SUPPLEMENTAL FEEDING OF HONEYBEES (*APIS MELLIFERA* LINNAEUS) *

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Summary

Forty colonies of honeybees were involved in a supplemental feeding program conducted at the University of California, Davis. The feeding was begun on 12 October 1970 and concluded 9 March 1971. Pollen trapped from 5 colonies showed no pollen being brought into the hives from 30 November to 25 January and during this period the supplementary fed colonies showed an increase of square centimeters of brood ranging from 13,225 to 2,741 whereas the control colonies showed losses ranging from 5,192 to 451. In contrast, when the control colonies were gathering pollen they produced as much brood as the colonies that were receiving like amounts of pollen from normal foraging plus supplemental food. Therefore, this work indicated there is value in feeding during October through January preceeding the almond bloom in California to provide colonies with greater populations for more effective almond pollination, but that feeding of pollen, pollen supplement, or pollen substitute is not beneficial after the spring pollen flow begins – late January to early February in Davis, California.

Introduction

It is often necessary to increase the brood rearing rate to: overcome pesticide damage; to provide abundant young bees for winter; to provide abundant foragers for spring pollination of almonds; to produce strong colonies for spring shaking of bees for packages; maintain colony population during pollination of alfalfa; and to overcome “autumn collapse”.

In order to build up colony populations when little or no pollen is being brought into the hives it is necessary to have a supply of pollen accessible in the hive or to supply pollen or an adequate substitute.

The search for a pollen substitute was reported as early as 1835 by L.L. LANGSTROTH in his book titled: “The Hive and the Honey Bee, a Beekeeper’s Manual”. Langstroth reported that “at the last annual apiarian convention in Germany, a cultivator recommended wheat flour as an excellent substitute for pollen. He said that in February 1852 he used it with best results, the bees forsook the honey which was set out for them and engaged actively in carrying in large quantities of the wheat flour which was placed about 20 paces in front of the hives”.

In 1958 LANGSTROTH was still seeking substitutes for pollen. In the biography of Langstroth in “The Hive and the Honey Bee”, 1922, revised, Charles and C.P. DADANT report that: “On the 19th of August 1895, he wrote us asking to try the feeding of bees with malted milk, to induce the rearing of brood”.

These early ideas have been followed by a continuous search to the present day for a pollen substitute equal in food value to pollen. HAYDAK, 1936, 1937, 1938, 1940, 1943, 1945, 1958, 1967 and 1970; and FARRAR, 1941, 1944, 1947 and 1963 were two of the chief researchers on pollen substitutes, and the search has been continued by later workers such as STANDIFER, 1966 a, b, 1968 and 1970; and DOULL, 1967, SPENCER BOOTH, 1960, published a very complete summary on feeding pollen, pollen substitutes and supplements.

In California SHEESLEY and PODUSKA, 1968 and 1969 a, b, and GRIPP and RIVES, 1966 through 1968, showed the value of mixtures using Drivert (a sugar containing invert sugars), pollen, soybean flour, brewer’s yeast as pollen substitutes.

Research conducted by HAGEN, TASSAN and SAWALL, 1970; HAGEN and LASSAN, 1970; and HAGEN, SAWALL and TASSAN, 1970 of the Albany Research Laboratory, University of California, Albany, California showed that Wheast (R), a yeast product derived from by-products in the manufacture of cottage cheese, is an excellent food material for beneficial insects other than honey bees. Because honey bees are also insects, it was Dr. HAGEN’s opinion that this same food might be beneficial to them. The senior author suggested the use of this material to beekeepers, and GRIPP and RIVES, 1970, reported using it with exceptional success.

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The research reported here was done to determine whether queens could be stimulated to lay and colonies to increase their populations during the winter months by feeding the colonies Wheast. Colonies are generally believed to be semi-dormant or “clustered” in the winter. Under this condition the bees are feeding the queens for maintenance only. The queens are usually not stimulated to lay eggs, though a few queens may lay eggs under some California winter conditions. During all of our weekly inspections and feeding (9 october-16 march), we observed only 2 instances of the bees clustering.

Materials and methods

Foods and Food Formulae Used

The materials used consisted of three products:

Wheast, produced and registered by the Knudson Creamery Company, Los Angeles, California;

Two types of Wheast were used: Feed Wheast, containing 54 to 58% protein, and a more finely divided Food Wheast, containing 58 to 60 % protein;

Drivert, produced and registered by the California and Hawaiian Sugar Company;

Drivert consists of 91 to 92 % sucrose and 8 to 9 % levulose and dextrose in about equal amounts.

Type 50 sugar syrup, also produced by the California and Hawaiian Sugar Company.

Type 50 sugar syrup contains 77 % sugar and 23 % water. The sugar component is ½ sucrose and ½ levulose and dextrose.

The foods used were prepared in 5 formulations which were mixed just before use as follows.

Food Formula 1 (a 23 % protein mixture)

113.50 grams pollen
184.27 grams Type 50 sugar syrup
14.175 grams water

The above 3 ingredients were mixed together, and then the following 3 ingredients were mixed together, and added with thorough mixing to the first mixture:

1077.3 grams Type 50 sugar syrup
439.42 grams Feed Wheast
439.42 grams Food Wheast

Food Formula 2 (a 23.2 % protein mixture)

907.2 grams Food Wheast
1,360 grams Type 50 sugar syrup

Food formula 3 (a 8.3% protein mixture). A food Wheast slurry consisting of:

326.02 grams Food Wheast
198.45 grams water
1743.52 grams Type 50 sugar syrup

Food Formula 4 (a 22.8 % protein mixture). Feed Wheast cakes made with:

907.2 grams Feed Wheast
1360.8 grams Type 50 sugar syrup

Food Formula 5 (a 11.4 % protein mixture). Feed Wheast and Drivert mixed at the ratio of:

453.6 grams Feed Wheast
1814.4 grams Drivert sugar

Table 1

Square centimeters of brood, frames covered with bees (first food fed 12 oct. 1970). The first figure of the colony number represents the group and the second represents the formula fed.

Colony number		Brood and bee counts[1]					
Group	Formula	9 Oct.		9 Feb.		16 Mar.	
		Br.	Fr.	Br.	Fr.	Br.	Fr.
1	1	2,161	9	4,676	15	8,514	16
3	1	1,677	7	3,547	8	8,256	17
4	1	1,483	5	3,225	10	5,934	15
5	1	645	6	6,450	11.5	8,707	17
7	1	2,386	5	3,709	9	6,643	13
	Total	8,352	32	21,607	53.5	38,054	78
1	2	2,128	7	2,419	8	5,740	13
2	2	1,322	4	4,192	12	6,740	16
4	2	1,483	4	2,096	7	6,321	10
7	2	1,677	6	5,160	11	9,288	17
8	2	3,160	7	4,837	10	7,024[2]	10
	Total	9,770	28	18,704	48	35,113[2]	66
1	3	2,580	7	2,902	13	9,546	20
3	3	2,709	5	3,709	11	7,675	15
5	3	2,096	9	2,741	9	7,450	18
6	3	2,257	5	2,741	9	6,869	15
8	3	2,612	8	2,902	10	7,030	13
	Total	12,254	34	14,995	52	38,570	81
1	4	3,515	9	4,676	15	8,940	20
2	4	3,515	5	3,709	8	4,967	10
3	4	1,161	5	2,741	10	6,611	13
5	4	1,322	8	4,837	12	5,257	10
6	4	742	4	2,741	6	4,095	10
	Total	10,255	31	18,704	51	29,870	63
3	5	2,451	8	3,386	12	7,192	14
4	5	1,387	4	3,064	8	9,223	9
6	5	3,676	7	3,547	7.5	5,966	12
7	5	2,709	4	2,741	7	7,121[2]	10
8	5	1,902	4	3,547	9	6,095	15
	Total	12,125	27	16,285	43.5	35,597[2]	60
2	6	2,773	7	3,386	6	8,707	16
3	6	4,128	6	2,096	6.5	7,805	13
4	6	903	5	1,612	6	6,901	12
7	6	1,483	6	2,580	11	7,546	16
8	6	3,580	7	2,741	7	9,933	17
	Total	12,867	31	12,415	36.5	40,892	74
2	7	3,354	6	2,096	8	9,772	16
4	7	3,064	6	1,774	7	6,450	7
5	7	1,677	5	1,774	7.5	7,095	10
6	7	2,096	8	2,902	8	6,160	15
8	7	1,483	5	1,774	9	6,095	13
	Total	11,674	30	10,320	39.5	35,572	61
1	8	3,225	8	1,451	5	5,515	12
2	8	3,289	5	1,612	8	7,514	13
5	8	1,000	4	2,096	5	7,063	12
6	8	3,741	7	1,774	6	7,708	15
7	8	2,644	5	1,774	5	6,224	13
	Total	13,899	29	8,707	29	34,024	65

[1] = *Brood counts made in square centimeters. Bee counts made in frames of bees, a full frame being one normally covered on both sides.*
[2] = *Queens lost – estimated values.*

The Experimental Colonies

Forty colonies were used. Mr. Clarence Wenner, Glenn, California, placed 40 two-story colonies of bees in the U.C. apiary on 7 October 1970, from his apiaries in Glenn County. The colonies were headed by sister queens and contained negligible amounts of stored pollen. Each colony contained approximately 11.4 kg to 18.2 kg of honey.

The colony were placed in 8 circular groups of 5 colonies each, and the groups were numbered 1 to 8. The control colonies and those receiving each formulation were distributed among the groups by using a random numbers table, and individual colonies were assigned numbers, such as 1-1, 4-2, which designated their group and the food formula respectively each would receive or the type of control they represented.

On 9 October, before the first feeding on 12 October, the square centimeters of brood were measured and the frames covered with bees were estimated for each of the 40 colonies. The measurements of brood and the estimates of frames of bees were repeated on 8 February and 16 March. In Table 1, the square centimeters of brood and frames covered with bees found in each colony and the total brood and bees for each group of 5 colonies receiving the same formula are recorded.

Feeding

Twenty-five colonies were fed the experimental food; each formulation was fed to 5 colonies. In addition, five colonies were fed Type 50 sugar syrup, 5 were fed nothing and had pollen traps, and 5 were fed nothing as controls.

All 5 colonies identified in Table 1 under formula number 6 were given no food and were considered controls.

All 5 colonies similarly identified under formula number 7 were given no food, and pollen traps were placed on the hives on 12 October and kept on the hives throughout feeding period to 16 March. The pollen collected by each colony was weighed and recorded each week, Figure 1.

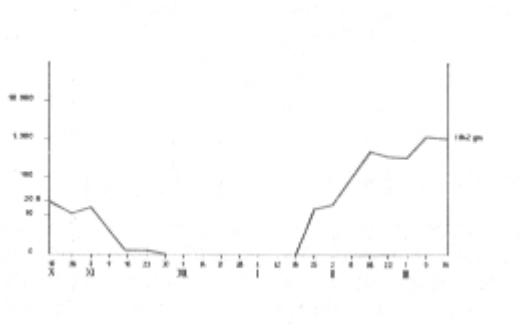

Fig. 1 – On the vertical: pollen (g); on the horizontal: months. Between 30 XI and 18 I no pollen was collected

All 5 colonies identified under formula number 8 were fed Type 50 sugar syrup from 0,95 liter bottles with a perforated screw cap inverted in a hole in the cover of the hive, and the bottles were refilled weekly.

All other food formulae were placed on the top bars of the broodnest; formulae 1,2 and 4 as cakes, formula 3 as a slurry on a clear plastic surface, and formula 5 as a powder on a clear plastic surface.

On 12 October, all fed colonies were given 454 g of the appropriate food formula for the first time. On 19 October, all fed colonies were fed the second time unless they had any food left from the first feeding. This procedure was continued each week through the 2 November feeding. From 9 November through 9 March, colonies fed food formulae numbered 1 through 5 were given 454 g of food each week if ½ or more of the food fed the previous week had been consumed.

From 12 October to 26 October, colonies receiving formula 5 were fed Feed Wheast (microcut) patties consisting of 907,2 grams of wheast and 1360.8 grams Type 50 sugar syrup. This microcut product was fed to determine if the bees preferred the finer divided material. When it was observed that there was no preference, the microcut wheast was discontinued because it is not a standard product, and therefore, is unavailable except when specially prepared in the laboratory. From 26 October until the end of the test (16 March) a dry mixture of Feed Wheast and Drivert was feed to the same colonies (food formula number 5).

Results

Feeding period of 12 October to 8 February, a period of 17 weeks

Weather. During the first 6 weeks, 12 October to 22 November, the weather was clear with average day time temperature of 18 to 24 ^{o}C (64.4 ^{o}F – 75.2 ^{o}F). On 23 November, it was rainy and overcast; this type of weather continued with the average day time temperature at 10 ^{o}C (50 ^{o}F) until 4 January. From 4 January through 12 January, the temperature was the same but it was clear. The 18 January was rainy and the temperature the same. By 25 January, it had cleared, but the temperature remained at approximately 10 ^{o}C (40 ^{o}F). This clear weather continued until 8 February, with early morning fog, temperatures ranging from 10 ^{o}C (50 ^{o}F) to 16 ^{o}C (60.8 ^{o}F). From 8 February until 16 March, it was also clear with some early morning and evening fog but the day time temperatures averaged 16 ^{o}C (60.8 ^{o}F).

Pollen flow. During the first week (12 October through 19 October), total pollen collection was approximately 20 grams for the 5 colonies that were equipped with pollen traps. The amount of pollen collected, Fig. 1, declined sharply beginning 2 November. By 30 November, there was no pollen being brought into the colonies. This condition continued until 25 January when the pollen income returned to the level of 2 November. Beginning 25 January the pollen flow increased sharply until 8 February.

Feeding. The colonies fed food formulae, numbered 1 through 5, showed significant increases in square centimeters of brood, Table 1, during this feeding period, 12 October to 8 February, while the controls showed a decrease. The fed colonies showed significant increases in bees also during the same period (Table 1), while the three kinds of controls showed little or no increases. The increase in square centimeters of brood and of frames of bees shown for those colonies fed formulae numbered 1 through 5 during the pollen dearth period (30 November to between 18 and 25 January) is believed to be due primarily to the supplementary food fed.

Feeding period of 8 February to 16 March, a period of 5 weeks. The temperature ranged from 2 ^{o}C to 18 ^{o}C. The early part of the period to 1 March was cloudy and rainy with temperatures of 3 ^{o}C to 16 ^{o}C. The temperature increased slightly 1 to 16 March to an average day time temperature of 18 ^{o}C, and it was clear and warm. The bees did not seem to cluster during this period.

On 25 January, the pollen income, Fig. 1, was equal to that on 2 November. From this date to 16 March, the pollen income steadily increased with a slight decline 16 February to 1 March. This explosion in pollen income reached a high of 1842 grams weekly total on 16 March from the 5 colonies trapped. All colonies, including the controls, showed increase in square centimeters of brood and frames covered with bees, with the increase in colonies' brood and population exceeding that of the colonies that were fed.

Over the whole feeding period, 12 October through 16 March. The 5 unfed colonies (numbered 6) had 40,892 square centimeters of brood on 16 March, Table 1, which was an increase of 28,024 square centimeters over that present 12 October. This increase is considered to be the result of pollen income after 25 January, Fig. 1. The trap colonies (numbered 7) and those receiving formula number 8, Table 1, also responded to the natural pollen income during the period 25 January to 16 March with a brood increase exceeding that of the fed colonies, and this increase was only slightly below that of the colonies for the entire test period, 9 October to 16 March.

Discussions and conclusions

If we refer to Table 1, we see that the unfed colonies and those fed formula numbered 8 showed a loss of square centimeters of brood and, except for colonies fed formula number 8, a modest gain in frames covered with bees during the period of 9 October to 8 February. In contrast to this, those colonies fed formulae 1 through 5 showed significant increases in square centimeter of brood and frame covered with bee, therefore they would be much better prepared for almond pollination in February. Food formulae 1, 2 and 4 produced the most square centimeters of brood and the most frames covered with bees during this period.

Pollen was brought into the colonies in large quantities beginning 25 January and continuing until 16 March, Fig. 1. For this reason the unfed colonies and those receiving formulae 8 produced as many or more bees by 16 March than any of the colonies fed supplementary protein.

Pollen is desirable but not necessary in a food formula for the supplementary feeding to be effective, but it has the advantage of making the formula more attractive. This may have been one reason that the colonies fed formula 1 were the best of the fed colonies.

Colonies with pollen traps (when a good pollen flow was available) showed population increases that were better than those of some of the fed colonies, therefore there must have been a significant amount of pollen taken into the hive in spite of the traps. This may indicate that incoming pollen is still the best protein source for bees.

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