers have reported difference in acceptance rates during two seasons, as higher rates obtained in the more favorable season i.e., period when bee flora is more abundant [11, 14, 17]. This allows beekeepers to extend their stock improvement programme, as they have two breeding seasons for rearing of good quality queen bees. Also, they can opt for queen bee rearing at the start of minor breeding season i.e. autumn, so that they have young queen bees by the month of November. Therefore, they will have colonies headed by young and prolific queen bees by the start of major breeding season, i.e. spring (mid-February to mid-April) which will aid in the enhancement of the productivity of the colony. The results of the study are in conformity with the results obtained by many workers who reported higher acceptance in plastic cell cups than in wax cell cups [18-20], though [21, 22] reported non-significant difference in larval acceptance in plastic and wax cell cups.

Table 1: Comparative performance of different mass queen bee rearing techniques of *A. mellifera* in queen less cell builder colonies

Queen rearing technique	Acceptance of cells (%)*	Raising of cells (%)*	Sealing of queen cells (%)* on the basis of		Emergence (%)* of gynes on the basis of		Weight of gynes (mg)
			cells given	cells accepted	cells given	cells accepted	
Cup kit apparatus	54.00 (47.29)	50.00 (44.99)	46.00 (42.68)	85.54 (67.96)	40.67 (39.59)	75.57 (60.41)	183.64
Karl Jenter apparatus	37.33 (37.62)	32.67 (34.81)	30.00 (33.17)	80.60 (64.12)	26.67 (31.04)	71.57 (57.87)	193.36
Doolittle method with plastic cell cups	42.00 (40.35)	41.33 (39.97)	38.67 (38.42)	93.04 (78.26)	35.33 (36.43)	84.67 (67.38)	202.57
Doolittle method with wax cell cups	40.00 (39.19)	36.67 (37.20)	34.67 (36.00)	86.34 (68.61)	30.00 (33.13)	74. 80 (59.98)	187.77
(p= 0.05)	4.54	4.36	3.48	9.44	3.50	5.70	6.15

*Figures in parenthesis are the means of arc sine √percentage transformations.

Sealing of queen cells (on the basis of cell cups given) ranged from 30.00 to 46.00% and sealing of queen cells (on the basis of cell cups accepted) varied from 80.60 to 93.04% in different techniques. Sealing (on the basis of cell cups given) in cell cups raised from Cup kit apparatus was significantly higher (46.00%) than that in the other techniques. On the other hand, the sealing (on the basis of cell cups accepted) in plastic cell cups was significantly higher (93.04%) than in the other techniques. Emergence of gynes (on the basis of cell cups given) among the different techniques ranged from 26.67 to 40.67%. The emergence of gynes from Cup kit apparatus (40.67%) was at par with plastic cell cups (35.53%), but significantly better than in the case of Karl Jenter apparatus and beeswax cell cups. The emergence of gynes (on the basis of cell cups accepted) ranged from 71.57 to 84.67% among different techniques. It was significantly better in the case of

plastic cell cups (84.67%) than in the other techniques. The weight of the newly emerged gynes varied significantly among the different queen rearing techniques, ranging between 183.64 to 202.57mg (Table 1). Gynes obtained from plastic cell cups had significantly higher weight (202.57mg) as compared with the other techniques. The weight of gynes reared from Karl Jenter (193.36mg) was at par with that from beeswax cell cups (187.77 mg) but significantly better than that in Cup kit apparatus (183.64mg), while the latter two were at par with each other. Present finding are in agreement with reports of the workers who reported emergence weight of queen bees raised with Doolittle grafting method in the range of 186.6-206.13mg [16, 17, 23, 24]. Reported queens weighing between 200 to 221mg, with the use of plastic queen cell cups. However, some workers have reported lower emergence weight in the range of 158.83-173.59mg [25, 26]. Similar results have been obtained in spring breeding season also where Cup kit apparatus recorded highest emergence rate but Doolittle grafting method in plastic cell cups yielded heaviest queen bees [13]. On the other hand, [14] reported that rearing season affects the quality of queen bee reared, where better quality of queen bee was obtained from end of March to end of April. It can be said that the persons who have skill and experience in grafting technique can opt for grafting in plastic cell cups. The cell cup sealing and gyne emergence, on the basis of cell cups accepted, is higher in the case of grafting in plastic cell cups. The weight of queen bee is considered as one of the criterion for judging the quality of queen bees, and the heaviest queen bees were obtained from grafting in plastic cell cups. So, if the acceptance is improved, it is possible to have reasonable number of good quality queen bees by this method.

Conclusion

The results indicate that Cup kit apparatus performs best in terms of larval acceptance, cell raising and sealing, and for the emergence of gynes. Those who cannot practice grafting due to poor eyesight, less skilled in the fabrication of wax cell cups or have difficulties in handling and grafting tiny larvae, can have Cup kit apparatus as an excellent option in queen bee rearing. It does not need any grafting and fabrication of cell cups and yields 40.67 per cent larvae converted into queen bees. With these emergence rates, it is evident that installation of apparatus for one time ought to cover up all the costs of the purchase of apparatus.

References

1. Tarpy DR, Nielsen DI. Sampling error, effective paternity, and estimating the genetic structure of honey bee colonies Hymenoptera: Apidae. Ann. Entomol. Soc. Am. 2002; 95(4):513-528.
2. Tarpy D, Nielsen R, Nielsen D. A scientific note on the revised estimates of effective paternity frequency in *Apis*. Insect Soc. 2004; 51(2):203-204.
3. Kraus FB, Neumann P, Moritz RFA. Genetic variance of mating frequency in the honeybee *Apis mellifera* L. Insect. Soc. 2005; 52(1):1-5.
4. Snodgrass R. Anatomy of the honey bee. Comstock Pub. Associates. 1956; 334.
5. Fell R, Morse R. Emergency queen cell production in the honey bee colony. Insect Soc. 1984; 31(3):221-237.
6. Hatch S, Tarpy D, Fletcher D. Worker regulation of emergency queen rearing in honey bee colonies and the resultant variation in queen quality. Insect Soc. 1999; 46(4):372-377.
7. Rangel J, Keller J, Tarpy D. The effects of honey bee *Apis mellifera* L. queen reproductive potential on colony growth. Insect Soc. 2013; 60(1):65-73.
8. Tarpy D, Keller J, Caren J, Delaney D. Experimentally induced variation in the physical reproductive potential and mating success in honey bee queens. Insect Soc. 2011; 58(4):569-574.
9. Woyke J. Correlations between the age at which honeybee brood was grafted, characteristics of the resultant queens, and results of insemination. J Apic. Res. 1971; 10(1):45-55.
10. Gatoria GS, Chhuneja PK, Singh J, Singh B. Mass queen bee rearing in *Apis mellifera* Linn. Indian Bee J. 2004; 66(1-2):41-51.
11. Sena L, Sena S, Gjurgji F, Nikolla M. Seasonal application of Jenter's method for a successful queen bees rearing in Albania. Bio technol. Bio technol. Eq. Special edition, 2010; 433-437.
12. McKinley WM. Grafting-how it is done. Gleanings in Bee Culture. 1963; 91:404-409, 443.
13. Dhaliwal NK, Singh J, Chhuneja PK. Comparative evaluation of Doolittle, Cup kit and Karl Jenter techniques for rearing *Apis mellifera* Linnaeus queen bees during breeding season. J Appl. Nat. Sci. 2017; 9(3):1658-1661.
14. Koc AU, Karacaoglu M. Effects of rearing on the quality of queen honeybees *Apis mellifera* L. raised under the conditions of Aegean Region. Mellifera. 2004; 4(7):34-37.
15. Genc F, Emsen B, Dodologlu A. Effects of rearing period and grafting method on the queen bee rearing. J Applied Anim. Res. 2005; 27(1):45-48.
16. Cengiz M, Emsen B, Dodologlu A. Some characteristics of queen bees *Apis mellifera* L. rearing in queenright and queenless colonies. J Anim. Vet. Adv. 2009; 8(6):1083-1085.
17. Ahmed SB, Dar SA. Mass rearing of queen bees, *Apis mellifera* L. Hym: Apidae for bee colony development raised under the temperate conditions of Kashmir. The Bioscan. 2013; 8(3):945-948.
18. Waffa AK, Hanna MA. Some factors affecting the production of royal jelly. Proceedings of XXI International Beekeeping Congress, Preliminary Science, Meeting Summary Paper, 11-17 Aug, 1967, Maryland, USA. 1967; 22:61-62.
19. El-din HAS, Samni MA. Comparison of two types of queen cell cups for commercial royal jelly production in honey bee *Apis mellifera* L. colonies. Honey Bee Sci. 1990; 11(4):159-160.
20. Wilde J, Woyke J, Wilde M. Rearing honey bee queens in wax and plastic queen cell cups. Proceedings of 6th Asian Apicultural Association International Conference and World Apiexpo, 24th Feb- 1st March, 2002, Bangalore, India, 2002; 167.
21. Chang SY. Effects of size and type of queen cup on the production of royal jelly and acceptance by nurse bees. Master Thesis, National Chung Hsing University Taichung, Taiwan. 1977; 2: 201-79. Apic Abst (1979).
22. Weiss K. Influence of different types of cell cups on acceptance and queen weight in artificial queen rearing. Z Bie men forsch. 1967; 9:121-134.
23. Dodologlu A, Emsen B. Effects of larvae transfer conditions on queen bee productivity. J Applied Anim.

Res. 2007; 31(2):181-182.
24. Bognoczky J. Queen rearing in plastic cells. Proceedings of XXI International Beekeeping Congress Summary Paper, 11-17 Aug, 1967, Maryland, USA. 1967; 124:91.
25. Mahbobi A, Farshineh-Adl M, Woyke J, Abbasi S. Effect of the age of grafted larvae and the effects of supplemental feeding on some morphological characteristics of Iranian queen honey bees *Apis mellifera meda* Skorikov, 1929. J Apic. Sci. 2012; 56(1):93-98.
26. Okuyan S, Akyol E. The effects of age and number of grafted larvae on some physical characteristics of queen bees and acceptance rate of queen bee cell. Turkish J Agric. Food Sci. Technol. 2018; 6(11):1556-1561.