

## PERFORMANCE OF COLONIES WITH INSTRUMENTALLY INSEMINATED AND NATURALLY MATED QUEENS

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Received 11 July 2003; accepted 1 October 2003

### Summary

On the basis of data from central breeding evaluation, the honey yields of colonies from the following groups were compared: I. 1105 colonies with instrumentally inseminated queens (IIQ) with 1114 colonies with island mated queens (IQ) from 189 bee yards. II. 1656 colonies with IIQ with 2025 colonies with naturally (island and more or less safely controlled land) mated queens (NQ) from 308 other bee yards. In both cases bee yards were compared where colonies from both groups were simultaneously tested.

Results for I.: The average honey yield for IIQ was 37.9 kg and for IQ 38.0 kg. The difference was not significant. The regression of the annual yields results in an annual increase of 0.49 kg for IIQ and 0.52 kg for IQ. Results for II.: The average honey yield for IIQ was 37.4 kg and for NQ 37.0. The honey yields of the colonies with IIQ are significantly higher. The regression of the annual yields results in an annual increase of 0.28 kg for IIQ and 0.24 kg for NQ. The average rate of inbreeding had no influence on the results. With regard to honey production artificial insemination proves to be as good as natural mating.

**Keywords:** honey bee, instrumental insemination and natural mating, performance

### INTRODUCTION

Studies previously carried out comparing the performance of instrumentally inseminated queens and naturally mated queens produced very different results.

Roberts (1946) examined the honey yields from 3 groups of bee colonies, distributed in the USA, with a total of 31 instrumentally inseminated queens and 43 naturally mated queens. Comparatively, the honey yield production of the instrumentally inseminated queens was 115%.

Ruttner (1976) compared the colony performance of 45 instrumentally inseminated queens and 27 naturally mated queens in 5 locations in Germany. The colonies with instrumentally inseminated queens produced 3.5 kg (7%) more honey.

Harbo and Szabo (1984) compared 59 instrumentally inseminated queens and 59

naturally mated sister queens in 4 locations in Canada and the USA. 18 instrumentally inseminated queens and 34 naturally mated queens survived. The remaining small number of colonies with instrumentally inseminated queens produced comparatively little brood and only 50% honey yield.

Vesely (1984) tested 716 colonies with instrumentally inseminated Carnica queens in different locations in the former Czechoslovakia and ascertained honey yields of an average of 108% of the respective bee yard average.

Wilde (1987) compared 39 instrumentally inseminated queens with 19 naturally mated queens in Poland. The instrumentally inseminated queens produced 20% more honey.

Boigenzahn and Pechhacker (1993), in Austria, determined significantly higher

honey yields from 186 colonies with instrumentally inseminated queens (20.47 kg) compared to 399 colonies with queens mated in bee yards (19.02 kg; 93%). The honey yields from 46 colonies with uncontrolled mated queens were even lower at 87%.

Szalainé (1995), in Hungary, carried out a 2 year long study of groups of 8 bee colonies with instrumentally inseminated and naturally mated queens from the same descent as well as naturally mated queens of the same age from unknown descent. The instrumentally inseminated queens produced a significantly higher honey yield of 21.9 kg, compared with 17.9 kg from the naturally mated queens from the same descent and 11.8 kg from the naturally mated queens from unknown descent.

Gerula (1999) compared the performance of 85 colonies with instrumentally inseminated queens to 54 colonies with naturally mated queens in Poland. The colonies with naturally mated queens produced 13% more honey.

The low performance of instrumentally inseminated queens in some of the above studies could be due to: an insufficient amount of sperm, low genetic diversity, inbreeding, influence of CO<sub>2</sub> narcosis or damage to the queen's health caused by insemination technique attending workers and the somewhat shorter lifespan experienced in instrumentally inseminated queens.

In most cases, however, comparisons were made between instrumentally inseminated and more or less uncontrolled mated queens, and it can therefore be assumed that some of the instrumentally inseminated queens and their mating partners were at least partly selected breeding animals.

The aim of this study was to examine the possible difference between instrumentally inseminated and naturally mated queens, considering their possible genetic quality.

## MATERIALS AND METHODS

On the basis of data from performance tests and central breeding evaluation (Bienefeld and Reinhard 1995; Pritsch and Bienefeld 1995) in the years 1991-2000 the honey yields of colonies from the following groups were compared:

- I. instrumentally inseminated with queens mated on islands.

It can be assumed that, in both cases, queens were mated by purebred drones of comparable quality. 1105 colonies with instrumentally inseminated queens were compared with 1114 colonies with queens mated on islands from 189 test apiaries.

The average rate of inbreeding for workers/queens was 1.25/0.88% in the colonies with instrumentally inseminated queens, and 1.71/1.02% in the colonies with queens mated on islands.

- II. instrumentally inseminated with naturally mated queens.

Instrumental insemination was compared with all types of more or less controlled natural mating (mating stations on islands, line and race mating stations on land). From 308 test apiaries, 1656 colonies with instrumentally inseminated queens were compared with 2025 colonies with naturally mated queens.

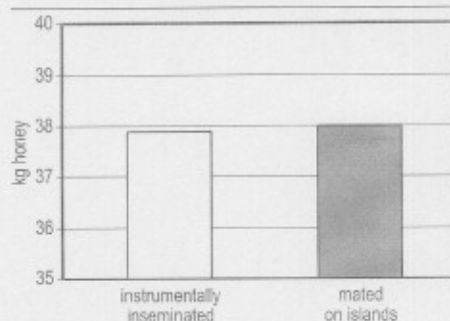
The average rate of inbreeding for workers/queens was 1.69/1.08% for the instrumentally inseminated and 1.62/1.16%, for the naturally mated.

For statistical reasons, only apiaries were used where queens that had been instrumentally inseminated or naturally mated on islands and on land were tested simultaneously.

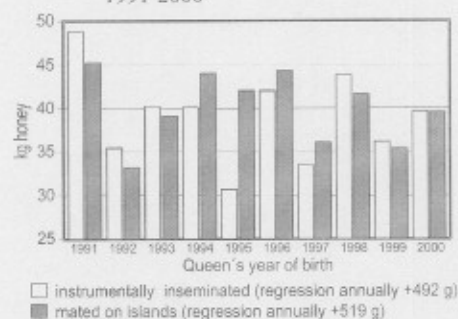
## RESULTS

- I. instrumental insemination compared with mating in island mating stations.

The average honey yield was 37.9 kg  $\pm$ 20.1 for the instrumentally inseminated



**Fig. 1.** Average yields for colonies with instrumentally inseminated queens (n=1105) and naturally mated queens in mating stations on islands (n=1114), 1991-2000



**Fig. 2.** Average yields for colonies with instrumentally inseminated queens and naturally mated queens (in mating stations on land and on islands)

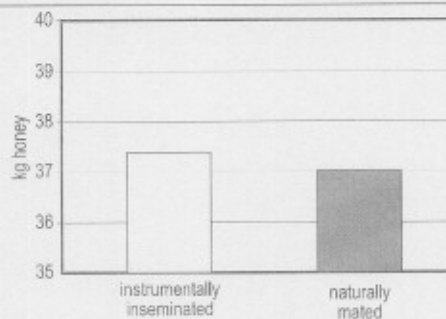
and 38 kg  $\pm$  19.5 for the island mated, and thus showed an equally high level (fig. 1). The difference in yields between both groups is not significant.

The regression of the annual yields (fig. 2) results in a slightly higher annual increase for the colonies with island mated queens.

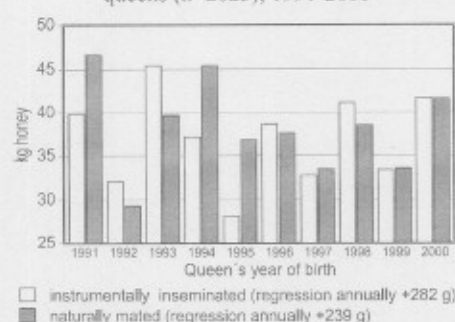
## II. instrumental insemination compared with natural mating in different mating stations.

The average honey yield was 37.4 kg  $\pm$  19.5 for the instrumentally inseminated, and 37 kg  $\pm$  18.5 (fig. 3) for the naturally mated.

The honey yields for colonies with instrumentally inseminated queens are significantly higher ( $P = 0.036$ ) than for colonies with naturally mated queens.



**Fig. 3.** Average yields for colonies with instrumentally inseminated queens (n=1656) and in mating stations on land and on islands naturally mated queens (n=2025), 1991-2000



**Fig. 4.** Average yields for colonies with instrumentally inseminated queens and naturally mated queens (in mating stations on land and on islands)

The regression of the annual yields (fig. 4) results in a slightly higher annual increase in colonies with instrumentally inseminated queens.

The rate of inbreeding was low in all the tested groups and was therefore not taken into account.

## DISCUSSION

In the majority of previous studies it was proven that bee colonies with instrumentally inseminated queens were superior to those with naturally mated queens regarding honey production. This was particularly convincing in the studies where larger numbers of colonies were used (Vesely 1984). The results from the studies by Boigenzahn and Pechhacker (1993) and

Szalainé (1995) show that the genetic level was the highest in the instrumentally inseminated and decreased in the queens from land mating stations and was the lowest in the uncontrolled mated queens and queens of unknown descent respectively.

In this study the honey production from a total of 5900 colonies in 497 apiaries distributed across Germany was examined. The genetic level was adjusted for by comparing instrumental inseminated queens with on islands controlled mated queens.

The performance of the tested colonies with instrumentally inseminated queens was not lower than colonies with island mated queens. As a result, it could not be determined that artificial insemination had a negative influence compared with natural mating. When compared with colonies from mixed natural mating (mated on islands or in bee yards on land) the honey yields were significantly higher. From this it can be concluded that possible mating with non-selected drones in land mating stations did not result in increased performance because of heterosis, but in fact a lower yield was caused by a number of drones from non-selected colonies.

Instrumental insemination is not only the most reliable form of mating for queen bees but proves to be as equally efficient as natural mating. Given small inbreeding and uncontrolled natural mating, a decrease in production caused by non-selected mating partners is more likely than an increase in production caused by heterosis.

## REFERENCES

- Bienefeld K., Reinhard F. (1995) - A new concept for calculation breeding values in the honeybee. *Proc. XXXIV Intern. Apic. Congr. Lausanne*: 96-99
- Boigenzahn C., Pechhacker H. (1993) - Über die Art der Anpaarung. *Bienenvater* 114:151-152
- Gerula D. (1999) - Comparison of honey production of caucasian and carniolan bees in years with nectar flow and honeydew flow. *Pszczel. Zesz. Nauk.* 43:59-69
- Harbo J. R., Szabo T. I. (1984) - A comparison of instrumentally inseminated and naturally mated queens. *J. apic. Res.* 23:31-36
- Pritsch G., Bienefeld K. (1995) - Central evaluation of performance testing in honey bees. *Pszczel. Zesz. Nauk.* 39:221
- Roberts W. C. (1946) - The performance of the queen. *Amer. Bee J.* 86:185-186, 211
- Ruttner F. (1976) - Besamte Königinnen im Leistungstest. *Imkerfreund* 31:351-353
- Szalainé Matray E. (1995) - Einige Ergebnisse mit künstlicher Besamung von Bienenköniginnen in Ungarn. *Pszczel. Zesz. Nauk.* 39:61-69
- Vesely V. (1984) - Der Einfluß der künstlichen Besamung auf die Leistungszucht. *Bienenvater* 105:332-335, 366-370
- Wilde J. (1987) - Development and productivity of honeybee colonies with naturally and artificially inseminated queens. *XXXI Intern. Apic. Congr. Warsaw*, 442-444

## WYDAJNOŚĆ RODZIN PSZCZELICH Z MATKAMI UNASIENIONYMI SZTUCZNIE I NATURALNIE

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### Streszczenie

Na podstawie danych z oceny materiału hodowlanego, prowadzonej w Niemczech w latach 1991 - 2000, porównano zbiory miodu z rodzin z następujących grup:  
I. Łącznie w 189 pasiekach porównywano 1105 rodzin z matkami unasienionymi sztucznie z 1114 rodzinami z matkami unasienionymi naturalnie na wyspach. W obu przypadkach

kojarzenie matek było kontrolowane, a trutnie pochodziły z linii hodowlanych podobnej jakości. II. W 308 innych pasiekach porównywano 1656 rodzin z matkami unasienionymi sztucznie z 2025 rodzinami a matkami unasienionymi naturalnie przy lepszej lub gorszej kontroli kojarzeń na wyspach lub na lądzie stałym. W obu grupach pod uwagę brano tylko te pasieki, w których wydajność rodzin z matkami sztucznie i naturalnie unasienionymi oceniana była równocześnie. We wszystkich badanych grupach natężenie chowu krewniaczego (poziom inbrodu) był bardzo niski.

Średnie zbiory miodu w grupie I w rodzinach z matkami unasienionymi sztucznie wynosiły 37,9 kg ( $\pm 20,1$ ), a w rodzinach z matkami unasienionymi naturalnie - 38 kg ( $\pm 19,5$  kg) i nie różniły się statystycznie (fig. 1). Regresja rocznych zbiorów miodu wykazała nieco większy roczny wzrost w rodzinach unasienionych naturalnie na wyspach (fig. 3).

Średnie zbiory miodu w grupie II (fig. 2) w rodzinach z matkami unasienionymi sztucznie wynosiła 37,4 kg ( $\pm 19,5$ ), a w rodzinach z matkami naturalnie unasienionymi 37 kg ( $\pm 18,5$ ). Zbiory miodu w rodzinach z matkami unasienionymi sztucznie były istotnie wyższe ( $P = 0,036$ ). Regresja rocznych zbiorów miodu wykazała nieco większy wzrost w rodzinach z matkami unasienionymi sztucznie.

Powyższe wyniki wskazują, że sztuczne unasienienie matek nie miało negatywnego wpływu na wydajność rodzin pszczoł (grupa I). Rodziny z takimi matkami dawały nawet istotnie wyższą produkcję miodu w porównaniu z rodzinami, których matki, unasienione naturalnie, mogły kojarzyć się z trutniami nieselekcyjowanymi (grupa II). Przy niskim poziomie wsobności i niekontrolowanym doborze bardziej prawdopodobne jest obniżenie produkcji spowodowane kojarzeniem matek z nieselekcyjowanymi trutniami, niż jej zwiększenie

**Słowa kluczowe:** wydajność miodowa, unasienianie sztuczne, unasienianie naturalne.