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GUAM AGRICULTURAL EXPERIMENT STATION

ISLAND OF GUAM

Under the supervision of the
UNITED STATES DEPARTMENT OF AGRICULTURE

**REPORT OF THE
GUAM AGRICULTURAL EXPERIMENT
STATION**

1927



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GUAM AGRICULTURAL EXPERIMENT STATION, ISLAND OF GUAM

[Under the supervision of the Office of Experiment Stations, United States Department of
Agriculture]

E. W. ALLEN, *Chief, Office of Experiment Stations.*

WALTER H. EVANS, *Chief, Division of Insular Stations, Office of Experiment Stations.*

STATION STAFF

C. W. EDWARDS, *Director.*

JOAQUIN GUERRERO, *Assistant in Agronomy and Horticulture.*

F. B. L. GUERRERO, *Assistant in Poultry Husbandry.*

S. R. VANDENBERG, *Entomologist.*

PETER NELSON, *Assistant.*

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ISLAND OF GUAM, U. S. A.

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Washington, D. C.



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REPORT OF THE DIRECTOR

C. W. EDWARDS

Conditions during the year covered by this report were unusually favorable to crop production. The rains were not as excessive as usual during the wet season, and the precipitation during the ordinarily dry months was sufficient for crop production. Plant pests, especially the European corn borer, were less troublesome than in some years. Observations indicate that during the most favorable seasons the corn crop reaches maturity with little damage from the borer, whereas during less favorable seasons, when growth is consequently slower, the crop is badly damaged.

During the year the swine house was completed, the floors being laid and the watering systems installed; the wooden slat house, tables, propagating beds, and seed flats of the plant-propagating unit were replaced by concrete structures; a septic tank was installed for the station residence; some repairs were made to the poultry plant and equipment and part of the work on the addition to the station residence was completed.

The assistant in agronomy and horticulture again cooperated with the department of education by serving as one of the judges of the agricultural exhibits at the school fairs and by giving a series of talks on gardening before the normal-school classes.

The work in horticulture included mainly care of the station orchard, introduction of various fruit trees for trial and distribution, propagation experiments with the mango and the avocado, propagation

and distribution of ornamentals, variety tests with cabbages, selective breeding of tomatoes, cultural tests with the banana, and storage trials with oranges and tangerines.

The entomologist, in addition to his other duties, gave a series of 10 lectures on proper methods of combating insect pests and plant diseases before the normal-school agricultural class. In cooperation with the department of education he also outlined lessons on agricultural subjects for use as a general agricultural course for the graded schools.

ANIMAL HUSBANDRY

HORSES

The results of further tests with coconut meal as a part ration for work horses agree with previous findings and confirm the conclusion that one-third to one-half by weight of the ordinary oat ration may be replaced by coconut meal. The combination feed is considerably cheaper than an entire oat ration.



FIG. 1.—Grade cow (three-fourths Ayrshire, one-fourth native). Milk yield for 300 days (second calving) was 4,500 pounds

The station has secured a young pure-blood Morgan stallion for use in range-breeding native mares. The station Morgan stallion, Donald, on account of age is unsuited for this use.

CATTLE

Experimental work with cattle was confined principally to a continuation of the project, having for its object the establishment of an improved station dairy herd by upgrading the native stock. In the present herd there are a number of half-blood and three-quarter blood Ayrshires, which show decided improvement over the average native cow in size and milk production. (Fig. 1.)

Feeding test.—A test with milk cows was begun during the latter part of the year to compare a local ration, consisting of equal parts of coconut meal and ground corn, with a ration of imported (with the exception of corn) feeds made up of corn, oats, bran, and cottonseed meal.

SWINE

Two imported purebred Duroc-Jersey boars were added to the swine herd. One of the boars died March 16, 1927, from an undetermined cause.

No hog cholera or other serious swine disease was noted on the island during the year, and the swine industry is gradually recovering from its loss of animals during the cholera outbreak of the early part of 1926. At the suggestion of the station, the island government is now keeping a supply of serum on hand to be used in an attempt to control the disease at the outset.

Coconut meal and cassava for brood sows.—A series of tests has been planned to determine the suitability of a ration made up of fresh cassava and coconut meal with and without tankage for brood sows from time of service to time of weaning their litters. Two grade gilts and one older grade sow were used in the one test completed during the year. Of these, one gilt farrowed and satisfactorily raised a litter of 7 pigs, the other gilt a litter of 5 pigs, and the sow a litter of 10 pigs. The dams kept in good condition, and the litters were healthy and of average weight. The ration consisted of equal parts by weight of coconut meal and fresh cassava. In addition, each sow had before her at all times a supply of fresh Para grass, and during the period she was suckling her litter was given 2 ounces of tankage daily.

Mineral mixture for growing pigs.—Ten female grade pigs, about 3 months old, were divided into two lots and turned on Para grass and fed a concentrate ration composed of 2 parts coconut meal and 1 part ground corn. Lot 2 in addition received a mineral mixture composed by weight of 20 parts salt, 15 parts wood charcoal, 25 parts ground local limestone (cascajo), and 40 parts wood ashes. Eight pounds of this mixture was added to each 100 pounds of feed. Unfortunately the test had to be terminated at the end of 30 days because the local supply of coconut meal had become exhausted. During the period each pig of the first lot made an average daily gain of 1.07 pounds, whereas each pig of the second lot made a daily gain of 0.82 pound. The results indicate that grade pigs of this age when pastured on Para grass and fed in addition a ration of 2 parts coconut meal and 1 part ground corn do not require the mineral mixture used in the test. The two lots of pigs made an average daily gain of 0.95 pound per head at a cost of \$0.039 per pound. The gain was both satisfactory and economical for pigs of this class.

POULTRY

Rhode Island Reds × *native cross.*—In the work devoted to the development of a new variety of poultry through the breeding and selection of Rhode Island Reds × native crosses, difficulty was encountered in the establishment of the desired solid-white plumage and the white-egg characters. It was decided that it would be advisable to introduce a cross of some white plumaged, white-egg breed. Accordingly a few reciprocal crosses were made with purebred White Leghorns. The results of these matings have been so promising as to plumage color and size and color of egg that it has been decided to follow this procedure in the further development of the project.

Chicken pox.—Chicken pox again appeared in the station flock. Because of prompt isolation of the sick fowls and the observation of general measures for the control of the disease only a few were lost. Results of experiments at the station through a number of years and on some of the few ranches where advice on control has been followed show that much of the loss from outbreaks of chicken pox throughout the island could be prevented by giving the flocks proper care and handling.

Parasites.—Near the close of the year the station flock was found to be rather generally infested with tapeworm and ascarids. Tests are being made to determine the comparative efficiency of a number of vermicides for these parasites.

Cod-liver oil for chicks.—Chicks are raised with difficulty during the period of heavy rains in Guam, and attempts to confine them indoors often result in losses from leg weakness. A preliminary test was conducted to determine the possibility of successfully raising chicks indoors during the rainy season by adding cod-liver oil to the ration. Two lots totaling eighty-seven 1-week-old chicks were used in the test. They were confined indoors without exposure to direct sunlight during the period of the test. The 37 chicks in the first lot were fed for a period of 11 weeks a standard ration to which was added 2 per cent by weight of cod-liver oil. The chicks in the second lot received 5 per cent of the oil in the ration for a period of nine weeks. A few mild cases of chicken pox occurred among the chicks of the first lot. Otherwise, all the chicks made fairly normal growth, and there was no case of leg weakness.

REPORT OF THE ASSISTANT IN AGRONOMY AND HORTICULTURE

By JOAQUIN GUERRERO

LAWN GRASSES

The most common of the locally grown lawn grasses are inifuk (*Andropogon aciculatus*), Bermuda grass (*Cynodon dactylon*), *Desmodium trifoliata*, and las-aga (*Monerma repens*). The first-named is hardy and makes a fine, dense growth, but is objectionable because of the adherent awns and its tendency to turn yellow during dry weather. Both Bermuda grass and *D. trifoliata* appear to be adapted to certain localities only, and they must be given constant attention to keep them from being crowded out by other grasses. Las-aga is hardy, but rather coarse for use as a lawn grass.

In an attempt to find lawn grasses better suited to local conditions than the above-mentioned species, the station introduced from Florida, through the United States Department of Agriculture, small samples of seed of Japanese lawn grass (*Osterdamia japonica*) and centipede grass (*Eremochloa ophiuroides*). The seed was sown in flats, and the seedlings were later transplanted to the field. Both introductions have made a good start. A later introduction of centipede grass plants from the department failed to survive shipment. Bahia grass (*Paspalum notatum*) was also received from the department, and although a number of roots were planted only one survived. This was given all possible care and has made such growth as to admit of root division for propagation.

FORAGE CROPS

There are now growing at the station a number of introduced forage plants, many of which appear to be well adapted to island conditions. The most promising of these have been distributed to various parts of the island for trial on soils differing from those of the station.

Adaptability test.—With the assistance of the station the island government made plantings of a number of varieties of grasses at the Barrigada farm, 10 miles from the station, in order mainly to furnish green forage for the government stock and also to collect some data regarding the adaptability of these grasses to the soil of that locality. The distance of the farm from the station and the lack of sufficient time and facilities prevented the collecting of as much data as were desired regarding these plantings. The soil of the area is a thin clay loam underlain by coral limestone and is very similar to that of the greater part of the north-central part of the island.



FIG. 2.—Napier grass at Barrigada farm 51 days after second cutting

Of the area devoted to the plantings, about 2.5 acres are occupied by Napier grass (*Pennisetum purpureum*), 1.5 acres by Guatemala grass (*Tripsacum laxum*), and approximately a $\frac{1}{10}$ -acre plat each by Japanese cane (*Saccharum officinarum*), Guinea grass (*Panicum maximum*), Rhodes grass (*Chloris gayana*), Vasey (*Paspalum larranagai*), jaragua (*Cymbopogon rufus*), *Pennisetum setosum*, and molasses grass (*Melinis minutiflora*). With the exception of the Japanese cane, all the plantings made a good initial showing. The Napier grass made the most rapid growth. The first cutting was made 46 days after date of planting, when the average height was 5 feet; the second cutting was made 51 days later, when the average height was 6 feet. (Fig. 2.) Sixty-eight days after they were planted the Vasey grass averaged 4.5 feet in height, the jaragua 5.5 feet, the Rhodes grass 3 feet, and the *Pennisetum setosum* 6 feet. At the end of 60 days the molasses grass was producing a heavy matted growth which completely covered the ground. The Guatemala grass grew comparatively slowly but gave a very heavy yield 96 days after date of planting. The stand showed a more rapid growth after it became well established.

The Guinea grass gave a heavy yield at the first cutting and a fair second crop, but thereafter the yield was poor, and the plants flowered at a comparatively short distance from the ground. This characteristic of Guinea grass has been noted also in plantings at the station. The grass apparently becomes root bound and requires replanting every few months. The stalks of the Napier grass at the government farm were much smaller in diameter and the leaves narrower than is the case until after a number of cuttings have been made with the same grass on the heavy clay lowlands of the station. In the latter case the growth becomes finer with successive cuttings. If the plantings are considered as a whole, the Napier and Guatemala grasses, mainly because of their much heavier yields, ranked far above any of the other grasses as a green forage for livestock.

The test to determine the adaptability of Japanese cane, Napier grass, Guatemala grass, Merker grass, and *Pennisetum setosum* to rocky limestone hillsides is being continued. The Napier grass has produced the highest forage yield, followed by the Guatemala, Merker, *P. setosum* grasses, and Japanese cane, in the order mentioned.

Effect of ground limestone (cascajo), burnt lime (local), and coconut cake on yield of Napier grass.—Seven cuttings have been made to date in this test, two of them being obtained during the fiscal year 1926. The plat receiving cascajo produced a much greater yield of forage than did any of the other treated plats, whereas the plat receiving no treatment produced the lowest yield.

Effect of fertilizer on yield of Japanese cane and Napier and Guatemala grasses.—Tests are being continued comparing the effect of manure, lime, and manure and lime in combination on yield of Japanese cane and Guatemala and Napier grasses. The test was begun October 25, 1923, and has yielded to date eight cuttings of Japanese cane and Guatemala grass and nine cuttings of Napier grass. So far the results show that with the Japanese cane and the Napier grass the plat receiving lime and manure in combination produced the highest yield, and that with the Guatemala grass the lime treatment gave the best results. Lime and manure in combination were tried to test the reputed inadvisability of using such application, but the results in the case of the Napier grass were not undesirable.

FIBER PLANTS

The henequen fiber plants which were obtained from the Office of Fiber Investigations, United States Department of Agriculture, and planted on a very rocky hillside August 3, 1925, are making good growth during the present rainy season. The plants average about 36 inches in height. One row of maguey was set out next to the henequen September 22, 1926. The plants are now about 35.4 inches high. Late in the year the station received from the same source additional henequen material and a few sisal bulbils. The plants are now being grown in the propagating bed and will be set out as soon as they are well rooted.

LEGUMES

Alfalfa.—Seed material of the varieties of alfalfa—Chinese and Province—harvested from lowland plats, was sown in flats, and the resulting seedlings were transplanted to a cascajo sidehill. Of the two varieties, the Chinese made the better growth.

Soy beans.—During the year seed of 12 varieties of soy beans was received from the United States Department of Agriculture. Part of these was planted in one section of the garden November 5, 1926, but a very poor stand was secured. On December 17, 1926, another planting was made with the rest of the seed on hand. A fairly good stand resulted, and enough seed was obtained to permit another planting on April 19, 1927. In this last planting, comprising 12 varieties, Hahto made the poorest growth and died before flowering, and Biloxi made the fastest and densest vine growth. All the varieties except Hahto are now fruiting, but none have as yet reached maturity.

Pigeon peas (*Cajanus indicus*).—Cover-crop and green-manure investigations and variety tests are being carried on with the pigeon pea. A planting was made January 9, 1926, to serve as a combination cover and green-manure crop. The plants are to be topped at each fruiting and the material placed between the rows and allowed to decompose. At the conclusion of a certain period the plat will be devoted to another crop and the yield obtained compared with that of adjoining plats which have not received the green manure. Observations will also be taken as to efficiency of the pigeon peas, treated as above stated, as a cover crop. To date one topping (about one-third of the height of the plants) has been made. The cutting yielded at the rate of 8.28 tons per acre. A planting of pigeon peas occupying about 2 acres of land was made April 16, 1927, as a test of Columbia, a white-seeded variety from British West Indies, and New Era, a variety selected for grain yield. At the close of the year the plants were about 5 feet high.

RICE (ORYZA SATIVA)

The generally low yields of rice in Guam are partly attributed to the need of new seed. During the early part of the fiscal year the station introduced from the Philippines a small amount of seed of five varieties. These were given to two local rice planters for trial. The Ramai and the Inachupal did very well and produced yields much above the yield of the native rice. Sufficient seed of these varieties was secured for more extensive plantings the coming year.

ROOT CROPS

Sweet potatoes (*Ipomæa batatas*).—In continuation of the variety test comparing the yields of imported and native varieties of sweet potatoes, one crop was harvested during the year. Porto Rico, which is becoming the most popular variety with the local farmers, again gave the highest yield. The native varieties gave the following estimated acre yields: Yap, 1,800 pounds; Dago, 300 pounds; Mamaka, 1,500 pounds; and Amarillo, 600 pounds. The introduced varieties gave the following estimated acre yields: Porto Rico, 9,400 pounds; Triumph, 1,600 pounds; Pumpkin, 2,800 pounds; Yellow Jersey, 5,500 pounds; Nancy Hall, 2,200 pounds; and Southern Queen, 8,300 pounds.

Last year a planting of the variety Porto Rico proved to be an effective means of destroying a heavy growth of the troublesome pest aroma (*Acacia farnesiana*). The aroma growth was first slashed and burned. Given two cultivations, the sweet potatoes made sufficient growth to suppress and eventually kill the aroma. From the planting of sweet potatoes a yield of 4,720 pounds per acre was obtained.

In the test undertaken to determine the effect of fertilizers on yield of sweet potatoes, the plat receiving superphosphate (acid phosphate) in combination with sulphate of ammonia and sulphate of potash produced the highest yield, followed by the plat treated with superphosphate and stable manure. The superphosphate and nitrate of soda plat produced an estimated acre yield of 8,700 pounds of roots; the superphosphate and sulphate of ammonia plat, 9,000 pounds; the superphosphate and coconut-meal plat, 8,900 pounds; the superphosphate and sulphate of potash plat, 10,600 pounds; the superphosphate and barnyard-manure plat, 10,900 pounds; the superphosphate, coconut-meal, and sulphate of potash plat, 8,500 pounds; the superphosphate, nitrate of soda, and sulphate of potash plat, 8,200 pounds; the superphosphate, sulphate of ammonia, and sulphate of potash plat, 13,700 pounds; and the check (untreated) plat, 5,800 pounds.

Cassava (Manihot utilissima).—Several plantings of cassava were made during the year primarily for use of the roots as a swine feed. Planted January 11, 1926, the varieties "white" and "bitter" were harvested November 13, 1926. The bitter variety yielded at the rate of 24.8 tons per acre, and the white variety at the rate of 19.36 tons. A planting of the bitter variety made July 9, 1926, and harvested March 10, 1927, yielded at the rate of 23.47 tons per acre. The other plantings are not yet ready for harvest. In general, the station soils are too heavy for best yields of root crops.

Edible canna (Canna edulis).—From previous distributions of planting material of edible canna it appears that this plant may fill a particular need in the list of root crops grown on the island. In some of the upland farming regions where most of the root crops, especially taro, can not be successfully grown, edible canna has made satisfactory yields. Edible canna seems to be much less damaged by the leaf hopper (*Megamelus* sp.) and the Egyptian cotton worm (*Prodenia litura*) than is taro.

Taro.—Taro was grown mainly for the purpose of producing feed for the station swine. A planting made February 10, 1926, was harvested January 16, 1927, and yielded at the rate of 3,087 pounds per acre. Dry weather following planting damaged the crop. Another planting, made March 15, 1927, included a variety of yautia which was introduced into Guam by the station many years ago. The variety only recently began to attract attention, and a number of the local ranchmen now prefer it to the local taro.

Yam (Dioscorea spp.).—The test with yams was continued to determine the effect of trellising on yield. The vines occupying one-half the plat of each variety were provided with supports. Results showed that of the seven varieties under test, five made increased yields due to trellising. In the trellised rows *Dioscorea alata* produced the highest yield, and *D. latifolia* the lowest. In the untrellised rows Haya yielded the highest and the wild yam, or gado, the lowest. The estimated acre yields were as follows: *D. latifolia*, nontrellised, 3,388 pounds; trellised, 1,815 pounds; *D. alata*, nontrellised, 3,760 pounds; trellised, 8,378 pounds; Red yam, nontrellised, 2,627 pounds; trellised 3,548 pounds; White yam, nontrellised, 2,556 pounds; trellised, 3,633 pounds; Haya, nontrellised, 4,840 pounds; trellised, 2,904 pounds; Nika, nontrellised, 1,488 pounds; trellised, 3,939 pounds; and the wild yam nontrellised, 1,449 pounds; and trellised, 4,035 pounds.

FRUIT INVESTIGATIONS

Orchard.—The orchard fruit trees were pruned and sprayed as conditions demanded. Scaly bark (probably psorosis) of citrus is being controlled by applications of a mixture of Bordeaux paste and bichloride of mercury. All the citrus trees are still badly attacked by tineid leaf miners. Lime-sulphur spray does not seem to be of much benefit for miner control. Other sprays are being tried.

Nursery.—In an effort to increase the production of improved varieties of fruits, a number of avocado and mango trees were grafted and some citrus trees were budded. Many of these have already been distributed to interested parties and the rest are to be distributed during the coming rainy season. A number of seedlings are being grown for further operations. Several hundred seedlings of local oranges, including tangerines, are being grown to replace older trees of the best varieties of oranges (as distinguished from tangerines), which are rapidly succumbing to scaly bark, and also to effect a more general distribution of tangerines. The latter appear to be



FIG. 3.—Native oranges. Left to right: Tangerine, smooth-skinned cahit, rough-skinned cahit.

immune, or at least highly resistant, to scaly bark. Recent introductions during the year include the white mountain apple, the star apple, and the Surinam cherry, and a few lanzones. All the plants have made a good start.

Banana cultural test.—In the banana cultural test having for its object the determination of the suitability of planting material in various stages of growth for propagating purposes, the plants were in fruit during the year. Most of the bunches are small, probably in large measure because of adverse soil conditions. The various plats seem to be comparable in this respect. Complete records are not yet available.

Storage tests with native oranges.—Of the so-called native oranges grown on the island, there are two general classes, the cahit and the naranghita. (Fig. 3.) The cahit appears to be a descendant of the Valencia, but it now shows a wide variation in size of fruit and texture and thickness of rind. The naranghita is a tangerine. The latter is at present grown only to a limited extent. The native orange, especially the cahit, is largely preferred to the imported orange for beverage purposes.

During the regular fruiting season the cahit fruit is generally over-abundant, while at other times the supply is very limited. An occasional tree may be found bearing more or less continuously. In order to remedy the situation to some extent preliminary tests were conducted to determine the feasibility of keeping the native oranges in cold storage and also at ordinary room temperature. The fruits used in both tests were carefully gathered by clipping the stems and were handled so as to prevent bruising as much as possible.

In the cold-storage test, one lot each of cahits and tangerines was allowed to remain on the tree until the fruits had partly or completely yellowed. The native oranges do not turn yellow on the tree as quickly as do most of the oranges grown in the semi-Tropics. The others were picked when they were mature but still green in color. Lots of the latter were held for various periods before they were placed in storage. In each instance the fruits were packed in ordinary double-sectioned crates. Some of the fruits were wrapped with paper, others were dipped in a 1:500 copper-sulphate solution, and still others were dipped in the solution and then wrapped. A fourth lot was stored untreated. All possible care was taken to have the fruits of each crate uniform in every respect.

The conditions under which the test was conducted were far from satisfactory. The only privately owned ice factory and cold-storage plant on the island has poor facilities for storing fruit. The oranges were stored in this experiment in an unventilated compartment having in consequence a high degree of humidity. The temperature of the compartment ordinarily ranges from 38° to 40° F. During the period of the test the temperature varied considerably because the compartment had frequently to be opened to permit entrance to a meat room. The results of the test are not therefore as conclusive as they might have been under more favorable conditions. They indicate, however, that under proper conditions cahit oranges can be stored satisfactorily for a considerable period between regular fruiting seasons.

Table 1 gives the results of storing oranges for different periods.

TABLE 1.—Results of storing oranges for different periods in Guam

Crate No.	Fruits	Kind of fruits	Time of holding previous to storing	Time in storage	Color when placed in storage	Treatment	Fruit spoiled	Remarks
	No.		Days	Days			P. ct.	
1	Section 1.	Cahit	1	92	Yellow	None	38.3	Box and fruit very wet when removed from storage.
	Section 2.				Half yellow		21.6	
2	Section 1.	do	4	93	Half yellow	Dipped; not wrapped.	7.1	
	Section 2.						65	
3	Section 1.	do	11	109	do	Dipped and wrapped.	12.5	
	Section 2.						80	
4	Section 1.	do	21	99	Yellow	Wrapped; not dipped.	16.2	
	Section 2.						90	
5	Section 1.	do	21	99	Green	do	3.4	
	Section 2.						90	
6	134	do	14	106	do	None	13.4	
7	160	do	26	94	Yellow	do	21.1	
8	Section 1.	Naranghita	1	80	do	Wrapped; not dipped.	100	
	Section 2.						145	100
9	Section 1.	do	7	76	Green	do	69.1	
	Section 2.						150	43.3

The mature but green fruits showed a lower percentage of spoilage than did the partly or wholly yellow fruits. Because of the humid conditions of the compartment no reliable information could be obtained as to the effect of wrapping or dipping. The naranghita oranges proved to have poor keeping qualities in cold storage. Those that did not decay dried out to such an extent as to retain little of their usual juiciness. The rind of the tangerine is much more porous or spongy than is that of the cahit orange.

In the test made to learn the length of time that oranges can be kept under ordinary room temperature, 314 closely uniform, green-colored but fully mature cahit fruits were used. Two hundred of the number were placed in a single layer on the cement floor of a well-ventilated room. The others were placed on wooden shelves in the same room, half of the fruit having first been dipped in a 1:500 copper-sulphate solution. Decaying fruits were removed from both lots at various intervals.

At the end of 30 days 4 per cent of the lot on the shelves and 2 per cent of the lot on the cement floor had spoiled, and at the end of 60 days 17 per cent of the former and 16 per cent of the latter had spoiled. Treating with copper sulphate offered no advantage. The results indicate that cahit fruits, if properly picked and carefully handled, can be kept without cold storage for a period of at least 60 days without serious loss.

The keeping quality of oranges naturally depends in large measure on the manner in which the fruits are picked and handled. The general practice among local farmers is to gather the crop by twisting or pulling the fruits from the stem and to shake or club from the tree such fruits as are not within convenient reach. Little care is exercised in handling the fruits during transport. In order to permit comparison of results with fruits so handled with those obtained in the above-mentioned test and to impress upon growers the importance of using proper methods of picking and handling the orange crop to lessen the rate of spoilage, 500 cahit oranges which had been gathered by a native rancher according to his own methods were placed in a single layer on the cement floor of the room in which the preceding test was conducted. During the test the decayed fruits were removed as soon as they were detected. Within 30 days 50 per cent of the lot had spoiled, and within 60 days 80 per cent had decayed. The fruits were of the same kind and approximately at the same stage of development as those used in the preceding test.

Shipping tests.—During the year a few trial shipments of avocados, watermelons, and vegetables were made to Manila by private growers. The results were encouraging. The station is lending assistance in this line of endeavor by inspecting products for shipment and by furnishing information relative to proper methods of handling and packing.

GARDEN-VEGETABLE DEMONSTRATION

The work with vegetables consisted largely in a continuation of selection and breeding work with tomatoes, variety tests with cabbages, and trials of new introductions.

Tomatoes.—In the breeding work with tomatoes in which different varieties received from the States were crossed on native stock, only the crosses with the varieties Gulf State Market and Greater Baltimore have shown marked improvement in size of fruit over the native,

and in prolificacy as compared with the imported varieties. The second-generation hybrids have been harvested.

Cabbage.—Four varieties of cabbage were tested during the year. Florida Drumhead produced the largest number of heads, followed by All Seasons, Genuine Surehead, and Centennial Late Flat Dutch, in the order named. The planting made during the rainy season proved to be a failure.

SEED AND PLANT DISTRIBUTIONS

During the year the demand for fruit trees exceeded the available supply. Grafted trees especially were in demand. In addition to the fruit trees, edible canna, lanzones, and various ornamentals were distributed to interested parties. The station supervised the distribution of the monthly orders of vegetable seeds which are purchased by the island government. A large amount of seed material of Napier grass and Paspalum grass was also distributed.

During the year 1,333 packets of vegetable seed were sold to the public, and 100 packets and 20 pounds of vegetable seed were distributed free of charge to the various government departments. The general distribution included 226 Isabella grapevines, 649 pepper plants, 216 eggplants, 988 lettuce plants, 343 tomato plants, 234 papaya plants, 5,802 ornamental plants, 61 grafted mangoes, 117 grafted avocado plants, 73 grafted citrus plants, 10 star-apple plants, 122 pili plants, 189 cabbage plants, 12 Araucaria plants, 23 tung-oil plants, 131 mabolo plants, 61 banana suckers, 1,537 edible-canna plants, 150 lanzon plants, 35 sacks of sweet-potato vine cuttings, 140 dugdug (breadfruit) plants, 219 teak plants, 894 taro plants, 3 mangosteen plants, 23 raul plants, 1 litchi plant, 1 pejibaye plant, 20 pounds of cowpeas, 7½ pounds of pigeon peas, 1,941 sacks of Paspalum grass, 1 chico plant, 2 Macadamia plants, 250 tobacco seedlings, 8 packets of seeds, 130 pounds of miscellaneous forest seeds, and 30 miscellaneous plants.

REPORT OF THE ENTOMOLOGIST

By S. R. VANDENBERG

COCONUT BUD ROT

Coconut bud rot is at present practically under control, as only four cases of true bud rot caused by *Phytophthora faberi* were found during the year. Early in the year a paper was prepared on the subject of bud rot giving all the pertinent information known and was presented to the Guam Chamber of Commerce with the recommendation that it be printed in pamphlet form in both English and Chamorro and distributed among the ranchers for their information and guidance as part of the educational campaign against this disease.

SEA WATER FOR CONTROL OF SOME INSECT PESTS AND DISEASES OF COCONUT PALMS

Preliminary work with sea water as a drench and spray for palm trees has given results that indicate the usefulness of this cheap material in combating insect pests and diseases. Owing to the manner of growth of palm trees, liquids are caught and held for a time

in and around the leaf bases, percolating slowly through the fabric-like outgrowths that flank the base of each leaf. *Pseudococcus cocotidis*, *Lepidosaphes megregor*, and *Hemichionaspis minor* often congregate in such large numbers on the tender white tissues in these places and in the folds of the young, unopened leaves as to seriously damage or even kill the palm. Sea water has been found to be very effective in destroying these insects when applied partly as a drench and partly as a spray.

That sea water has an antiseptic value in combating disease was indicated in the case of an African oil palm which was so badly infested with *Pseudococcus cocotidis* that the crown shoot was dead and decaying at the base. The odor accompanying the decay indicated that putrefactive bacteria had gained access to the live tissue through the injury done by the insects. Three applications each of 5 gallons of sea water, half as a drench and half as a spray, at intervals of about 10 days, were sufficient to rid the palm of mealybugs, arrest the progress of the decay, and permit the tree to resume its normal rate of growth.

A "fire blight" of young and seedling coconut palms, somewhat similar to coconut bud rot, has been noted during the past few years. The name "fire blight" was suggested by the fact that the newer leaves are distorted and have a blackened appearance as though the affected parts had been destroyed by fire and smoke. Fire blight occurs only where the planting is intercropped and the custom is practiced of clearing the land for planting by cutting the weeds and brush and burning them in windrows. Burning is done usually after a series of clear, hot days, and the intense heat of the fire in addition to that of the sun causes a breaking down of the tender tissues at the base of the crown shoot, allowing bacterial infection to enter, but does little or no apparent damage to the older leaves.

The ground around affected coconut palms was flooded with a salt solution of approximately the same concentration as that of sea water. Three palms were treated and three left untreated (checks). The results were not wholly conclusive, inasmuch as all the trees recovered. Two of the treated palms recovered in a few months, and the third treated palm returned to normal growth only slightly in advance of the first check, or in about six months after treatment. Two of the check palms showed evidences of damage at the end of a year. The salt water is thought to have a tonic effect which speeds up the growth to the point where the crown shoot grows faster than the bacterial infection can progress.

BACTERIAL INJURY TO COCONUT PALMS

In connection with observations and studies of bud rot, fire blight, and infections due to injuries of various sorts, it is concluded that bacteria alone can not compete with the rapidly growing bud of a healthy coconut palm unless, of course, the bud tissue itself is directly injured. Where vitality is lowered or growth ceases, bacterial infection through insect or mechanical injury, excessive heat, and the like may invade the bud and destroy it. Cases of this kind occur during the dry as well as the rainy season and show symptoms which are distinguished from those caused by true bud rot. In bacterial infection only the tender crown leaves and bud are destroyed, the outer leaves remaining green, and the older nuts (if the tree is in bearing)

may mature normally. Bud rot, on the other hand, is a wet-season disease caused by a fungus, *Phytophthora faberi*, which attacks the crown shoot and bud of a healthy palm; and while the crown shoot and bud are usually the first parts to succumb, the older tissues are soon invaded and the nuts are shed early and the remaining foliage dies. True bud rot from inception to death of the palm is of much shorter duration than is a fatal case of bacterial infection. The presence of putrefactive bacteria following attack by the fungus in cases of true bud rot often serves to complicate and render uncertain a diagnosis of these diseases.

A PHYSIOLOGICAL DISEASE OF THE COCONUT PALM

A wasting disease of the coconut palm, cause unknown, which has been mentioned in former reports of the station, was made the subject of a special order issued by the Governor of Guam in January of this year. The order, long advocated by the station, required the destruction by March 15 of all trees affected with the disease. The disease, locally known as "tinangaja," is definite in its symptoms and character and gives evidence of being infectious. Weston¹ in 1917 stated that—

the symptoms shown by this disease involve first the withering and hanging down of the lower leaves, followed gradually by others nearer the tip, until finally the whole top dies and the dead stub remains with a few dead leaves still hanging to it.

The first symptoms are followed by a gradual diminution in the diameter of the trunk, with a corresponding decrease in the size of the top and consequently the number and size of the nuts produced. At about the middle course of the disease, while flower bracts are still produced, no nuts are set, and the bracts wither and die. Later no flower bracts are put out, and the top is reduced to only two or three stunted sickly yellow leaves at the top of a trunk reduced to a diameter of only 2 or 3 inches. This condition continues until the top dies or is blown off.

COCONUT-SCALE CONTROL

A shipment of *Comperiella bifasciata*, which is parasitic on the diaspid scale, was received from Riverside, Calif., via Honolulu, for trial on the coconut scale (*Aspidiotus destructor*). The parasites were received on an *Aspidistra* plant infested with the Florida red scale as a food. The parasites were emerging upon arrival, and large numbers of them had probably escaped through a rent in the muslin cloth covering the cage. However, a total of 70 parasites was obtained. Approximately one-third of the number were liberated in the field, and the others were tried on the coconut scale without success under insectary conditions. Doubts were had in the beginning as to the success of the experiment, as it seemed obvious that *C. bifasciata* was too large an insect to fully attack the comparatively small and very flat *A. destructor*. Those liberated in the field may become established, if not on *A. destructor* then possibly on *Lepidosaphes megregor*, which is often found on coconuts in conjunction with *A. destructor*. *L. megregor* is a larger scale insect than *A. destructor*.

¹ WESTON, W. H. JR. REPORT ON THE PLANT DISEASE SITUATION IN GUAM. Guam Agr. Expt. Sta. Rpt. 1917: 45-62, illus. 1918.

In a consignment of ladybird beetles (*Lindorus lophanthæ*) received, 6 adults were recovered alive and used as a nucleus for breeding. They were given special care and attention and had increased in number to 22 at the end of three months, when they were liberated in the field in two equal lots. This is the second attempt to establish this ladybird beetle on *Aspidiotus destructor*. The first was a failure.

An attempt was made to send a colony of the small black ladybird beetle (*Cryptogonus nigripennis*) to the Fiji Islands, via Honolulu, where *A. destructor* is on the increase. This small ladybird beetle has effected complete control of the scale in Guam and should be able to duplicate its performance in Fiji if it survives the trip.

MISCELLANEOUS NOTES

Damping off attacked the first corn crop, which matured in November, 1926, and attracted considerable attention. It appears about tasseling time on the stalk a few inches above the ground as a dark, water-soaked area which gradually spreads. The lower leaves die as the disease progresses. In cases where the stem is girdled the plant dies. The pith of a dead or dying corn plant has a dry, tough, corky texture as compared with the pith of a normal plant, which is crisp. These symptoms have long been known to the natives, but seem to have been worse for the crop of 1926 than before. The present crop of corn, which is almost mature, shows only slight evidence of the disease.

The European corn borer (*Pyrausta nubilalis*), while present throughout the island, did perceptibly less damage than usual to the two main corn crops of the past year. With the first crop this was due to unfavorable conditions for the increase of the borer, and with the second crop to the extremely quick growth to maturity made by the corn. Dry weather, which checks the growth of the corn plant, allows two or three generations of the borer to develop, and the crop is practically ruined. When there is sufficient rain to maintain a rapid growth of the corn plant the one generation of the corn borer that develops does little damage. For this reason the borer is not as serious a pest in the southern end of the island, which apparently has a more equable rainfall, as in the central corn-growing region, where there are periods of little or no rainfall.

The taro crop was attacked by the Egyptian cotton worm (*Prodenia litura*). Investigation and study of the pest lead to the conclusion that it is firmly established in Guam as a forest form and that it is impossible to eradicate or even to combat it except locally. An effort was made to breed the insect on edible canna, and although adults, eggs, and young and old larvæ were used, only the larger of the larvæ fed on the canna. Taro is also subject to epidemics of a leaf hopper (*Megamelus* sp.) and a fungus disease (*Glaosporium* sp.) incidental to the leaf-hopper injury that often entirely ruins the crop. Edible canna is seemingly free from these and other pests and is strongly recommended as a substitute crop for taro.

A tick, either new or not previously recorded as occurring in Guam, was discovered attacking dogs. So far as can be determined it is the brown dog tick (*Rhipicephalus sanguineus*).² Ridding the animals of

² HALL, M. C. PARASITES AND PARASITIC DISEASES OF DOGS. U. S. Dept. Agr. Circ. 338; 28 p., illus. 1925.

the pest is not as much of a problem as is ridding the house and premises of the seed ticks. Washing the floors and walls with a strong solution of bichloride of mercury did not seem to effect a control.

Chrysomelid leaf beetles of the subfamily Eumolpinæ which were first noticed two years ago attacking an Oxalidaceous tree at the station are spreading and doing considerable damage to the new growth of mango and rose-apple trees. The beetles eat the tender bark of the new shoots as well as the leaves and thus destroy the plant. Spraying with a weak arsenical was found to be sufficient for controlling the beetle, but its spread is regarded with apprehension because of the impracticability of extensive spraying operations by local ranchmen. The larvæ of the beetle have not yet been found.

A number of coconut palms have been injured and a few killed by the sugar-cane borer (*Rhabdocnemus obscurus*). The borer is not considered a menace to the copra industry.

The common practice of using old weedy lands or land that has been cleared of brush is attended by considerable loss to vegetable gardeners. Milliped worms attack the pepper and other vegetable plants of bushy habit of growth at about 2 inches below the soil surface and girdle or gnaw through the stems, causing them to fall over. Carbon bisulphide applied once on bits of cotton (three to each plant) set beneath the soil surface at about 2 inches from the stem was effectual in controlling the pest.

Plant bugs (*Leptoglossus* sp.) attacking watermelons, squash, and muskmelons in a garden in the southern part of the island were effectually controlled by spraying with a solution made by macerating and steeping 4 pounds of tobacco refuse (left over from the manufacture of chupas or native cigars) in a gallon of water. The spray killed the eggs and nymphs and seemed to act as a repellent to the adults.

Land slugs regularly damage vegetable crops on newly cleared or near forest land. A salt-line barrier was effectively used as a control for slugs attacking a well-cared-for tomato plat on a ranch where salt is made. Most of the slugs did not cross the salt line, and the few that did died without damaging the tomato plants. Salt apparently dries the slimy mucosa on which the slugs depend for locomotion.

A tineid leaf miner is doing some damage to the citrus trees of the island. The miner distorts the leaves by tunneling shallow mines immediately beneath the epidermis of both sides. Mature trees are rendered unsightly by the pest, but otherwise are not greatly damaged, but the growth of the young seedlings is seriously retarded because of reduction of effective leaf surface. The life cycle of the miner is short, 12 to 25 days, and many generations may overlap one another during a year. No generally applicable treatment for mature trees is recommended. Various kinds of sprays are being tested to learn their effectiveness in repelling the egg-laying moths on young seedlings.

A scale, *Asterolecanium* sp., was found attacking the only two specimens of serali tree (*Flacourtia ramonchi*) on the island. Kerosene-emulsion spray appeared to be an effective control for the scale. The scale is parasitized by a *Chalcis* sp. A diligent search has failed to

locate the scale or any other host save a cover crop of *Tephrosia* sp. planted from seed around the trees.

A white fungus, apparently *Sclerotium rolfsii*, did much damage to the station tomato plat. The fungus attacks the larger roots, the crown, and the stem, cutting off the food supply and causing the plant to wilt and die, and appears after the plants begin to bear. Other hosts of the fungus are cowpeas, cucumber, muskmelon, and a hedge plant, *Barleria cristata*.

An entomogenous fungus was discovered attacking the red scale (*Chrysomphalus aurantii*) of citrus and gives promise of effectually suppressing any possible future spread of the scale. The fungus was successfully established at places where it was not formerly in evidence.

Work carried on in cooperation with the poultry department in the detection and examination of coccidiosis, tapeworms, and other intestinal parasites of chickens has revealed the general presence of coccidiosis in these fowls. It is believed that a large percentage of the rather high mortality of young chicks raised under urban conditions is due directly to this cause. Many cases of infestation with tapeworms, ascarids, cæca worms, and threadworms of the stomach were found.

METEOROLOGICAL OBSERVATIONS, 1926-27

Observations made at the station on temperature, precipitation, and wind are summarized in Table 2.

TABLE 2.—Condensed meteorological data for the year ended June 30, 1927

Month	Temperature					Total precipitation	Prevailing direction of wind
	Maximum	Minimum	Mean maximum	Mean minimum	Monthly mean		
1926	°F.	°F.	°F.	°F.	°F.	Inches	
July	90.5	73.0	87.25	76.06	81.65	10.62	East.
August	89.5	73.0	87.08	76.15	81.61	8.40	South.
September	91.0	74.0	88.07	75.94	82.00	10.28	Northeast-east.
October	90.5	73.0	87.37	75.72	81.54	11.35	Northeast.
November	90.0	72.5	88.46	76.62	82.54	7.78	Do.
December	90.0	73.5	87.58	76.31	81.94	6.26	Do.
1927							
January	89.0	71.0	86.91	75.23	81.07	3.59	Do.
February	89.0	71.0	86.75	74.90	80.82	5.89	Do.
March	89.5	74.0	87.87	75.53	81.70	2.41	East.
April	90.0	71.5	88.03	74.65	81.34	3.33	Northeast.
May	90.0	74.5	87.96	76.53	82.24	8.32	Southeast.
June	90.0	73.5	87.53	76.10	81.81	5.77	Do.
Total						84.00	

While the total rainfall was somewhat less than in 1926, it was more equably distributed and there was no pronounced drought. No severe storms visited the island during the year.



