Original paper

THE EFFECT OF HIVE VOLUME ON EFFICIENCY AND STRENGTH CONSERVATION AND RESTORATION OF FOOD SUPPLIES DURING THE WINTERING IN LANGSTROTH HIVES

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Abstract

The influence of volume of the hive on wintering, colony strength and food supply was observed during the three-year period. Standard LR hives were used for the experiment. Colonies were tested based on the number of hive bodies and the number of frames in the brood hive bodies. The colonies were divided into two groups based on the number of frames: group I had eight frames in the brood bodies, the second group included 10 frames in the brood bodies. Based on the number of hive bodies, colonies were also divided into two groups: colonies with a single hive body and colonies with two hive bodies. The inspections were carried out in the autumn in late August and early September, and in the spring in late March and early April. Colony strength was determined by the amount of brood and food supplies through the amount of honey and pollen. It was found that the number of frames in the brood bodies had almost no impact on the colony strength and the amount of food in the autumn and spring inspections. Percentage ratio in spring and autumn inspections was more favourable in ten-frame hives considering the amount of bees and pollen. The ratio for the amount of brood between the two inspections was higher in eight-frame hives. The colonies replenished bees more rapidly and foraged pollen more efficiently in ten-frame hives while the colonies in eight-frame hives replenished brood quicker. It was found that, during the three-year period, the hive volume had impact on strength and food supply of colonies. Colonies that have wintered in two hive bodies had favourable ratio of spring and autumn inspections for the amount of bees, brood and pollen, while the ratio for the amount of honey was more favourable in the colonies with a single hive body. The colonies with two hive bodies quicker restored strength and pollen supply, while the colonies with a single hive body consumed honey supply more rationally.

Key words: *colony strength, food supply, hive volume, Langstroth hives*

Introduction

A large number of factors affect the successful wintering of honey bees. These factors can be divided into internal and external (Avetisijan, 1982). The external factors include climate, nectar pasture and presence of beneficial or harmful organisms in environment. External conditions

have a decisive impact on the vitality and productivity of honey bee colonies, but beekeepers themselves can not significantly alter most of those conditions.

The internal factors include colony strength, queen bee quality, food supply, honeycomb quality, microclimate and the hive volume. This group of factors is present within the hive and is the result of the life of the very colony. Rinderer and Baxter (1978, 1980), by testing the bees in the laboratory and in field conditions, found that the volume of the honeycomb affects foraging activity of honey bees. Colonies that had more space (empty combs) have processed sugar syrup significantly more and significantly quicker than colonies that had less space.

The aim of this paper is to determine the influence of volume of the hive on overwintering of honey bee colonies in standard Langstroth hives and on the colony strength and food supply during the main inspections.

Materials and methods

The observation of colonies was conducted during the period from 2010 to 2012. Colonies were in standard LR-hives with ten and eight combs. In each group were 5 colonies. In addition to the number of combs, hives had the different number of main bodies. Colonies were prepared for winter in hives with one and two bodies. Autumn inspection was carried out in late August and early September, and spring inspection in late March and early April.

Colony strength (the amount of bees and brood size) and volume of food (honey and pollen surface) were determined on inspections. The amount of bees per hive was determined visually by the amount of bees that occupy combs. It is expressed in parts of the comb that are possessed by the bees (1/10) or as a percentage. Total quantity of bees per hive can be calculated by addition of the amount of bees on combs.

The brood surface is also evaluated in the spring and autumn, by detailed observation of each frame with open and closed brood in the hive. Results are also expressed in parts of the frame (1/10) or as a percentage. Surfaces under honey and pollen were also determined in the same way and at the same time as the two previous traits. The relationships for all observed traits were calculated between spring and autumn inspections, to establish their increase or decrease. At the beginning of the experiment, one year old queens produced in 2009 were in all colonies.

Results and discussion

Hives with eight and ten combs

The amount of bees per hive was more affected by the years of observation than by the number of combs in the hives. In the second year of observation, colonies in ten-comb hives have wintered much better. Although the colonies in eight-comb hives had slightly more bees in autumn survey they wintered worse, and were much weaker in spring with lower number of bees (Table 1). The relationship between wintered and bees after last winter was, in ten-comb hives, increased by 20%. In the next year, the situation has turned around and, in eight-comb hives, the ratio was higher by 10%. Overall, the amount of bees was very similar but colonies in ten-comb hives wintered better (4%).

Table 1. *Inspections of eight- and ten-comb hives (1/10 of combs)*

Year	Hive	Inspection	Bees	Brood	Honey	Pollen
I	Eight-comb	Autumn	6.12	1.98	3.82	0.28
		Spring	3.38	1.50	2.98	0.52
		Relation	**0.55**	**0.76**	**0.78**	**1.86**
	Ten-comb	Autumn	6.44	1.94	3.80	0.16
		Spring	3.36	1.18	2.78	0.36
		Relation	**0.52**	**0.60**	**0.73**	**2.25**
II	Eight-comb	Autumn	7.14	1.74	4.96	0.18
		Spring	2.20	0.96	3.30	0.34
		Relation	**0.31**	**0.55**	**0.66**	**1.89**
	Ten-comb	Autumn	6.56	1.88	4.38	0.34
		Spring	3.50	1.48	3.78	0.38
		Relation	**0.53**	**0.79**	**0.86**	**1.12**
III	Eight-comb	Autumn	7.42	1.50	5.48	0.12
		Spring	5.24	2.20	3.90	0.46
		Relation	**0.71**	**1.47**	**0.71**	**3.83**
	Ten-comb	Autumn	7.80	1.44	4.88	0.08
		Spring	4.74	1.82	2.66	0.74
		Relation	**0.61**	**1.25**	**0.54**	**9.25**
Average	Eight-comb	Autumn	6.89	1.74	4.75	0.19
		Spring	3.61	1.55	3.39	0.44
		Relation	**0.52**	**0.89**	**0.71**	**2.32**
	Ten-comb	Autumn	6.93	1.75	4.35	0.19
		Spring	3.87	1.49	3.07	0.49
		Relation	**0.56**	**0.85**	**0.71**	**2.60**

A similar situation has been also established for the amount of brood, better results were found in eight-comb hives (4%). Variations are expressed per year. Higher amount of brood in the first and third year was determined in eight-comb hives and in the second year in ten-comb hives. Colonies in eight-comb hives had more honey on both inspections. The relationship between spring and autumn inspections was identical in both groups of hives. Colonies in ten-comb hives had slightly more pollen in the spring. Especially, ten-comb colonies foraged large amounts of pollen in spring in the third year of observation (0.74 combs), considering that they were wintered with almost no pollen (Table 1).

Table 2. *Variations of parameters in hives with different number of combs per inspection*

Autumn inspection				
	Number of bees	Brood	Honey	Pollen
CV (%) - 8 combs	28.88	30.23	48.23	60.15
CV (%) - 10 combs	28.39	40.55	35.15	84.011
Spring inspection				
	Number of bees	Brood	Honey	Pollen
CV (%) - 8 combs	55.49	52.63	25.94	53.55
CV (%) - 10 combs	47.11	55.89	48.82	60.97

The number of bees showed very little variation in autumn inspections, and somewhat higher variation in autumn, considering the number of combs per hive (Table 2).

Colonies with one and two bodies

In addition to the fact that colonies with the two bodies had more bees on both fall and spring inspections they had a better relationship between the two examinations (7% more). Colonies with one body wintered badly in the first year of observation. A large area of the brood during the autumn might have had influence on this. Colonies with one body had significantly more brood during this period, which led to the depletion of bees due to its nurturing. These colonies were much more weakened during winter and in spring they very slow rebuild strength and badly fostered brood. In average, colonies with two bodies had almost the same amount of brood in the spring inspections, while companies with one body had almost half as many brood when compared to the autumn inspections. It is interesting to point out that colonies with one body have had larger food supplies in the spring than in the autumn inspection. In colonies with two bodies there was less honey in the spring compared to the autumn inspection. Naturally, greater food supply is determined in colonies with two bodies on each inspection. Wintering of honey bee colonies is very dependent on the amount of food that the bees store before winter (Kulinčević, 1997).

Table 3. *Inspections of hives with one or two bodies*

Year	Hive	Inspection	Bees	Brood	Honey	Pollen
I	One body	Autumn	5.30	2.50	2.44	0.30
		Spring	1.96	0.74	2.68	0.12
		Relation	**0.37**	**0.29**	**1.10**	**0.40**
	Two bodies	Autumn	5.72	1.38	3.40	0.22
		Spring	3.70	1.42	3.24	0.62
		Relation	**0.65**	**1.03**	**0.95**	**2.82**
II	One body	Autumn	5.80	2.26	3.28	0.30
		Spring	3.08	1.52	3.80	0.42
		Relation	**0.53**	**0.67**	**1.19**	**1.40**
	Two bodies	Autumn	6.92	1.94	4.34	0.34
		Spring	3.76	1.82	3.64	0.46
		Relation	**0.54**	**0.94**	**0.84**	**1.35**
III	One body	Autumn	5.20	1.84	3.02	0.14
		Spring	3.42	1.52	2.66	0.60
		Relation	**0.66**	**0.83**	**0.88**	**4.29**
	Two bodies	Autumn	7.14	1.52	5.00	0.16
		Spring	4.30	1.60	3.08	0.66
		Relation	**0.60**	**1.05**	**0.62**	**4.13**
Average	One body	Autumn	5.43	2.20	2.91	0.27
		Spring	2.82	1.26	3.05	0.38
		Relation	**0.52**	**0.57**	**1.05**	**1.41**
	Two bodies	Autumn	6.59	1.61	4.27	0.24
		Spring	3.92	1.61	3.32	0.58
		Relation	**0.59**	**1.00**	**0.78**	**2.41**

Medium-strong and strong colonies survive winter much better than poorer colonies (Jevtić et al., 2005). Wintering of the colonies can be influenced by the quantity of solid food fed to the bees

(Jevtić et al., 2004). In addition, the colony strength depends on the genetic potential of the parent and it depends on the quality and quantity of food that is stored over winter (Mladenović et al., 2002). The presence of a sufficient amount of food affects the amount of royal jelly secreted in the hypopharingeal glands of nursing bees (Taranov, 1986).

Variations between studied traits were higher in spring than in autumn inspections (Table 4).

Table 4. *Variations of parameters in hives with different number of bodies per inspection*

Autumn inspection				
	Number of bees	Brood	Honey	Pollen
CV (%) - one body	14.02	21.70	30.01	74.21
CV (%) - two bodies	20.12	33.85	30.95	97.58
Spring inspection				
	Number of bees	Brood	Honey	Pollen
CV (%) - one body	41.99	51.68	24.67	56.89
CV (%) - two bodies	25.64	38.91	30.08	30.00

After three years of research, it was concluded that the number of combs in the brood (8 and 10) has almost no effect on the colony strength and on the food supply. Colonies quickly replenished bees and foraged larger amounts of pollen in ten-comb hives, while brood was quicker replenished in eight-comb hives. Volume of hives (one or two bodies) has had an impact on colony strength and food supplies. Colonies that have wintered in two bodies had been in more favourable relation between spring and autumn inspections considering the amount of bees, brood and pollen. Colonies with two bodies quickly replenished strength and a pollen supply, while companies with one body consumed stored food more rationally.

Conclusion

After three years of research, it can be concluded that the number of frames in brood box (8 or 10) has almost no influence on the colony strength and the food supply. Honey bees gathered pollen in greater supply in ten-comb hives, while the brood was quicker replenished in eight-comb hives. Volume of the hives (one and two bodies) had impact on colony strength and food supply per. Colonies that have wintered in two bodies had more favorable relation of the spring and autumn inspections for the amount of bees, brood and pollen. Colonies with two bodies quickly renewed strength and a supply of pollen while colonies with one body consumed stored honey more rationally.

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