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# VARIABILITY OF PRODUCTION CHARACTERISTICS OF DISTINGUISHED LINES OF BEES IN WESTERN SERBIA

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**Abstract:** Condition for achieving high performance results in beekeeping is focused on the use of high-quality breeding queen bee. Because that a large amount of research are based on the examination of properties of selected lines of bees and choosing the best queen mothers in the aim of selection and improving the production characteristics of honey bees from the territory of Serbia. The amount of bees, brood, honey and pollen was investigated in two spring and one autumn survey and productivity controlled in the pasture of accacia. Line 1 had the greatest amount of brood (1.23, 4.04 and 5.39), while line 3 had the best spring development. The best quality of brood in all three exams had the lines 1 and 3 (3.00, 3.00 and 2.95) as well as the best productivity compared to the average yield of all other three lines. All tested lines were exhibited variability, which provides enough possibility for their further improvement and single out the mother queenbees with best results.

**Key words:** beekeeping, honey bee lines, production characteristics, breeding

## Introduction

Domestic animals have been raised and bred for thousands of years. When the modern breeding techniques were introduced into everyday use, the man had already created some breeds of domestic animals and for the further development of selection man had followed the established path *(Nedić et al., 2009)*. However, in beekeeping, some subspecies of bees were developed under the influence of environment and geographical spreading, and have greater variability in

comparison to races of other domestic animals. In order to achieve excellent production results, for which the beekeepers are most interested, it is necessary to choose the right parents for future generations. However, that task is very difficult due to the fact that quantitative traits are conditioned by the influence of several genes. Also, the important production traits, such as honey yield, are being influenced by a number of paragenetic factors *(Hellmich et al., 1985; Milne, 1985)*. The honey yield per colony often depends on the weather conditions during flowering time, type and proximity of honey pasture, the strength of colony *(Doull, 1980; Moritz, 1986)*, and also could depend on the genetic constitution of queen bee *(Oldroyd and Goodman, 1990)*. *Szabo and Lefkovitch (1989)* have found that honey production was in significant correlation with the number of worker bee cells in the nest (r = +0.65) and worker bee population (r = +0.62). The rapid brood development in the spring is one of racial traits of the Carniolan honey bee. The brood development is in significant correlation with winter food supply *Mladenović et al. (2002)* and the presence of pollen in the spring *Georgijev et al. (2003)*. Identification and selection of lines of bees and queen mothers with above average production traits from the population is a primary task in the selection of bees. Therefore, the aim of this research was to study the most important productive traits of some bee lines from Western Serbia and give recommendations for breeding work and spreading of the best lines in practice.

## Materials and Methods

This research was carried out on the apiary of the selection center in Kraljevo (west Serbia) and four bee lines of the *Apis mellifera carnica* race were included in the evaluation procedure. The bee colonies were put into standard Langstrot-Rut beehives and at the start of the trial they were equalized in terms of strength (population of bees). The evaluation was performed in two spring examinations (I and II) before the beginning of black locust pasture and in the autumn examination in the first 10 days of September. In order to do so, the individual frame was though to be divided in 10 horizontal parts (5 parts per side), a method described in the 'Rulebook for measuring of the breeding livestock traits' *(Službeni Glasnik RS 21/96)*. The numbers represent the sum of values recorded for each trait from all frames of the colony. The following productive traits were examined using the above method: the surface of frame covered with bees, brood, honey and pollen. Brood quality was recorded using a system of points: 3 = excellent (without empty cells), 2 = good (present of few individual empty cells), 1 = unpleasent (spotty brood). Gentleness of bees was also evaluated using the point system: 4 = keep still, 3 = restless, 2 = runs for the honey, 1 = leaves the comb. The productivity was measured by using a modified *Szabo* method *(1982)*. The weight of the colonies was recorded on day 1 and day 3 of the foraging season during

black locust pasture. The bee lines used in this research work were: 1= Kk, 2 = Tr, 3 = Me, 4 = Dc.

The data were analyzed by one way ANOVA analysis investigating the traits of 4 different bee lines during the same rearing conditions for the period 2006-2008.

## Results and Discussion

One of the major aims in beekeeping is a numerous bee colony both in spring and during honey collecting, and also to secure a sufficient number of worker bees for winter period for getting through the winter. For this reason the quantity of bees per colony is a very important economic trait in a bee.

Results from all productivity traits are presented in Table 1. In general, line 1 had the largest surface of bees during autumn and I spring examination (2.10 and 3.27 frames respectively) while line 3 followed closely by line 1 had the largest surface of bees during II spring exam (with 6.19 and 6.11 frames of bees respectively). The greatest difference between the I and II spring examination was observed in line 3 (3.65 frame), what seems to confirm the statement that the Carniolan bee line, after its hibernation in a weaker colony, develops rapidly up to the time of a black locust pasture *(Georgijev and Plavša, 2005; Nedić, 2009).* However, no significant differences were found between the lines ($P>0.01$) in all examinations in respect of honeybee surface (Table 2).

The largest average surface of brood in the all three examinations was observed in the line 1 (1.23, 4,04 and 5,39 frame). However the higher difference in the surface of brood between spring I and spring II exam was observed in line 3 (increase 1.4 frame), folowed closely by line 1 (increase of 1.35 frame). This fact indicates a very high potential for a fast spring development in the trial bee lines. For a bee colony to have the highest possible productivity during fruit tree flowering black locust pasture it needs to have a dynamic spring development. Therefore it is extremelly important to have a great number of broods cells of all ages *(Jevtić, 2007; Nedić et al., 2009)*.

**Table 1. Descriptive statistics for the examined traits of honeybee lines**

| Fc. | Autumn exam | | | | Fc. | I Spring exam | | | | Fc. | II Spring exam | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ln. | n | $\bar{x}$ | Sd | Sd err. | Ln. | n | $\bar{x}$ | Sd | Sd err. | Ln. | n | $\bar{x}$ | Sd | Sd err. |
| Honeybee surface (1/10 frame) | | | | | | | | | | | | | | |
| 1 | 19 | 2,10 | 0,87 | 0,20 | 1 | 19 | 3,27 | 1,33 | 0,30 | 1 | 19 | 6,11 | 1,81 | 0,41 |
| 2 | 23 | 1,54 | 1,14 | 0,24 | 2 | 20 | 2,65 | 1,24 | 0,28 | 2 | 20 | 5,33 | 1,58 | 0,35 |
| 3 | 22 | 1,61 | 0,67 | 0,14 | 3 | 22 | 2,54 | 1,16 | 0,25 | 3 | 22 | 6,19 | 1,53 | 0,33 |
| 4 | 21 | 1,73 | 1,03 | 0,22 | 4 | 19 | 2,86 | 1,33 | 0,30 | 4 | 19 | 5,63 | 1,46 | 0,34 |
| Av. | 85 | 1,73 | 0,96 | 0,10 | | 80 | 2,81 | 1,27 | 0,14 | | 80 | 5,82 | 1,61 | 0,18 |
| Brood surface (1/10 frame) | | | | | | | | | | | | | | |
| 1 | 19 | 1,23 | 0,56 | 0,13 | 1 | 19 | 4,04 | 1,12 | 0,26 | 1 | 19 | 5,39 | 1,23 | 0,28 |
| 2 | 23 | 0,96 | 0,60 | 0,12 | 2 | 20 | 3,55 | 1,04 | 0,23 | 2 | 20 | 4,65 | 1,14 | 0,25 |
| 3 | 22 | 0,97 | 0,29 | 0,06 | 3 | 22 | 3,87 | 0,87 | 0,19 | 3 | 22 | 5,27 | 0,98 | 0,21 |
| 4 | 21 | 0,90 | 0,37 | 0,08 | 4 | 19 | 4,04 | 1,17 | 0,27 | 4 | 19 | 5,23 | 0,90 | 0,21 |
| Av. | 85 | 1,01 | 0,48 | 0,05 | | 80 | 3,87 | 1,05 | 0,12 | | 80 | 5,14 | 1,09 | 0,12 |
| Honey surface (1/10 frame) | | | | | | | | | | | | | | |
| 1 | 19 | 6,05 | 1,15 | 0,26 | 1 | 19 | 2,85 | 0,83 | 0,19 | 1 | 19 | 3,16 | 1,13 | 0,26 |
| 2 | 23 | 4,67 | 1,72 | 0,36 | 2 | 20 | 2,32 | 0,90 | 0,20 | 2 | 20 | 2,57 | 1,40 | 0,31 |
| 3 | 22 | 5,00 | 1,70 | 0,36 | 3 | 22 | 2,46 | 1,18 | 0,25 | 3 | 22 | 2,71 | 1,58 | 0,34 |
| 4 | 21 | 5,07 | 1,81 | 0,40 | 4 | 19 | 2,22 | 0,60 | 0,14 | 4 | 19 | 2,68 | 1,05 | 0,24 |
| Av. | 85 | 5,16 | 1,68 | 0,18 | | 80 | 2,46 | 0,93 | 0,10 | | 80 | 2,78 | 1,31 | 0,15 |
| Fc. | Autumn exam | | | | Fc. | I Spring exam | | | | Fc. | II Spring exam | | | |
| Ln. | n | $\bar{x}$ | Sd | Sd err. | Ln. | n | $\bar{x}$ | Sd | Sd err. | Ln. | n | $\bar{x}$ | Sd | Sd err. |
| Pollen surface (1/10 frame) | | | | | | | | | | | | | | |
| 1 | 19 | 0,13 | 0,19 | 0,04 | 1 | 19 | 0,60 | 0,51 | 0,12 | 1 | 19 | 0,66 | 0,55 | 0,13 |
| 2 | 23 | 0,21 | 0,29 | 0,06 | 2 | 20 | 0,47 | 0,30 | 0,07 | 2 | 20 | 0,61 | 0,39 | 0,09 |
| 3 | 22 | 0,19 | 0,21 | 0,04 | 3 | 22 | 0,46 | 0,36 | 0,08 | 3 | 22 | 0,58 | 0,49 | 0,11 |
| 4 | 21 | 0,19 | 0,19 | 0,04 | 4 | 19 | 0,52 | 0,34 | 0,08 | 4 | 19 | 0,58 | 0,47 | 0,11 |
| Av. | 85 | 0,18 | 0,22 | 0,02 | | 80 | 0,51 | 0,38 | 0,04 | | 80 | 0,61 | 0,47 | 0,05 |
| Brood quality (mark from 3 to 1) | | | | | | | | | | | | | | |
| 1 | 19 | 3,00 | 0,00 | 0,00 | 1 | 19 | 3,00 | 0,00 | 0,00 | 1 | 19 | 2,95 | 0,23 | 0,05 |
| 2 | 23 | 3,00 | 0,00 | 0,00 | 2 | 20 | 2,95 | 0,22 | 0,05 | 2 | 20 | 2,95 | 0,22 | 0,05 |
| 3 | 22 | 3,00 | 0,00 | 0,00 | 3 | 22 | 3,00 | 0,00 | 0,00 | 3 | 22 | 2,95 | 0,21 | 0,05 |
| 4 | 21 | 2,95 | 0,22 | 0,05 | 4 | 19 | 2,84 | 0,37 | 0,09 | 4 | 19 | 2,89 | 0,32 | 0,07 |
| Av. | 85 | 2,99 | 0,11 | 0,01 | | 80 | 2,95 | 0,22 | 0,02 | | 80 | 2,94 | 0,24 | 0,03 |
| Gentleness (mark from 4 to 1) | | | | | | | | | | | | | | |
| 1 | 19 | 3,89 | 0,32 | 0,07 | 1 | 19 | 3,68 | 0,48 | 0,11 | 1 | 19 | 3,84 | 0,37 | 0,09 |
| 2 | 23 | 3,91 | 0,29 | 0,06 | 2 | 20 | 3,85 | 0,37 | 0,08 | 2 | 20 | 4,00 | 0,00 | 0,00 |
| 3 | 22 | 4,00 | 0,00 | 0,00 | 3 | 22 | 3,68 | 0,48 | 0,10 | 3 | 22 | 4,00 | 0,00 | 0,00 |
| 4 | 21 | 3,81 | 0,60 | 0,13 | 4 | 19 | 3,68 | 0,48 | 0,11 | 4 | 19 | 4,00 | 0,00 | 0,00 |
| Av. | 85 | 3,91 | 0,37 | 0,04 | | 80 | 3,73 | 0,45 | 0,05 | | 80 | 3,96 | 0,19 | 0,02 |

Fc. – Factor; Ln. – Line; Av. – Average.

Line 1 had also the largest average surface of honey (6.05, 2,85 and 3,16 frames) as well as the the largest surface of comb containing pollen (0.60 and 0.66 frames for spring I and spring II exam) showing its great capacity to supersede the lack of pollen from autumn period. However, no significant differences (P>0.01) were observed between the lines (Table 2).

**Table 2. Results of analysis of one way ANOVA for examined traits**

| Factor | Autumn exam | | I Spring exam | | II Spring exam | |
|---|---|---|---|---|---|---|
| | $F_{exp.}$ | p | $F_{exp.}$ | p | $F_{exp.}$ | p |
| | Honeybee surface | | | | | |
| Line | 1,380 | 0,255 | 1,304 | 0,279 | 1,317 | 0,275 |
| | Brood surface | | | | | |
| Line | 1,896 | 0,137 | 0,908 | 0,441 | 1,910 | 0,135 |
| | Honey surface | | | | | |
| Line | 2,683 | 0,052 | 1,785 | 0,157 | 0,740 | 0,531 |
| | Pollen surface | | | | | |
| Line | 0,478 | 0,699 | 0,526 | 0,666 | 0,128 | 0,943 |
| | Brood quality | | | | | |
| Line | 1,016 | 0,390 | 2,359 | 0,078 | 0,252 | 0,860 |
| | Gentleness | | | | | |
| Line | 0,979 | 0,407 | 0,680 | 0,567 | 3,622 | 0,017* |

* - P<0.05.

*Jevtić (2007)* established the average surface of bee pollen in spring examination to be between 0.28 and 0.66 frames for different bee lines, while in the autumn examination it was between 0.26 and 0.47 frames.

The higher scores (but not significantly higher) for brood quality in all three examinations was observed in line 1 (3.00, 3.00 and 2,95 points respectively) while the line 4 had the lowest scores per exam (2.95, 2.84 and 2.89 points) (Table 2). The scores published by *Nedić (2009)* closely correspond to the values in our study.

The sixth studied trait, gentleness, was similar in all lines during autumn examination with line 3 having the higher value (4.00 points), while in the I spring exam line 2 had the best calmness (3.85 points). Only during autumn examination the gentleness of line 1 was significantly lower (P<0.05) than the rest (3.84 points) (Table 1, 2).

Average nectar income during the three days of black locust flow for all lines is presented in Table 3. Line 1 collected the highest amounts of nectar (10.42 kg), followed by line 4 (8.72 kg). However, differences between the lines were not significant (P>0.01; F value= 1,060; P=0.371).

**Table 3. Descriptive statistics for the productivity test of examined honeybee lines**

| Line | n | $\bar{x}$, kg | Sd | Sd err. |
|---|---|---|---|---|
| 1 | 19 | 10,42 | 6,27 | 1,44 |
| 2 | 20 | 7,28 | 6,23 | 1,39 |
| 3 | 22 | 7,68 | 5,10 | 1,09 |
| 4 | 19 | 8,72 | 6,58 | 1,55 |
| Average | 80 | 8,47 | 6,04 | 0,68 |

*Georgijev (2006)* previously studied productivity of different honeybee lines in Timok region (productivity varied from 4,78 kg to 8,07 kg) and those results were different from our present study. The values published by *Nedić (2009)* for the productivity of the different lines of *Apis mellifera carnica* Poll. from Serbia closely correspond to the results in our study.

# Conclusion

On the basis of the research results on productive traits: surface of bees, surface of brood, surface of honey, surface of pollen, brood quality, gentleness and productivity in the four lines of honey bee *Apis mellifera carnica* Poll. on the territory of Serbia the following can be concluded:

The studied lines have displayed characteristic productive traits and among them bees of the line 1 showed in general the best results for the properties of surface of: bees, brood, honey and pollen, and had the highest yield of honey (10.42 kg). The best brood quality (3.0, 3.0 and 2.95) had a bee line 1 and 3, and the best gentleness were in line 2.

The present variability provides enough room for further improvement of the analyzed traits in a desired direction and a possibility to separate outstanding lines, whose genetical or morphometrical differences could also acount for differences in productive traits.

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# Varijabilnost proizvodnih osobina izdvojenih linija pčela u Zapadnoj Srbiji

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## Rezime

U dvogodišnjem istraživanju ispitivano je četiri odabrane linije medonosne pčele na području Zapadne Srbije. Proizvodne karakteristike praćene su prema standardnoj metodologiji. Na osnovu rezultata istraživanja utvrđeno je da je najveću površinu pčela imala linija 1 (u jesenjem i prvom prolećnom pregledu: 2,10 i 3,27 rama), dok je u drugom prolećnom pregledu najviše pčela imala linija 3 (6,19 rama). Utvrđene razlike u površini pčela nisu bile statistički značajne (P>0.01). Najbolji prolećni razvoj legla između prva dva prolećna pregleda utvrđen je u liniji 3 (povećanje za 1,4 rama) i liniji 1 (povećanje za 1,35 rama). Najveću površinu meda i polena imala su društva linije 1. Najbolji kvalitet legla, po pregledima utvrđen je u linijama 1 i 3.

Na osnovu rezultata istraživanja, utvrđeno je da su linija 1 i 3 imale najbolje proizvodne karakteristike. Postojeća varijabilnost ispitivanih karakteristika pčela pruža mogućnost daljeg usavršavanja linija i širenja genetskog napretka na području Srbije, pri čemu prednost treba dati umnožavanju matica na bazi biološkog materijala pčela linija 1 i 3.

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