FORAGING AND HOARDING EFFICIENCY IN BUCKFAST PUREBREDS AND NORWEGIAN BLACK BEE (*A. m. mellifera*) HYBRIDS PART 1. ANNUAL HONEY YIELD VERSUS RESULTS OF FIELD FLYING CAGE AND LABORATORY TESTS

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Summary

Honey yield measured throughout the entire season was compared with the foraging and hoarding efficiency (sugar syrup/candy) in Buckfast (Bcf) and in Norwegian Black Bee queens x Caucasian drone hybrids (Nor x Cau) using both field and laboratory cage tests. During the field tests artificially made nucleus colonies were tested under flying cages. Nor x Cau do not seem to be overly sensitive to adverse weather conditions. Bcf bees were efficient both in good and in worse weather and they represent more efficient foraging/hoarding behaviour. Nor x Cau, which may be encountered in the Lublin region did not prove to be a good combination. Results of the cage tests correspond to the honey yield measured in the full size colonies. The amount of syrup foraged in the test under the flying cages corresponded to the amount of the stored syrup supplies. Therefore combining these two tests results in the proper assessment of the hoarding behaviour.

Keywords: hoarding, foraging, honey yield, cage tests, *A. mellifera*.

INTRODUCTION

Adapting one of numerous breeds or lines of bees to local environmental conditions is of considerable importance to beekeepers. In their search for the „best bee", Polish beekeepers are willing to use imported breeds, even those which have not been officially recognised. A growth in the import of queens belonging to foreign breeds may be expected due to the accession of Poland to the European Union. Therefore, over the last few years, our laboratory has been conducting research on various productivity and behaviour aspects of imported breeds in south-eastern Poland. Subsequent apiary seasons differ significantly with regard to weather and pollen/nectar flow conditions, which may be the reason for different opinions on each breed. Due to that fact, only long-term research, lasting many years may bring an answer as to the real usefulness of a given breed. The present study is a part of a such research.

It may be stated, on the basis of contacts with beekeepers, that Buckfast bee is enjoying a growing interest in our country. That breed is also highly praised by professional beekeepers from such countries as: Israel, France, Luxembourg, Germany, Denmark, Sweden or the United States (Büchler 1998). Therefore, this bee has been the object of our interest over the last few years (Paleolog et al. 1999, Paleolog and Flis 1999).

Recently, much attention has been paid to European bee, *A. mellifera mellifera* (Neumayer 2003). It was the latter breed

that was used for assisting the setting up local populations of *Apis mellifera mellifera* in Poland (Prabucki and Chuda-Mickiewicz 2002), as well as for creating productive hybrids (Prabucki and Chuda-Mickiewicz 1998). That is also why that breed was the subject of our previous research (Paleolog 2002, Paleolog et. al. 1999).

Because of the economic results of apiaries, honey yield is a trait of particular interest to practising beekeepers. As a complex trait it is dependent on, among other things, the efficiency of nectar sources utilisation, the extent in which nectar is used to satisfy the livelihood needs of a colony and, finally, the effectiveness of processing nectar into food hoards. These processes are conditioned by both environmental and hereditary factors. Evaluation such traits, however, meets with difficulties. Hence, some researchers used laboratory assays in order to concentrate on genetic background and to minimise the influence of the environment (Milne 1985). Nevertheless, the opinions on how the results of field and laboratory tests can be correlated differ (Paleolog and Flis 1999, Milne 1985, 1977).

Therefore the authors of the present study have decided to assess honey yield as well as foraging and hoarding efficiency in Buckfast bees and in Norwegian Black Bee queens x Caucasian drone hybrids, using both field and laboratory tests.

MATERIAL AND METHODS

The experiments comprised bees from two different groups – (1) eleven Buckfast colonies (Bcf), and (2) eleven colonies of Black Bee queens x Caucasian drone hybrids (Nor x Cau). In the eleven-day field tests comprising small, artificially set up nuclei colonies, foraging and hoarding effectiveness of sugar syrup was assessed, whereas the laboratory tests, which lasted for 53 days, tested the hoarding behaviour. The results of both tests were compared with the honey yield of the colonies representing both groups evaluated in the apiary over the entire season.

Field test

A 750 ml sample of bees was taken from each of the colonies in both groups, at the time when workers did not fly in order to ensure a balanced age structure of workers. An artificial nucleus colony was established from each sample by placing the bees in three-frame, two-colony mating hives (frame – 120 mm x 190 mm) with empty and weighed combs. A Zander cage with a young virgin queen was placed in the middle comb of each nucleus colony. The queens were sisters and remained in the cages throughout the experiment. The nuclei colonies obtained in this way were kept in a cellar for two days. During that time bees were feeding on candy, with 200 g of which each hive was supplied. Subsequently, after being transported to a bee yard, nuclei colonies of both groups were placed under separate 400 x 400 x 180 cm screen flying cages so as to exclude the competition from other bee colonies. Artificial feeding stations of 0.9 litre each were placed under the flying cages. There were two nuclei colonies to one feeding station. Every day at the same time the amount of syrup foraged from the feeding stations was recorded and then the combs were weighed in order to assess the amount of the supplies.

Laboratory test

One-day bees coming from each colony of both groups were caught, on the basis of their characteristic appearance, on the combs with emerging brood and put into a separate transport box. After being anaesthetised with CO_2 the bees from each colony were put into 3 wooden cages (125 x 125 x 48 mm), 60 bees per cage. Hence, each group (Bcf and Nor x Cau)

numbers 33 cages, each of which was closed with a moving glass pane, and had two openings and one wax foundation comb. Cages with bees were placed in an air-conditioned room (temp.=28°C; H=65%). A feeder was placed in one of the opening whereas the other one was used for ventilation. Each feeder had a slit (2 x x 40 mm), through which the bees were taking candy made from powdered sugar and linden honey. Candy was replenished every day and water was injected through ventilation openings. The feeders were weighed every second day to assess the candy taking rate.

Colony spring build-up and honey yield

Colony spring build-up of the Bcf and Nor x Cau colonies was assessed on the basis of three brood area measurements conducted at 21-day intervals. The brood area was calculated according to the ellipse area formula. Honey yield was assessed on the basis of the amount of extracted honey calculated as comb mass difference before and after extraction.

RESULTS

Field test

Bcf hybrids (Table 1) foraged about 200 ml more syrup and hoarded slightly more supplies (only 70 g more) than Nor x Cau, which became visible only in the second half of the test (Fig. 1). This is also confirmed by the results in Table 2 particularly when "F per day" is compared over the period from 6th to 10th day and from 11th to 14th day. These results also corresponds with those at Fig. 1. In the final phase of the test (Table 2), the amount of foraged syrup decreased (in Bcf bees from 179.05 to 111.91 and in Nor x Cau from 195.48 till to 89.10), as if the bees were less active in the final days after foraging big amounts of syrup. It is clear, that this was more clearly in evidence in Nor x Cau. Undoubtedly, changing weather conditions during the experiment affected the process of syrup foraging and hoarding. On as many as seven days (1st, 3rd, 5th, 6th, 9th, 10th and 13th) there were showers and temperature drops. The biggest weather collapses occurred on the 3rd and 9th day. The weather was generally better during the final days of the test. It is, therefore, worth noticing that Bcf bees turned out to be more resistant to adverse and changing weather because "F per day" estimated over the periods from 1st to 5th day and from 6th to 10th day did not differ each other only in this bees (compare Table 2; Fig. 1, II). The variability of the examined trait (Table 2) was similar in Bcf and Nor x Cau.

Bees foraging similar amounts of food could use it to various extents to satisfy their livelihood needs and, what it involves, to produce supplies. This is visible when values of "F per day" with "H per day" and "F total" with "H total" were

Table 1

Amount of syrup foraged from the feeding stations (F) and hoarded in the combs (H) in Buckfast (Bcf) and Norwegian x Caucasian (Nor x Cau) bees during the field test, - average per one colony

	Throughout the entire test period		Average per a single day of the test	
	F [ml]	H [g]	F [ml]	H [g]
Bcf	2199	788 (SE 79.45)	157.06	56.27 (SE 6,13)
Nor x Cau	1998	719 (SE 95.88)	142.74	51.37 (SE 5,98)

SE – standard error

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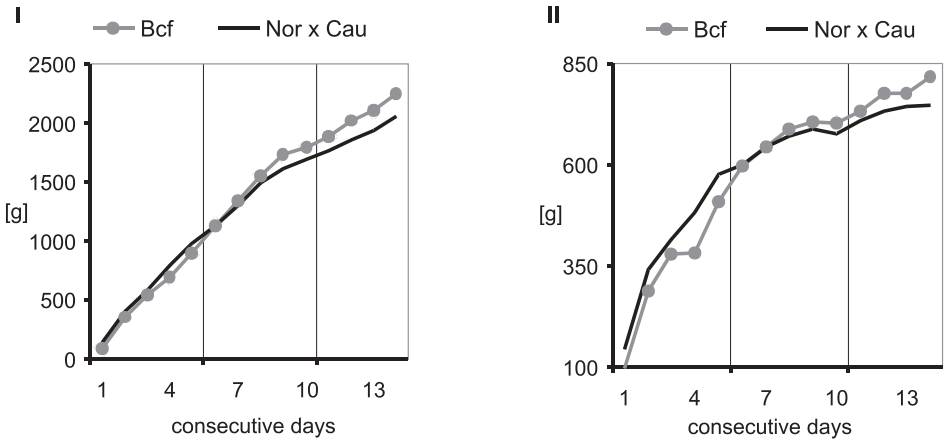


Vertical lines mark the consecutive periods of the test examined separately (also statistical verification) in Table 2.

Fig. 1. Total amount of the syrup foraged from the feeding stations (Part **I**) and the syrup hoarded in the combs (Part **II**) in Buckfast (Bcf) and Norwegian x Caucasian (Nor x Cau) bees

Table 2

Amount of syrup foraged from the feeding stations (F) and hoarded in the combs (H) in Buckfast (Bcf) and Norwegian x Caucasian (Nor x Cau) bees during the three consecutive periods of the field test (from 1st to 5th day, from 6th to 10th day and from 11th to 14th day), - average per one colony

		F per day [ml]			F total [ml]; from the beginning of the test		
Period		1st-5th	6th-10th	11th-14th	1st-5th	6th-10th	11th-14th
Bcf	x	179.05	180.22	111.91	513.56	1505.44	2061.41
	SD	60.60	63.93	34.01	308.54	279.60	152.84
	CV	33.84	35.47	30,39	60.08	18.57	7.41
Nor x Cau	x	195.48	143.63	89.10	578.88	1443.96	1900.80
	SD	47.72	44.62	20.91	328.54	235.21	121.79
	CV	24.41	31.06	23.47	56.75	16.29	6.41
		H per day [g]			H total [g]; from the beginning of the test		
Period		1st-5th	6th-10th	11th-14th	1st-5th	6th-10th	11th-14th
Bcf	x	101.42	39.44a	27.91a	330.49	667.33	775.02
	SD	100.78	51.10	28.37	189.49	207.35	239.30
	CV	93.37	129.56A	106.65	57.44	31.07	30.87
Nor x Cau	x	115.58	20.21b	17.18b	392.43	656.60	733.39
	SD	89.03	35.58	18.32	204.19	247.62	298.05
	CV	77.03	176.05B	106.63	52.03	37.71	40.64

small letters (a, b) - a difference is significant for P 0.05; capital letters (A, B) - a difference is significant for P 0.01; x – mean; SD – standard deviation; CV – variability coefficient

Table 3

Efficiency of the foraged syrup processing into stored supplies (EP%) in Buckfast (Bcf) and Norwegian x Caucasian (Nor x Cau) bees during the first (from 1st to 7th day) and the second (from 8th to 14th day) period of the field test

	EP%; from 1st to 7th day	EP%; from 8th to 14th day
Bcf	49.86 (SE 12.56)	17.33 (SE 5.63)
Nor x Cau	49.27 (SE 11.78)	14.70 (SE 6.89)

SE – standard error

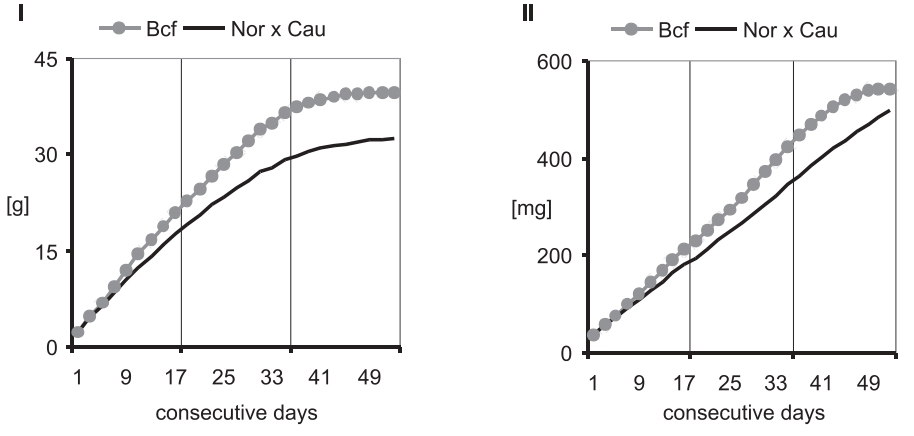
compared in Bcf and Nor x Cau (Table 2). Therefore, the authors have decided to calculate a coefficient expressing the amount of foraged syrup which was processed into food supply (EP%) in the following way:

EP% = (amount of syrup hoarded / amount of syrup foraged) x 100%

In the initial phase of the test, EP% values were higher (Table 3). In this stage, bees may not have managed to evaporate the syrup and then the amounts of foraged syrup dropped, at similar livelihood needs of the nuclei colonies The EP% of Bcf was slightly higher, particularly towards the end of the test. It is probably the reason, apart from their lover weather sensitivity, that Bcf started hoarding more food only in the final phase of the test (see "H total" in table 2).

Laboratory test

Bcf bees foraged more candy (Table 4). They surpassed Nor x Cau considerably, almost throughout the entire cage test, except for the last 17 days (Fig. 2, I; Table 5, A). Apart from assessing the amount of candy foraged by bees in each cage, the average amount of candy foraged by an individual worker was also calculated (Fig. 2, II; Table 5, B). That was done because, due to various mortality rates, the number of bees in various cages differed, which affected the amount of foraged candy. As it is clear, the differences between Bcf and Nor x Cau decreased (compare part A with part B in Table 5) because Bcf lived on average 1.2 days longer. On the other hand, a single Bcf worker still foraged more candy than a single Nor x Cau worker (see in Table 5 part B, particularly "total" values). Therefore, Bcf were



Vertical lines marks the consecutive period of the test considered separately (also statistical verification) in Table 5.

Fig. 2. Total amount of the candy taken in from the feeders in Buckfast (Bcf) and Norwegian x Caucasian (Nor x Cau) bees. Part **I**, per a single cage. Part **II**, per a single bee

Table 4

Amount of candy taken in from the feeders in Buckfast (Bcf) and Norwegian x Caucasian (Nor x Cau) bees, average per a single day of the cage test

	Per a single bee [mg]	Per a single cage [g]
Bcf	21.50^{A} (SE 0.45; SD 13.42^{A})	1.47^{A} (SE 0.032; SD 0.94^{A})
Nor x Cau	17.52^{B} (SE 0.26; SD 7.08^{B})	1.21^{B} (SE 0.027; SD 0.80^{B})

small letters (a, b) - a difference is significant for P 0.05; capital letters (A, B) - a difference is significant for P 0.01; SE – standard error; SD – standard deviation

Table 5

Average amount of the candy taken in from the feeders per a single cage (A) and per a single worker (B) in Buckfast (Bcf) and Norwegian x Caucasian (Nor x Cau) bees during the consecutive periods of the cage test: from 1st to 17th day, from 18th to 35th day and from 36th to 53rd day

A		Per day [g]			Total* [g]		
Test period		1st-17th	18th-35th	36th-53rd	1st-17th	18th-35th	36th-53rd
Bcf	x	2.32^{A}	1.72^{A}	0.37	11.78^{a}	29.99^{A}	39.04^{A}
	SD	0.41	0.53	0.49	6.23	5.44	4.18
	CV	17.67^{A}	30.81	132.43^{A}	52.89	18.14	10.71^{A}
Nor x Cau	x	1.97^{B}	1.27^{B}	0.38	10.30^{b}	24.55^{B}	31.52^{B}
	SD	0.52	0.50	0.39	5.41	4.93	4.89
	CV	26.39^{B}	39.37	102.63^{B}	52.52	20.08	15.51^{B}
B		Per day [mg]			Total* [mg]		
Test period		1st-17th	18th-35th	36th-53rd	1st-17th	18th-35th	36th-53rd
Bcf	x	23.41^{A}	23.74^{A}	17.34^{A}	123.27	322.60^{A}	509.34^{A}
	SD	6.51	8.31	18.94	58.65	74.43	73.48
	CV	27.81^{A}	35.00^{A}	109.22^{A}	47.58^{a}	23.07	14.43^{A}
Nor x Cau	x	20.06^{B}	18.25^{B}	14.25^{B}	109.25	268.35^{B}	435.52^{B}
	SD	8.12	4.76	9.52	50.84	63.42	80.38
	CV	40.48^{B}	26.08^{B}	66.81^{B}	46.51^{b}	23.63	18.45^{B}

small letters (a, b) - a difference is significant for P 0.05; capital letters (A, B) - a difference is significant for P 0.01; x – mean; SD – standard deviation; CV – variability coefficient; (*) total from the beginning of the test

characterised with a stronger expression of foraging/hoarding behaviour.

Apiary results

The results obtained throughout the entire season in full size Bcf and Nor x Cau colonies have been presented in Table 6. As it may be observed, Bcf were characterised by a stronger spring colony build-up and greater strength. This was particularly visible in brood area measured on 18 of March (12.46 in Bcf but only 6.51 in Nor x Cau). That may have influenced their honey yield which was also higher,

Table 6

The colony strength expressed as the brood area [dm^2] in three consecutive examinations and the honey yield [kg] from three consecutive honey extractions in Bucfast (Bcf) and Norwegian x Caucasian (Nor x Cau) bees

		Brood area			Honey yield		
		18. III	08. IV	29. IV	02.VI	23.VI	22.VII
Bcf	x	12.46^{A}	48.93	62.01	12.25^{A}	5.58	20.70^{a}
	SD	5.73	8.26	10.42	3.53	2.08	5.08
	CV	45.99^{a}	16.88	16.51	28.82	37.27	24.54
Nor x Cau	x	6.51^{B}	41.89	51.62	7.20^{B}	4.15	15.41^{b}
	SD	2.84	9.58	13.26	3.26	1.26	5.06
	CV	43.62^{b}	22.88	25.69	45.28	30.36	32.83

small letters (a, b) - a difference is significant for P 0.05; capital letters (A, B) - a difference is significant for P 0.01; x – mean; SD – standard deviation; CV – variability coefficient

particularly with the early nectar flow (on 02.IV).

DISCUSSION

Bcf bees turned out to be better than Nor x Cau, which was the most clearly visible in full size colonies monitored in the apiary throughout the entire season and also in cage tests. The more dynamic colony build-up, especially in spring, of Bcf bees certainly influences the results obtained in the apiary, since in field tests under flying cages, where the artificially set up nuclei colonies had equal strength, Bcf bees did not surpass Nor x Cau so much. In the field tests which were conducted previously by our team, Bcf bees turned out to be efficient and they were not inferior to Caucasian or to Carniolan bees. Cage tests and the field test under the flying cages also proved that Bcf bees were characterised with a stronger expression of hoarding behaviour. Therefore, Bcf bee is worth recommending.

The comparison of the present results with those obtained previously (Paleolog 2002, Paleolog et. al. 1999) suggests that Norwegian bees and their crosses are more efficient in worse, more changeable weather, which was also suggested by Ruttner (1992). Confrontation of our results with those obtained by other authors (Prabucki and Chuda--Mickiewicz 2002, 1998) points out to the fact that Norwegian queens x Caucasian drones composition cannot be considered successful. Using Black Bee on the paternal side seems to bring better results. Moreover, divergent results obtained in various years on different material suggest that Buckfast/Norwegian bees coming to our country from various sources are quite frequently more or less different from the original.

By applying laboratory tests the authors wanted to find out to what extent the laboratory results would be similar to those obtained in the apiary (Milne 1985, 1977; Kulincevic and Rothenbuhler 1973) In the research being the subject of the present work, the results obtained in the cage test and in the apiary correlated with each other. What is interesting, the results obtained in the field tests under the screening flying cages and in full size colonies were much more divergent.

Comparing the average amount of candy foraged by bees in one cage with the average amount of candy foraged by an individual worker points out to the fact that life length of worker bees may affect the results of the cage test (Pham-Delegue et. al. 1987).

In the first days of the field test under the screening flying cages, bees foraged much syrup and then the foraging diminished. Similar way of foraging was observed in small nuclei colonies during previous experiments (Paleolog 2002; Paleolog et. al. 1999). Fewell and Winston (1996) suggest that the amount of accumulated nectar/honey supplies does not slow down either the pace of the accumulation or the work rate in worker bees. However, in the case of our research, which was conducted in small nuclei colonies, lack of available space in a hive and the necessity of engaging a large number of bees in jobs such as syrup processing might nevertheless cause a considerable limitation of the worker bee activity. It is worth noticing that the amount of syrup foraged in the test under the flying cages corresponded to the amount of the stored food supplies.

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CONCLUSIONS

1. It may be stated on the basis of long-term, multi-season research that Norwegian Bee crosses do not seem to be overly sensitive to adverse weather conditions.
2. Buckfast bees were efficient both in good and in worse weather. They are, therefore worth recommending.
3. The crosses Norwegian queen x Caucasian drones, which may be encountered in the Lublin region did not prove to be a good combination.
4. Laboratory cage tests may be useful in assessing honey production potential of bees. The amount of syrup foraged in the test under the flying cages corresponded to the amount of the stored food supplies. Therefore combining these two tests results in the proper assessment of the hoarding behaviour.

REFERENCES

Büchler R. (1998)- Erfahrungen mit der Buckfastbiene I. *Deut. Bienen J.*, 6(4):136-139.

Fewell J. H., Winston M.L. (1996)- Regulation of nectar collection in relation to honey storage levels by honey bees, *Apis mellifera*. *Behav. Ecol.*, 7(3):286-291.

Kulincevic J. M., Rothenbuhler W. C. (1973)- Laboratory and field measurements of hoarding behavior in the honey bee, *J. Apic. Res.*, 12(3):179-182.

Milne Ch. P. (1977)- An improved laboratory measurement of hoarding behavior in the honey bee. *Amer. Bee J.*, 117(8):502-507.

Milne Ch. P. (1985)- The need for using laboratory testes in breeding honeybees for improved honey production. *J. Apic. Res.*, 24(4):237-242.

Neumayer R. (2003)- Die dunkle Biene. *Bienenvater*, (4):30-31.

Paleolog J. (2002)- The food storage efficiency and competition abilities in black bees tested in Poland, *J. Apic. Sci.*, 46(2):55-63

Paleolog J., Flis W. (1999)- Wpływ genotypów i środowiska na zdolność pobierania wziątku u pszczoły miodnej w testach polowych i laboratoryjnych. *Annales UMCS*, sectio EE, XVII, 37:199–206.

Paleolog J., Flis W., Wiśniewska M., Wiśniewski K. (1999)- Wpływ zdolności do konkurowania rodzin o różnych genotypach na stopień wykorzystania źródeł pokarmu u pszczoły miodnej, *Zesz. Nauk. Przeg. Hod.* PTZ Warszawa, 40:49-58.

Pham-Delegue, Minh-Ha, Mason C., Douault P. (1987)- Comparative laboratory study of foraging abilities of honey bees Apis mellifica ligustica and interracial hybridis *Apis mellifica*. *Apiacta*, 22(1):13-19.

Prabucki J., Chuda-Mickiewicz B. (1998)- Results of the Middle European Bee Improvement in Western Pomerania. *Zesz. Nauk. AR Szczec*., 185, Sec. Zoot. 36:27-37.

Prabucki J., Chuda-Mickiewicz B. (2002)- Honey yield of polish commercial lines of European bee (*Apis mellifera mellifera* L) and their crossbreeds with other races, *J. Apic. Sci.*, 46(2):65-72.

Ruttner F. (1992)- Naturgeschichte der Honigbienen, Ehrenwirth Verlag, München.

EFEKTYWNOŚĆ POZYSKIWANIA I MAGAZYNOWANIA WZIĄTKU U PSZCZÓŁ BUCKFAST I MIESZAŃCÓW NORWESKIEJ CZARNEJ PSZCZOŁY (*A. m. mellifera*) CZĘŚĆ 1. ROCZNA WYDAJNOŚĆ MIODOWA A WYNIKI POLOWYCH TESTÓW POD IZOLATORAMI I TESTÓW LABOLATORYJNYCH

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S t r e s z c z e n i e

Prezentowane badania były kontynuacją cyklu doświadczeń z pszczołą Buckfast oraz pszczołą norweską prowadzonych w celu poznania ich wartości użytkowej oraz behawioru. Tym razem postanowiono porównać wydajność miodową monitorowaną w ciągu całego sezonu w pasiece z efektywnością pozyskiwania i magazynowania syropu cukrowego w polowym teście pod izolatorami oraz efektywnością pobierania ciasta cukrowego w klatkowym teście laboratoryjnym. Porównano grupę rodzin Buckfast (Bcf) oraz grupę rodzin mieszańców pszczół norweskich z trutniami kaukaskimi (Nor x Cau). W teście polowym (Tab. 1 i 2, ryc. 1) nieco więcej syropu pozyskały Bcf. Ilość pozyskanego syropu korespondowała z ilością zgromadzonych zapasów (Tab. 1 i 2, ryc. 2.). Bcf nieco lepiej przetwarzały przyniesiony syrop w zapasy (Tab. 3). Wyniki uzyskane w teście laboratoryjnym (Tab. 4 i 5, ryc. 2) wykazały przewagę, a przede wszystkim silniejszy instynkt do gromadzenia pokarmu cukrowego u Bcf. Na podstawie wielosezonowych badań, można stwierdzić, że pszczoły Bcf pracowały efektywnie zarówno przy dobrej, jak i gorszej pogodzie. Są zatem godne polecenia. Z kolei mieszańce pszczół norweskich wydają się być mało wrażliwe na niesprzyjające warunki pogodowe. Z przeprowadzonych badań wynika, że pojawiające się na terenie Lubelszczyzny mieszańce matka norweska x trutnie kaukaskie nie są najlepszą kombinacją. Znacznie lepsze wydaje się użycie Black Bee jako strony ojcowskiej. Laboratoryjne testy klatkowe mogą być przydatne w ocenie potencjału produkcyjnego pszczół. Ilość syropu pozyskanego w teście pod izolatorami korespondowała z ilością zgromadzonych zapasów, a zatem połączenie testów laboratoryjnych i polowych pod izolatorami daje dobrą ocenę hoarding behaviour.

Słowa kluczowe: gromadzenie pokarmu, zbieranie pokarmu, wydajność miodowa, testy klatkowe, pszczoła miodna (*A. mellifera*).