

THE CORRELATION BETWEEN COLONY STRENGTH, FOOD SUPPLY AND HONEY YIELD IN HONEY BEE COLONIES

G. Jevtić¹, M. Mladenović², B. Anđelković¹, N. Nedić², D. Sokolović¹, R. Štrbanović¹

¹Institute for Forage Crops, 37000, Kruševac, Republic of Serbia

²Faculty of Agriculture, 11080, Belgrade-Zemun, Republic of Serbia

Corresponding author: goran.jevtic@ikbks.com

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Abstract: The dependence between traits is determined by the correlation coefficients. The experiment was conducted using two generations of honey bee. The first generation consisted of the mother queen bees, and the second were their offspring. The experiment lasted for two years per generation. In the first generation, the correlation between colony strength in the both spring and autumn inspection and the honey yield was high. Considering food supply, the high correlation between food supplies in autumn and honey yield was determined. In the offspring colonies, the high correlation was determined between colony strength in autumn and honey yield. The colony strength in the spring inspection and honey yield were in medium correlation. Also, the medium correlation was determined between honey yield and brood area in the spring inspection. Other studied characteristics in the offspring colonies were not significantly correlated with honey yield.

Key words: honey bee, correlation, colony strength, honey yield

Introduction

Determination of the correlation between different traits is especially important in honey bee breeding programs. Correlation can be positive or negative, and there are, also, such traits that show no correlative relations.

The many factors have the effect on the pollen amount in the colony. These factors can be either negative or positive correlated (the colony size, brood quantity, surrounding vegetation, empty space in the hive etc.). *Лебедев, (2001)* points that the pollen input is in high positive correlation with the colony strength and with the brood quantity and appearance. *Georgijev et al. (2003)*, determined that the correlation coefficient between brood quantity and pollen input in spring is extremely high and is lower in autumn. In the colonies with the higher brood level,

the supplies of pollen are rapidly decreased due to extensive consumption for brood feeding.

The colony size has the effect on the pollen gathering. It has been determined that the smaller colonies collect significantly smaller amounts of the pollen. Also, it has been determined that the number of the foragers is increased if the empty combs are added between the combs with brood (*Keller et al., 2005*). The amount of the pollen in the colony is increased proportionally to the amount of the brood (*Georgijev et al., 2003*). The colony strength has the high influence on the gathering and consumption of the pollen (*Jevtić et al., 2005*). If the number of the honey bees is higher in the October then their number will be higher in the March of next year (*Liebig, 2002*). During two-year study *Georgijev and Plavša (2005)* proved that there is positive correlation between the honey bee and brood quantity and the honey yield.

The aim of this work was to determine the correlation between production properties of honey bee (colony strength and food supplies), determined in the spring and autumn inspections, and the honey yield.

Materials and Methods

The correlation coefficients were calculated for the production traits. These coefficients were calculated separately for both the mother queen bee colonies and for daughter queen bee colonies.

The correlation coefficients were calculated using the following formula (*Hadživuković, 1991*):

$$r = \frac{\sum_{i=1}^n (X_i - \bar{X})(Y_i - \bar{Y})}{\sqrt{\sum_{i=1}^n (X_i - \bar{X})^2 \sum_{i=1}^n (Y_i - \bar{Y})^2}}$$

The following scale was used for the assessment of correlation strength:

0.00 - 0.30 - weak correlation

0.31 - 0.60 - medium strong correlation

0.61 - 0.90 - strong correlation

The standard correlation coefficient errors were calculated using the relation (*Hadživuković, 1991*):

$$S_r = \frac{\sqrt{1-r^2}}{\sqrt{n-2}}$$

The testing of the significance of the correlation coefficients was done using the t-test with the use of the following formula, as well as the table by *Snedecor (Hadživuković, 1991)*:

$$t = \frac{r}{Sr}$$

n - 2 degrees of freedom from the table of t-distribution, where n is the number of colonies in the experiment.

Results and Discussion

Correlation coefficients of the basic traits of parents

In the parent colonies It has been determined that there is a strong correlation between the amount of bees in the spring inspection, brood quantity and the amount of pollen in the both inspections, and the medium strong correlation with the amount of bees in the autumn inspection (Table 1).

Table 1. Correlation coefficients of productive traits in mother colonies

Trait	Bees - autumn	Brood - spring	Brood - autumn	Honey - spring	Honey - autumn	Pollen - spring	Pollen - autumn	Honey yield
Bees - spring	0.51*	0.81**	0.42	0.21	0.30	0.70**	0.69**	0.64**
Bees - autumn		0.57*	0.82**	-0.14**	0.29	0.23	0.47	0.73**
Brood - spring			0.39	-0.08	-0.13	0.47*	0.72**	0.62**
Brood - autumn				-0.02	0.37	0.26	0.60**	0.66**
Honey - spring					0.57*	0.22	0.15	0.21
Honey - autumn						0.44	0.46	0.60*
Pollen - spring							0.80**	0.51**
Pollen - autumn								0.72**

It was, also, found that the amount of bees in the fall inspection is in strong correlation with the brood quantity in the fall and the honey yield. It is, also, in the medium strong correlation with the brood quantity in the spring. The brood quantity in the spring was in the strong correlation with quantity of honey in spring, and in medium strong correlation with honey and pollen yield in autumn.

The brood quantity in autumn was in the strong positive correlation with the honey yield, and in medium strong positive correlation with pollen quantity in autumn.

The quantity of the honey in spring was in low correlation with the most of traits except with the quantity of the honey in autumn (medium strong). It was, also, in the negative correlation with some traits (quantity of honey bees and the quantity of brood in both inspections). The quantity of honey per colony in autumn was mostly in the weak or medium strong correlations with the other traits.

In the parent colonies, the honey yield was in strong and medium strong correlations with the majority of the studied traits, except with the honey yield in the spring with which was in the low correlation. The amount of honey in the spring and fall inspections showed the lowest correlation with the observed traits.

Correlation coefficients of the offspring traits

When testing offspring (queen bee daughters), in the third and fourth year, the most of traits, that were in positive correlation in their parents, now are, also, correlated. The only difference is that, unlike the parents, the yield of honey per colony and the quantity of honey and pollen in both inspections were in lower correlation (Table 2).

Table 2. Correlation coefficients of the production traits in offspring colonies

Trait	Bees - autumn	Brood - spring	Brood - autumn	Honey - spring	Honey - autumn	Pollen - spring	Pollen - autumn	Honey yield
Bees - spring	0.52*	0.91**	0.25	0.03	-0.21	0.26	0.24	0.56*
Bees - autumn		0.51*	0.24	0.19	0.28	0.01	0.10	0.71**
Brood - spring			0.45	0.04	0.18	0.39	0.33	0.55*
Brood - autumn				0.20	0.25	0.15	0.69**	0.37
Honey - spring					0.59*	-0.30	0.05	0.16
Honey - autumn						-0.23	0.12	0.52
Pollen - spring							0.17	0.18
Pollen - autumn								0.29

The amount of bees in the spring inspection was in strong correlation with the brood quantity in the spring and, also, in the medium strong correlation with the amount of bees in the autumn and with the honey yield. The amount of bees in the

autumn inspection was in strong correlation with the honey yield and in the medium correlation with the amount of brood in the spring.

Food supplies (the amount of honey and pollen) was in the low or negative correlation with the most of the observed traits in the both inspections.

Bilaš and Krivcov (1991) claim that there is positive correlation between the length of Caucasian honey bee proboscis and the honey yield. Due to that, the proliferation of colonies with the longer proboscis gives the offspring colonies with higher production of honey. However, it is found in the same research that the length of proboscis is in negative correlation with queen bee fertility and resilience to nosema disease. Besides the proboscis length, the honey production of the colony is, also, in strong correlative relation with the front wing length, the third tergite length, maximum queen bee fertility, the intensity of the flight, etc. Several authors (*Gold, 1937; Miller, 1939; Bessonnet, 1945; Bichtler, 1951; Hunkeller, 1953*) claim that the honey yield is not in correlation to the external (morphological) traits of honey bees.

In the two-year research of *Georgijev and Plavša (2005)* it has been proven that the quantity of bees and the quantity of brood are in the positive correlation with the colony productivity, meaning with the honey yield. *Lebedev (2001)* announces that the input of the pollen is in the strong correlative dependence ($r = 0.82$) with the colony strength and the brood quantity per colony. *Georgijev et al. (2003)* have determined that the correlation coefficient is extremely high between the brood quantity and the amount of pollen in the spring ($r = 0.93$), while in the fall is much lower ($r = 0.16$). The honey yield is in correlation with the lifespan of worker honeybee (*Milne, 1980*), with honey input per day (*Szabo, 1981*), with the brood quantity (*Georgijev and Plavša, 2005*), and with other factors.

Mladenović (2006) states that the productivity of domestic Carniolan honey bee colonies is in direct correlation with the meteorological factors and the capacity of the honey flora, and then depends on the honey bee belonging to the different strains and eco-types.

Conclusion

Two generations (4 years) of honey bee colonies were studied. During the research it has been determined that some production traits have a great impact on the overall productivity of colony, i.e. the honey yield.

In the first (queen bee mothers) and second generation (queen bee daughters) there is a very strong correlation between the honey yield and the traits determining the strength of the colony (the quantity of bees and brood).

The smaller degree of correlation was determined between the food supply (the amount of honey and pollen) and the total honey yield per colony. This is especially evident in second generation.

Certain production traits have been in very strong correlation, for example the quantity of bees and the quantity of brood in the spring.

However, there were, also, negative correlations, such as the correlation between amount of honey in the spring and the number of bees in the autumn and the amount of pollen in spring and autumn.

Korelacija između snage, zaliha hrane i prinosa meda kod pčelinjih društava

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Rezime

Stepen zavisnosti jedne osobine od druge utvrđuje se na osnovu koeficijenta korelacije. Ogled je sproveden na dve generacije društava medonosne pčele. U prvoj generaciji praćene su majke matice, a u drugoj njihovo potomstvo. Ispitivanje po svakoj generaciji trajalo je po dve godine.

U prvoj generaciji utvrđena je visoka korelacija između snage društava na prolećnom jesenjem pregledu i prinosa meda po društvu. Kod zaliha hrane utvrđena je visoka korelacija između prinosa meda i zaliha hrane na jesenjem pregledu.

Kod potomstva utvrđena je visoka korelacija između snage društava na jesenjem pregledu i prinosa meda. Snaga društva na prolećnom pregledu i prinos meda pokazuju srednji stepen korelacije. Takođe, utvrđen je i srednji stepen korelacije između prinosa meda i površine legla na prolećnom pregledu. Ostale praćene karakteristike potomačkih društava nisu pokazivale značajan stepen korelacije sa prinosom.

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