Pollen Substitute Diets

Project No.: 01-JS-00

Project Leader: Justin Schmidt and Gordon Wardell, USDA-ARS, Carl Hayden Bee Research Center, USDA-ARS, Tucson, AZ

Approach

We took two approaches: 1) Develop assay methods to evaluate the nutritional value of pollen substitute diets for honey bees; and 2) Test currently available diets on the market to obtain a background of performance.

Toward the first goal we developed three assay systems. The first was an apiary-wide system in which large trays containing diet were designed so that the number of bees attracted could be counted, and the weight of diet collected could be measured. The second and third systems were laboratory methods in a walk-in environmental chamber designed to simulate the conditions within the brood chamber of a hive. The second system simply evaluated how readily nurse bees ate a test diet in reference to a control diet, usually pollen, but sometimes another diet. The third system focused only on the question of "how nutritious" was the diet, irrespective of its flavor and acceptability to the bees. Obviously the third system depended somewhat upon the second, for if the diet were totally rejected, then the bees could not obtain nutrition.

We tested diets produced by Dadant, Kelly, Mann Lake, and International Ingredients, as well as pollen and powdered sugar (field) or sugar syrup (lab) as controls. The goals were to determine the strengths (or appropriateness) of each diet for apiary versus in-hive feeding and to obtain indications of what benefit, if any, the bees could obtain from the diets. Secondary goals were to determine the general value of soybean products, yeast products, or combinations as sources for bee nutrition.

Results

Field tray assays — The findings were striking, but informative, and caused us to rethink the issue of pollen substitute diets. First, the bees would collect all of the powdered diets, but generally rejected the powdered sugar. This confirms that bees are not blindly collecting powder because it has the right size and texture of pollen (as sometimes had been alluded in the literature), but actively selected diet based on some presumably nutritional factors. The second finding was that the yeast products were mechanically unsuitable because they tended to blow away in the breeze, even if slight. The third and rather discouraging observation was that the bees stopped collecting diet after about 3 weeks despite no flowers or pollen available whatsoever and abundant syrup feeding. Moreover, after the feeding period the colonies were all weaker than

before. It appeared that the diets were avidly collected, but that they did little, if anything, to help the colonies in the long run and may have been negative.

Lab cage diet preference tests — All of the diets were nearly completely rejected by young nurse bees if they were given a simultaneous choice of fresh pollen. If pollen was not included and the bees could only choose among diets, some differences among the diets were observed. However, addition of the flavor of only a very little pollen dramatically enhanced the preference of the diets over non flavored diets. On the other hand, if pollen-flavored diets were compared to pollen, the preference for the pollen was much stronger than for the flavored diet.

Lab nutrition tests — In these tests, bees were simply given one diet plus sugar water and plain water. We measured how much diet per bee was eaten and how long the bees lived on the diet. Varroa infested bees were used and these bees provided a model for how nutrition and stress interact. Two test series each involving 4 cages of bees were used for each of 6 diets: pollen, Diet 1 alone, Diet 1 with pollen flavor, Diet 2 alone, Diet 2 with pollen flavor, and nothing (except sugar water and water). In both series, the bees with all diets died at a rate very similar to the bees lacking diet. In both, the bees given pollen fared much better and lived significantly longer. In most cases the bees refused to eat the diets after a few short days.

Preliminary Interpretations

1) Foragers will readily collect diets if given the opportunity. However they do not eat the diets, the nurse bees do. Despite good collection, the diets did not appear to benefit colonies in the long run.

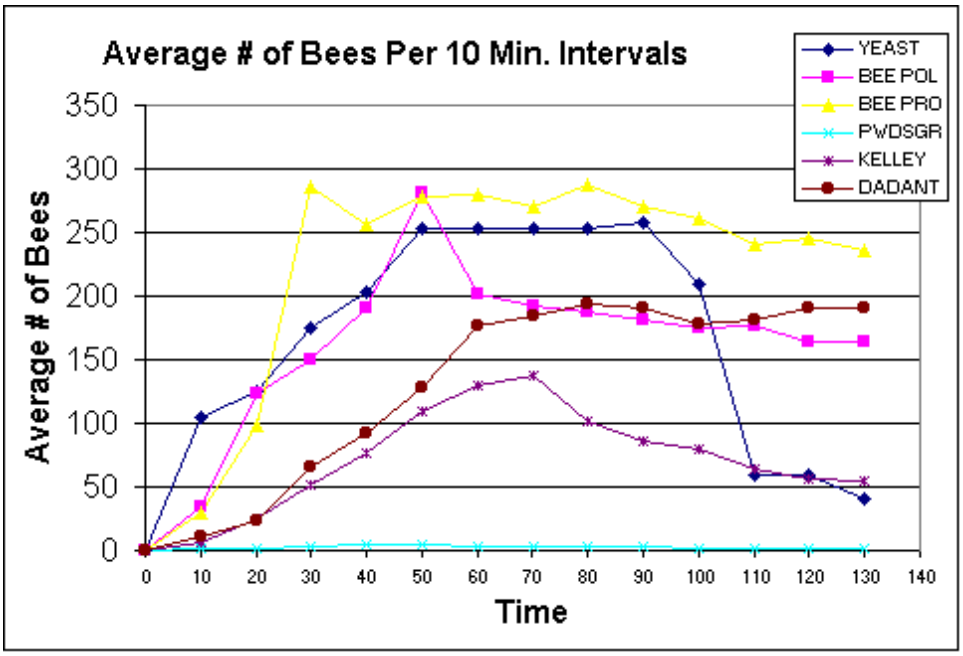
2) Nurse bees did not readily eat any of the diets, but addition of pollen flavor greatly enhances acceptability. This suggests that essential flavor stimulants are low or lacking in all commercial diets.

3) Varroa stressed bees do not recover if fed any of the diets, with or without pollen flavor. In contrast, they do recover in part if given pollen. This suggests that some nutritional inadequacy might exist in all of the diets

Discussion

These results are preliminary. Although the results appear discouraging because they indicate serious questions and potential problems with all currently available diets, they are useful because we now have some clear indications of the problems that need to be solved to produce a truly useful pollen diet for honey bees. These results have made us return “to square one” in our thinking about honey bee diets. As a result we are now focusing our efforts on other experimental diets that do not contain soy beans, as well as on individual ingredients. Our hope is that with these approaches we can ensure the healthy and more populous honey bee colonies can be delivered to the orchards on time.

TIME	YEAST	BEE POL	BEE PRO	PWDSGR	KELLEY	DADANT
0	0	0	0	0	0	0
10	104	34.57	29.92	1.29	6.80	11.17
20	125.5	122.79	98.00	1.71	24.80	23.00
30	175.5	149.57	285.42	2.71	52.00	65.00
40	202.5	190.64	255.92	4.71	77.00	91.67
50	252.5	281.07	278.75	4.86	110.00	128.33
60	253.5	201.57	279.17	3.57	130.00	176.67
70	252.5	191.62	270.83	3.71	137.00	185.00
80	252.5	188.21	287.50	3.14	102.00	193.33
90	257.5	181.14	270.42	2.43	86.00	190.00
100	210	175.00	261.25	2.14	80.00	177.50
110	60	176.79	240.50	2.14	64.00	181.67
120	60	163.57	244.58	2.14	57.00	190.00
130	40	163.43	236.25	2.14	55.00	190.00
Grand Average	160.4286	158.4	217.03571	2.622449	70.114286	128.80952



Diet Preferentials of Apis Mellifera

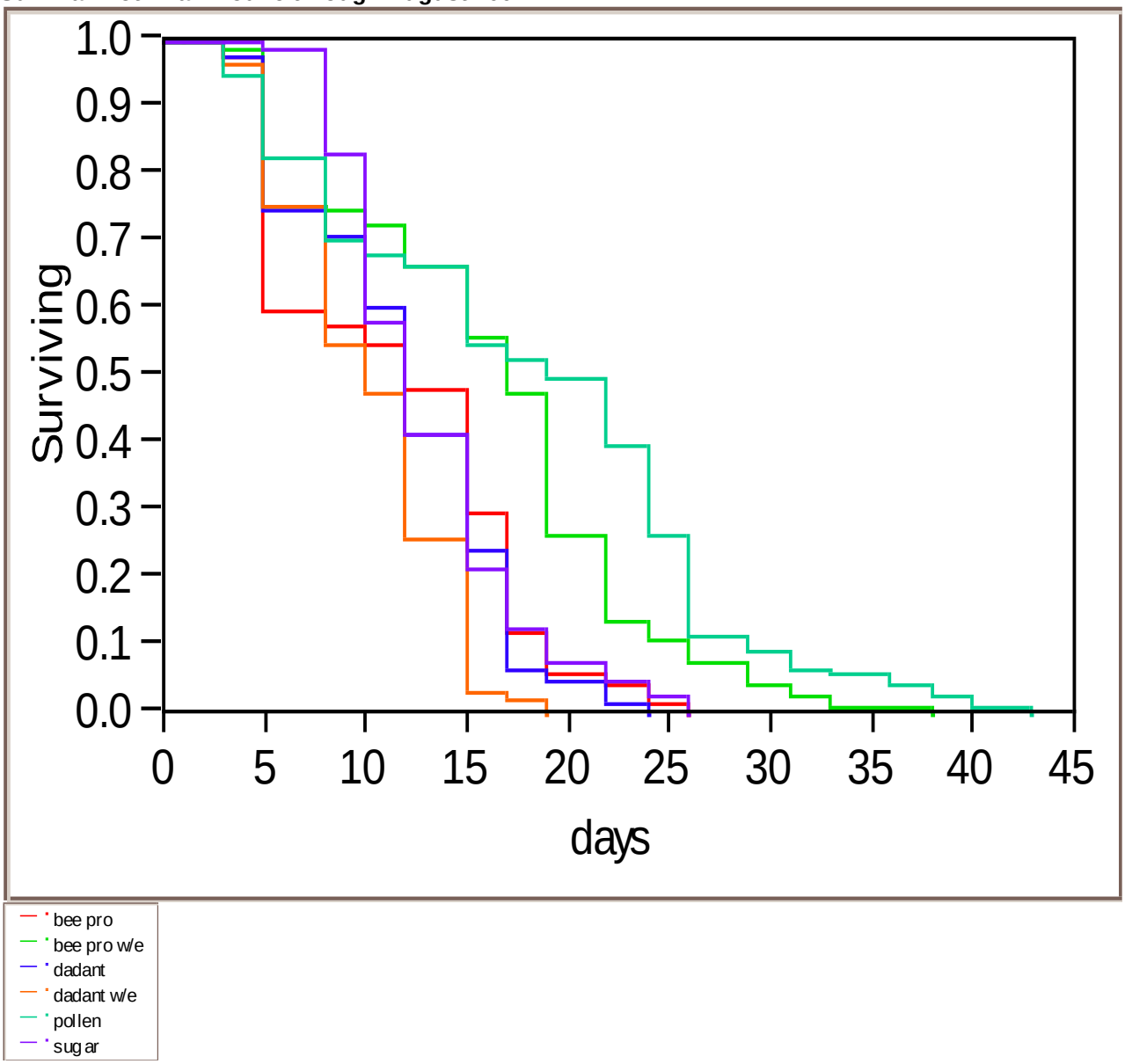
Diet	Observed	Expected		ChiTest
Bee Pro	0	1.5		
Bee Pro /E	3	1.5		0.083265
Dadant	0	1.5		
Dadant /E	3	1.5		0.083265

When offered a choice between the artificial diet and the artificial diet with 5% pollen extract addded, the observed preference was the diet with pollen extract. However ChiTest does not demonstrate a significant difference suggesting that additional replicates be made to establish trend.

Diet	Observed	Expected		ChiTest
Bee Pro	0	1.5		
Pollen	3	1.5		0.083265
Bee Pro /E	0	1.5		
Pollen	3	1.5		0.083265
Dadant	0	1.5		
Pollen	3	1.5		0.083265
Dadant /E	0	1.5		
Pollen	3	1.5		0.083265

Given the choice between artificial diet alone, artificial extract with pollen, or spring pollen, the preference was spring pollen. But once again the ChiTest suggests additional replicates be made to show a significant difference and thus establishing a trend.

Product-Limit Survival Fit
Survival Plot Trial 1- June through August 2001



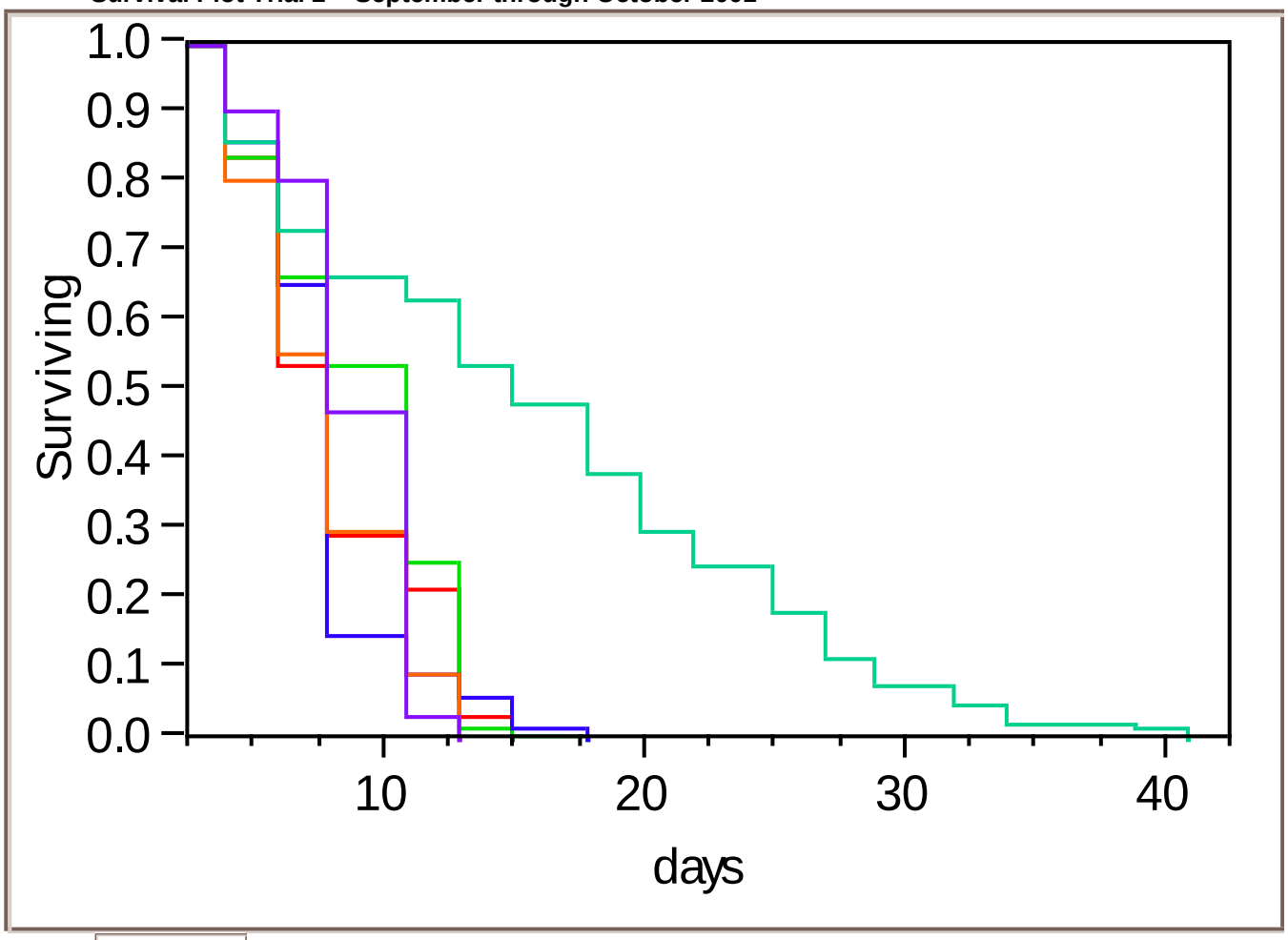
Summary

Group	Mean	Std Dev	Median Time
bee pro	11.5433	0.35828	12
bee pro w/e	15.9133	0.45673	17
dadant	11.85	0.29883	12
dadant w/e	10.1167	0.23579	10
pollen	18.0933	0.57353	19
sugar	13.0667	0.2619	12
Combined	13.4306	0.16893	12

Tests Between Groups

Test	ChiSquare	DF	Prob>ChiSq
Log-Rank	376.5561	5	<.0001
Wilcoxon	199.5755	5	<.0001

Product-Limit Survival Fit
Survival Plot Trial 2 – September through October 2001



Summary

Group	Mean	Std Dev	Median Time
bee pro	8.11667	0.21038	8
bee pro e	9.175	0.21859	11
dadant	7.8125	0.18384	8
dadant e	7.8	0.18591	8
pollen	**16.1**	**0.61501**	**15**
sugar	8.88333	0.15694	8
Combined	9.64792	0.14685	8

Tests Between Groups

Test	ChiSquare	DF	Prob>ChiSq
Log-Rank	334.7442	5	<.0001
Wilcoxon	158.3918	5	<.0001