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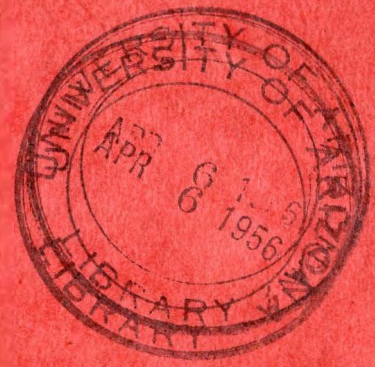
ALFALFA POLLINATION IN ARIZONA

A Progress Report



Arizona Agricultural Experiment Station

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SUMMARY

Production of commercial alfalfa seed crops requires bees for tripping and cross-pollinating the flowers. Surveys in Arizona over several years have shown that native bees are not abundant enough to adequately set commercial alfalfa seed crops. The Arizona grower must depend upon the honey bee for this service. The value of providing adequate honey bee populations in a large-scale seed production area was clearly shown in observations near Yuma in 1955.

The relation of honey bees to alfalfa pollination was studied in an area on the Yuma Mesa of about 600 acres of contiguous alfalfa fields bordered on two sides by the desert. Three colonies of bees per acre were present during the seed setting period; toxaphene, DDT and sulfur (15-5-40) dust mixture was applied three times with a ground duster at night at the rate of 20 pounds per acre. These treatments had little or no effect upon the honey bees, but provided control of alfalfa insect pests.

The gross yields of the 1955 first crop of alfalfa seed in the test area were between 425 and 450 pounds per acre, with parts of some fields yielding as high as 700 pounds per acre. Fields bordering the study area also produced good seed yields although they were not supplied with bee colonies. Where few or no bees were present for pollination, low yields or complete seed crop failures resulted. During 1955 there were several such fields on the Yuma Mesa and in the Yuma Valley.

Suggestions for the use of honey bees for alfalfa seed pollination in Arizona are given in this report with suggestions on the use of insecticides to minimize injury to the honey bees.

ALFALFA POLLINATION IN ARIZONA--A PROGRESS REPORT

George D. Butler, Jr., Frank E. Todd, and Donald M. Tuttle

Introduction

Prior to 1945, Arizona led the nation in per-acre alfalfa seed yields. This supremacy has been lost to California and Washington. While both acreage and yield per acre have declined in Arizona, the reverse has been the case in California (Table 1).

Table 1. -- Alfalfa Seed Production*

Years	Acreage (thousands) Ariz.	Calif.	Yield (lbs./a.) Ariz.	Calif.
	Thousands of acres		Pounds per acre	
1924-30	18	15	306	216
1930-39	23	16	288	198
1940-49	40	27	158	170
1950	60	115	185	270
1951	45	77	215	325
1952	30	84	225	460
1953	26	93	200	475
1954	32	128	190	440
1955	24	178	160	480

*Source: Agricultural Statistics and U. S. D. A. Yearbooks

Methods of alfalfa seed production have undergone radical changes during the past 15 years. Modern methods have tended to increase the yields per acre and brought greater year-to-year stability in production. The principal changes in methods have been:

(1) Successful controlling of most of the injurious insects with organic insecticides;

(2) A conscious effort to provide pollinators by moving colonies of honey bees into seed fields;

(3) Planting in 36- to 48-inch rows at low rates of seeding (3/4 to 2 pounds per acre). Fields planted and managed for seed production alone. Hay not harvested from many fields. Cultural efforts to produce plants of high seed capacity.

(4) Improvements in havesting equipment and methods.

As experience is gained it has become evident that none of these factors can be neglected without suffering loss in yields.

and ditch banks to control weeds. Even more damaging, however, is the recent use of highly toxic insecticides which have destroyed many of the native bees in alfalfa seed-growing areas.

The following key will identify the species of bees most often observed in alfalfa fields in Yuma County:

Much smaller and more slender than honey bee

Front part of body metallic green, abdomen yellow with darker bands.
Agapostemon melliventris Cresson — GREEN SWEAT BEE

Shiny black or black with red abdomen, very small
Halictus spp. — SWEAT BEES

In same size range as honey bee

Pollen basket on underside of abdomen; black with white bands on abdomen
Megachile sidalceae Cockerell — LEAF-CUTTER BEE

Abdomen dark with conspicuous iridescent bands
Nomia melanderi Cockerell — ALKALI BEE

Thorax yellowish, velvety; abdomen black; legs red
Hemisia rhodopus (Cockerell) — ----------

Very similar in color to honey bee

Antennae very long
Melissodes tepida yumensis LaBerge — LONG-HORNED BEE (MALES)

Conspicuous hairy bands on abdomen
Melissodes tepida yumensis LaBerge — LONG-HORNED BEE (FEMALES)

No conspicuous hairy bands on abdomen
Apis mellifera L. — HONEY BEE

Tha alkali bee is a very effective pollinator of alfalfa in Washington (Menke 1954), but observations in Yuma County in 1954 and 1955 indicate that there are too few of this and other species of native bees in alfalfa fields to provide adequate pollination. There is no practical way known to introduce and establish adequate populations of native bees; therefore, honey bees, which can easily be moved into alfalfa fields in large numbers, were provided to assure adequate cross-pollination of the alfalfa flowers in the Yuma County tests.

Honey bees and alfalfa pollination

The honey bee (*Apis mellifera* L.) visits alfalfa flowers to collect pollen or nectar. Pollen-collecting bees can be recognized by the pollen pellets adhering to the hind legs. The more pollen-collecting honey bees that are present in an alfalfa field, the better will be the tripping and cross-pollination of the flowers. The Yuma Mesa has been observed to have exceptionally abundant pollen-collecting honey bee populations. The acitvity of nectar-gathering honey bees in tripping alfalfa blooms should not be discounted for, although their tripping may be comparatively inefficient, it is very important when large populations of bees are working in a field.

A practical demonstration of the effectiveness of honey bees as alfalfa pollinators was carried out in 1955 in a large area on the Yuma Mesa which had no native bees.

Observations on Alfalfa Seed Production on the Yuma Mesa, 1955

Description of the test area

Observations on the relationship of honey bees to alfalfa pollination were made in 1955 on the Yuma Mesa in an area of approximately 600 acres, adjoining and bordered on two sides by desert. The alfalfa was of the African variety, planted in a solid stand and in its second year of growth on virgin land. In some of the fields, plants were still weak and the stand sparse. The seed crops in the area were started during May, following winter pasturing and one or two spring hay crops. The cultural methods were those commonly practiced in the area.

Grower-beekeeper contracts

Contracts for bees were signed between individual growers and the beekeeper. The beekeeper agreed to supply three colonies of bees per acre during the seed-setting period, while the grower agreed to apply only certain "safe" insecticides to the field with ground equipment during this period and to harvest and give the beekeeper one-third of the yield of alfalfa seed above 300 pounds per acre.

Control of harmful insects

Several injurious insects (enumerated below) appeared in alfalfa seed fields on the Yuma Mesa during the 1955 season. All of these insects were controlled with a dust mixture of toxaphene, DDT, and sulfur (15-5-40), applied with a Hardie ground duster at night at the rate of 20 pounds per acre.

Clover seed chalcid. Where an adequate insecticide program against other insects was followed, there was little loss from clover seed chalcids. It appeared that good cultural practices, combined with a moderate use of toxaphene, DDT and sulfur dust, held the chalcids in check even during the second seed crop when, in most years, their presence has been a limiting factor in seed production.

Corn earworm. Larvae of the corn earworm or bollworm, or a closely related species, were abundant on the buds of the alfalfa plants in mid-June. Toxaphene and sulfur (20-40), or toxaphene, DDT and sulfur (15-5-40) dusts used at the rate of 20 pounds per acre gave excellent control.

Serpentine leafminer. The serpentine leafminer was more abundant than in previous years. No special treatments were applied for it in the observation area.

Leaf-roller. Leaf-rollers (Platynota sp.) became very injurious during the period of the second seed crop. On the Yuma Mesa, some growers applied insecticides too late and were forced to clip the plants before starting on a second seed crop.

Lygus bugs. Lygus bugs became abundant during August and September. The periodic use of toxaphene or toxaphene combinations controlled this pest well.

Spider mites. Sulfur was usually included in dust formulations as a preventive against spider mite increase. In some fields outside the observation area, excessive use of insecticides and the omission of sulfur resulted in rapid build-ups of mites. When abundant, mites are capable of webbing over and drying up the plants and blooms.

Spotted alfalfa aphid. High populations of aphids caused the drying up of plants and blooms in some portions of the test area during late June. Aphid populations were held in check by properly-timed applications of toxaphene, DDT and sulfur (15-5-40) used at the rate of 20 pounds per acre.

Stink bugs. Adults were quite abundant in June and were successfully controlled with either a toxaphene and sulfur (20-4-) dust or toxaphene, DDT and sulfur (15-5-40) dust used at the rate of 20 pounds per acre. Stink bugs became numerous again in September 1955, and remained until cold weather. In some fields there were 40 to 60 stink bugs per 100 sweeps. Stink bugs were not controlled properly in some fields in the test area because of lack of treatments, improper timing, or the use of too little insecticide. Such fields had poor yields of cleaned seed, in addition, served as reservoirs from which stink bugs migrated to treated fields, causing further damage and necessitating additional dust applications.

Alfalfa seed yields:

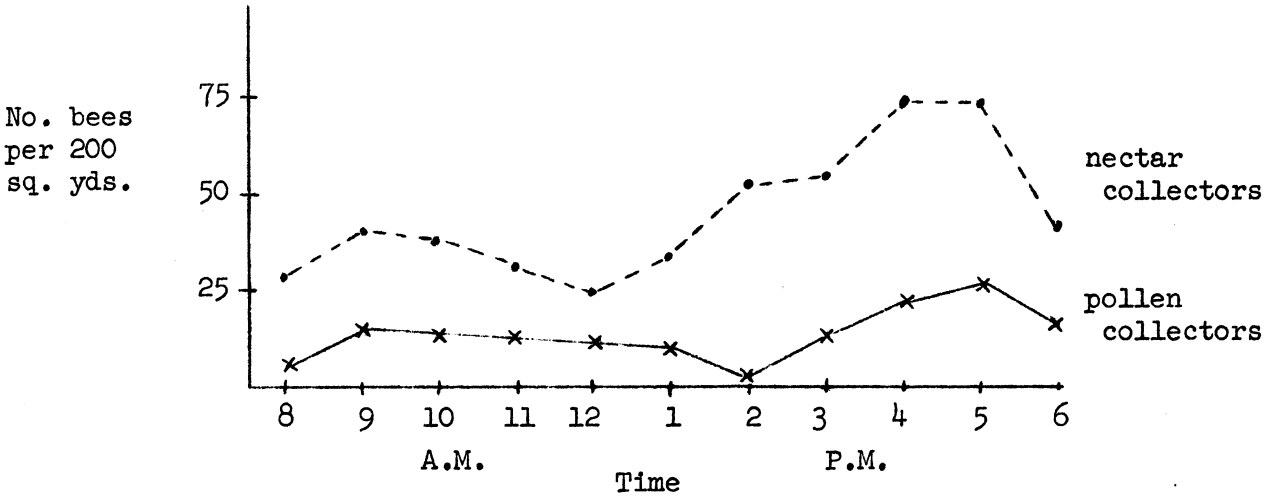
In the test area on the Yuma Mesa which had 3 colonies of honey bees per acre and in which no native bee activity was observed, gross yields of the 1955 first crop of alfalfa seed ran between 425 and 450 pounds per acre. Some parts of the fields yielded as high as 700 pounds per acre.

Fields which bordered in the test area also produced good seed yields, although they were not supplied with bee colonies. Seed fields one mile from any honey bee colonies yielded about 250 pounds of seed per acre, while fields two or more miles from bee colonies yielded only 150 pounds or less of seed per acre.

Where there were no bees available for pollination complete failures resulted. There were several such fields on the Yuma Mesa and in the Yuma Valley during 1955.

Observations on honey bee activity and alfalfa tripping.

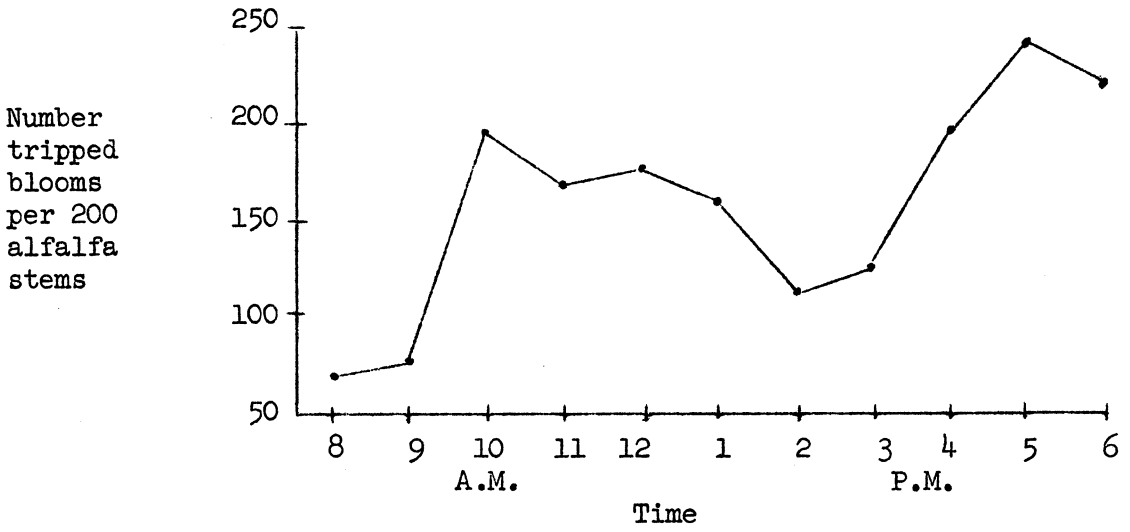
The number of nectar and pollen-gathering honey bees was counted at hourly intervals throughout the day on June 22, 1955, in a 200 square-yard-area in an alfalfa field in the observation area. Graph 1 presents the results of these observations:



Graph 1. The number of nectar and pollen collecting honey bees per 200 square yards. Yuma, Arizona. June 22, 1955.

At 8 a.m. there was an unusually heavy flight of bees, particularly nectar gatherers. There was a decline in the number of nectar gatherers during the morning. About mid-day the number of nectar gatherers began to increase, with a very marked rise in numbers from 4 to 5 p.m. Pollen gatherers increased in numbers from 8 to 9 a.m. but then declined until 2 p.m., when there was almost no pollen-collecting activity. This reduction in pollen collecting in the early afternoon is a common phenomenon. From 4 to 5 p.m. there was an increase in the number of pollen collectors.

The relationship between honey bee activity and the tripping of the alfalfa flowers was determined by counting the number of freshly tripped alfalfa blooms on 200 alfalfa stems in the area where the bee population counts were made. The number of freshly tripped blooms on 200 stems is shown in Graph 2.



Graph 2. The number of tripped blooms per 200 alfalfa stems. Yuma, Arizona. June 22, 1955.

The increase in the number of freshly tripped blooms in the morning, the reduction at mid-day, and the increase again in the afternoon closely follows the number of honey bees observed in the field. A highly significant mathematical correlation of .51 was determined for the relationship between the number of honey bees per square yard and the number of freshly tripped blooms per stem. The variation of the tripping of the alfalfa blooms throughout the day was closely associated with the variations in the activity and number of honey bees present.

Results of a survey of alfalfa seed fields

On June 25, 1955, Dr. D. M. Tuttle, Dr. G. D. Butler, Jr., and three assistants made a survey of several fields on the Yuma Mesa from 9 a.m. to 12 noon to determine the activity of honey bees and to make notes on pollination and insect pests. Some of these observations, together with the final seed yields of the fields visited, are given in Table 2. Although bee population counts for any one day in a field are not sufficient for an adequate comparison with the final yield of seed, the data which were obtained show a definite trend and reflect the observations of bee activity made on other days. The bee populations observed in these fields represent typical situations found in alfalfa-growing areas and a discussion of these fields is given below:

Table 2. Observations made of honey bee activity in Yuma Mesa alfalfa fields on June 25, 1955, and the subsequent yields of alfalfa seed.

Field	Variety of alfalfa	No. bees per 100 sq. yds. nectar gatherers	No. bees per 100 sq. yds. pollen gatherers	Yield lbs.
1.	African	38	5	450
2.	African	51	14	430
	9:10 a.m.-12:00 noon	58	18	
3.	African	68	32	450 (est)
4.	African	70	13	180
5.	Ranger	2	0	100
6.	Ranger	5	2	No crop
7.	African	0	0	No crop

Fields 1 and 2 were in an area that had an average of 3 colonies of honey bees per acre. Due to the constant activity of the bees, there were never large numbers of untripped blooms present and, therefore, not a large number of bees per square yard.

Field 3 was an example of a field which had large plants with many attractive flowers but was not provisioned with honey bees. Its attractiveness was such that many honey bees were flying to this field from several directions, in some instances ignoring the poorer alfalfa fields in which they had been placed. This field had one of the largest populations of honey bees and the largest number of pollen-collecting bees per square yard observed during 1955. Unfortunately, parathion dust was used on this field several times and bee populations were observed to be greatly reduced following the applications.

Field 4 had no bee colonies placed in it but was near enough to attract bees from Fields 1 and 2. Although bee activity on June 25 was good, the activity of the bees in the field was probably reduced thereafter by several applications of a dust containing 2 per cent benzene hexachloride and 50 per cent sulfur. Numerous dead bees were observed at the colonies in Field 1 and 2 after the insecticide applications in Field 4.

Fields 5 and 6 were examples of fields which had no bee colonies near them and were treated with applications of parathion and benzene hexachloride, both of which are highly toxic to bees. Both fields had virtually no seed set. In addition, both fields had heavy populations of mites and corn earworms on June 25.

Field 7 is an example of a field which was not worked by bees even though colonies had been placed in it. There was not enough seed set to justify harvesting costs. In the past, single fields have been provisioned with bees, as this field was, but have not produced satisfactory seed crops. The bees scattered over a wide area and worked in other fields which were more attractive. It is such cases that emphasize the point that providing bees for alfalfa seed production and protecting the pollinators from toxic insecticides must be a community-wide effort.

SUGGESTIONS FOR ALFALFA POLLINATION IN ARIZONA

Suggested uses of bees:

1. Move colonies into alfalfa seed fields 7 to 10 days after the first flowers appear.

2. On small fields, up to 40 acres, colonies should be located on all four edges. In larger fields, colonies should be scattered on the edges of each 40-acre unit. Better results are obtained where large areas rather than isolated individual fields are provided with bees.

3. Provide two to three colonies of bees per acre.

4. Place colonies where they will interfere as little as possible with irrigators, cultural operations or the public.

5. Colonies may be removed about two weeks before seed harvest.

Suggested uses of insecticides:

1. Apply insecticides only if necessary and at recommended times and dosages.

2. Apply insecticides before bees are moved into fields, if possible.

3. When insecticides are required during an alfalfa flowering period, apply them in the early morning, late evening or during the night while bees are inactive. Ground applications after dark are preferred, and care should be exercised to avoid drift of insecticides into bee colonies.

4. A dust mixture containing toxaphene, DDT and sulfur applied at the recommended time and dosage rates causes the least damage to bees of any of the commonly used insecticides.

5. DO NOT apply arsenicals, EPN, chlordane, BHC, lindane, parathion, malathion or dieldrin at any time to alfalfa fields in bloom or near honey bee colonies.

6. Notify beekeepers two days before spraying or dusting alfalfa seed fields.