new locations and not returned to the original location for 7 or more years, and that is the best practice to follow from every point of view.

RED STRIPE

A disease of the leaves known as red stripe, caused by a bacterial organism (*Bacterium rubrilineans* (Lee, Purdy, Barnum, Martin) Elliott), has been noted in comparatively recent times in several localities where cane is grown for sirup, including Louisiana, Georgia, and Florida. It is known to be serious in some parts of the world, and while damage to varieties now grown commercially in the United States is not specially severe, it constitutes a threat and should be so recognized. The main sign of red stripe is the presence of long, narrow, maroon or deep wine-colored stripes lengthwise of the leaves. The narrow stripes originate midway between base and tip of the leaf as a rule and extend toward the tip. The first stripes tend to develop near the midrib, while the later ones arise farther away from the midrib but not at the extreme edges of the leaf. Occasionally the stripes run together, forming a broad band. Stripes are found on the lower side of the midrib itself but rarely on the upper side. The disease spreads in moist weather and has been observed in epidemic proportions in southern Georgia.

One of the most promising sirup seedlings ever produced at the Canal Point (Fla.) cane-breeding station (C.P. 155) had to be discarded because of special susceptibility to red stripe. The disease is of no special consequence in Cayana, P.O.J. 213, Co. 290, or C.P. 29/116.

BROWN STRIPE

Brown stripe, caused by the fungus *Helminthosporium stenospilum* Drechs., is widespread in the eastern Gulf States and at times causes damage there, but is infrequent in Louisiana. It causes very dark-brown to blackish pencil streaks one-fourth to one-half inch in length, each surrounded by a pale green "halo" on the older leaves. The early stages of this disease, before the streaks become brown, are sometimes confused with mosaic.

The stripes may become so numerous as to cause the leaves to shrivel and die during hot, dry weather. The advent of rain, or application of irrigation water, starts the plants growing again, and they resume the development of green, healthy leaves. The extent of damage is in direct proportion to duration of the drought. It is interesting to observe that red stripe spreads and damages the cane in wet weather, whereas brown stripe is held in check by the same agency.

POKKA BOENG

A disease known by the Malay term pokka boeng (damaged top), caused by a fungus, *Fusarium moniliforme* Sheld., sometimes makes its appearance in sirup areas on certain varieties. As long ago as 1919 whole fields of Louisiana Purple cane were observed to be affected by this disease in the vicinity of Cairo, Ga. In severe cases the whole top or growing point of the cane stalk becomes distorted, the emerging leaves being tangled and matted together. Accompanying this there may be a series of cavities, presenting a very characteristic ladderlike or chainlike appearance along the center of the stalk near the growing point. Sometimes the top rots cause destruction of the stalk, but usually the stalk recovers and resumes growth, leaving no trace except a series of shortened internodes where the injury occurred.

OTHER DISEASES

There is a long list of other local diseases of sugarcane, but, as most of them are not of regular occurrence or do not cause great damage when they do occur, they are not considered to be important factors in commercial cane production. Among these diseases are the common red rot of the leaf sheath, caused by *Sclerotium rolfsii* Sacc.; the eye spot of the leaf common in southern Florida, caused by *Helminthosporium sacchari* Butl.; rind disease, caused by *Melanconium sacchari* Mass.; black rot, caused by *Ceratostomella adiposum* (Butl.) Sartoris; pineapple disease, caused by *Ceratostomella paradoxa* (DeSeyn.) Dade; sheath rot, caused by *Cytospora sacchari* Butl.; and other diseases and injuries. Throughout the world nearly a hundred diseases and injuries of sugarcane have been described.

INSECT PESTS OF SUGARCANE

Many of the remarks in the introduction to the section on diseases would apply equally well to insect pests. Indirect methods of controlling pests are preferable for the same reasons, namely, the difficulty of moving heavy equipment through the fields for applying sprays or dusts. Airplane dusting has been attempted, but the economic soundness of such measures is not definitely proved. Biological control, including the artificial rearing and colonization of parasitic insects that destroy eggs and other forms of certain insect pests, has been tried with encouraging results, but this line of attack is still experimental.

The major pests of sugarcane in the United States are not present in all cane areas, and strenuous efforts should be made to prevent penetration of the uninfested areas by these pests. Establishing of a pest in areas not already occupied by it is often brought about by shipment or exchange of seed cane. This practice is engaged in by planters and others for the purpose of introducing new varieties for trial and has been responsible in a large degree for extending the areas occupied by pests. Such exchange of seed cane should be reduced to the minimum, and precautions should be taken to reduce the hazard of transporting insects with the seed cane. It has been found that hot-water treatment [7] of the seed cane or cuttings will kill all stages, including eggs, of the common pests that may lodge on or in the cane, without killing the buds, if the treatment is carefully controlled. The temperature of the water should be 122° to 126° F. and duration of treatment 30 minutes. This is an easy and practicable procedure for small lots of a dozen or less cuttings, the usual package for shipment, and requires no special equipment.

The practice of assembling cane varieties for trial or display, a tendency of some individuals with a bent for collecting, is dangerous for their neighbors who may also grow sugarcane, unless the dangers are recognized and guarded against. In general, it is well to leave this function to the State and Government experiment stations, whose experts are familiar with diseases and pests.

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[7] BRANDES, E. W., and KLAPHAAK, P. J. GROWTH STIMULATION AND PEST AND DISEASE CONTROL BY HOT-WATER TREATMENT OF SUGARCANE "SEED." La. Planter 71: 371–372, 392–394, 412, illus. 1923.

YODER, P. A., and INGRAM, J. W. HOT-WATER TREATMENT OF SUGAR CANE FOR INSECT PESTS.—A PRECAUTION. U.S. Dept. Agr. Dept. Circ. 303, 4 p. 1923.

SUGARCANE MOTH BORER

The most serious insect pest of sugarcane in the United States is the moth borer, *Diatraea saccharalis* Fab.[8] The borer is responsible for immense damage to sugarcane in Louisiana and is present also in southwestern Mississippi, southern Florida, and the Gulf section of Texas. This insect has not been found in Georgia, Alabama, or western Florida, and every reasonable effort to exclude it is justifiable. Injury to the cane by borers takes many forms, but is not specially noticeable in old cane except by close examination. If the leaves are pulled away, small holes may be observed in the rind, and the frass or sawdustlike material may be seen clinging to the stalk in the vicinity of holes. Upon splitting the stalk lengthwise tunnels are discovered through which the larva of the insect has eaten its way sometimes for several feet. The tunnels are about an eighth of an inch wide and meander lengthwise and crosswise through the interior of the stalk often joining but pursuing a course in general parallel with the main axis of the stalk, which is weakened to the extent that in some cases it is broken or blown down by the wind. Almost invariably the disease known as red rot becomes established in these injuries and finishes the work of destruction. Injury to young cane is more apparent in the field than injury to older cane. It takes the form of "dead heart" or death of the growing point and shriveling of the whorl of youngest leaves, and such affected stalks are conspicuous early in the season when the plants are 1 to 3 feet high.

Numerous ameliorative practices have been suggested to reduce damage by the borer. The practice of burning cane trash after the harvest should be discouraged as it results in destruction of the egg parasite *Trichogramma minutum* Riley, a beneficial insect that attacks borer eggs, as well as preventing the return of badly needed humus to the soil. Soaking the seed cane in water for several days is effective in killing many of the borer larvae and may be practicable where water is available. As the borer also attacks corn, the destruction of cornstalks near cane before the adult insects emerge from them would eliminate large numbers of borers. Direct attack on the borers by dusting the cane with sodium fluosilicate, either by airplane or hand dusters, has not given satisfactory results. The rearing of the egg parasites and scattering them through the fields is claimed to be effective and economically sound, but until more experience confirms this it must be considered to be only a suggestion worthy of serious trial.

THE MEALYBUG

The mealybug (*Pseudococcus boninsis* Kuwana) is a ubiquitous pest of cane in the United States, but it becomes important only when attended by ants, especially the Argentine ant. This peculiar relationship of the mealybug and ant is explained by the fact that the ants use for food the honeydew excreted by the mealybugs and solicitously care for them and protect them from their enemies. The white, woolly mealybugs feed by sucking sap from the tender stalk tissue at the growth ring and cluster around the eyes of cane

[8] HOLLOWAY, T. E., HALEY, W. E., LOFTIN, U. C., and HEINRICH, CARL. THE SUGAR-CANE MOTH BORER IN THE UNITED STATES. U.S. Dept. Agr. Tech. Bul. 41, 77 p., illus. 1928.

stalks in such numbers that often the eyes are killed. They can be discovered by pulling away the leaf sheaths of infested cane and are present in both standing cane and cane in the banks or planted. Reduction of ant populations by poisoning[9] automatically reduces damage by mealybugs and is effective in Louisiana where the Argentine ant is present. Planting uninfested seed cane at some distance from fields where the mealybug occurs, low cutting of the cane at harvest time, and destruction of cane scraps left in the fields and around mills are practices that tend to reduce mealybug damage. Hot-water treatment of cuttings or seed cane intended for shipment is recommended. Even where the insect is already present, it serves to retard development of the pest in the new plantings.

APHIS MAIDIS

Direct injury to cane by the corn leaf aphid, *Aphis maidis* Fitch, is insignificant, but this insect is the principal agent in transmitting mosaic to healthy plants during epidemics of this disease and, therefore, must be regarded as a pest of first importance. The corn leaf aphid is universally present in greater or lesser numbers in or near cane fields where it infests certain wild grasses and cultivated grass crops like corn. Abundance of the insect depends mainly on availability of food plants at the proper stage of succulent development, which in turn depends upon seasonal and weather conditions. Where varieties susceptible to injury by mosaic are planted (including those classed as tolerant) it is worth while to supplement seed-selection practices with measures tending to reduce infestation by *A. maidis*. These measures include eliminating from the near vicinity of seed-cane plots any plantings of corn or sorgo, which are favored food plants of the aphid and on which the insect breeds in enormous numbers. Sugarcane itself is not especially attractive for the aphid, but when the corn or sorgo becomes mature and less desirable as a source of food, they leave it and migrate to the cane. If any mosaic is present in the cane, it then serves as a source of the virus and is rapidly spread to other cane plants by the successive feedings of the insect.

SUGARCANE BEETLE

Injury by the sugarcane beetle, *Euetheola rugiceps* Leconte, is serious in some localities and in particular years, but it does not present a problem comparable with the insect problems already mentioned. The newly emerged adult beetle is black and shiny, about one half to five eighths of an inch long. Ragged holes gnawed in the shoots of cane just below the surface of the ground are responsible for the noticeable injury to cane. The inner leaves turn yellow, and the shoot usually dies. Damage to the field is apparent early in the season and is in proportion to the number of beetles present. Losses are ordinarily greater in plant than in stubble cane. The beetles breed heavily in sod lands and little or not at all in woodland. Where possible, sod and grass pastures in the vicinity of cane fields

[9] BARBER, E. R. THE ARGENTINE ANT: DISTRIBUTION AND CONTROL IN THE UNITED STATES. U.S. Dept. Agr. Bul. 377, 23 p., illus. 1916.
HOLLOWAY, T. E., and INGRAM, J. W. THE SUGAR CANE MEALYBUG IN GEORGIA. The Planter and Sugar Manufacturer. v. 77, no. 17, pp. 330–331. Oct. 23, 1926.

should be eliminated as a measure tending to reduce beetle population. In some sugarcane areas there is a gradual shift to early fall or summer planting, and because of the larger number of shoots the following spring from such plantings there is proportionately less beetle injury and better stands result.

SUPPLIES AND EQUIPMENT REQUIRED FOR GROWING CANE AND MAKING SIRUP

The implements required for field work are for the most part the same as those required for other field crops, with the addition of cane knives and stripping tools.

Certain supplies, some of which are peculiar to the production of cane and sirup, are also needed. The following represents an estimate of the requirements per acre for a plant-cane crop yielding 18 to 25 tons of cane, or 360 to 500 gallons of sirup, per acre, based upon experience in southern Georgia:

Seed cane; 1,500 to 3,000 stalks, depending upon average length of the stalks and rate of planting. (See p. 24.) Seed cane is usually grown on the same farm, the yield from one tenth of an acre ordinarily sufficing for planting 1 acre or more.

Commercial fertilizer; 1,000 to 1,500 pounds complete fertilizer mixture. (See p. 15.)

Barnyard manure; from none up to 10 tons. The application of barnyard manure permits of a corresponding reduction in the quantities of commercial fertilizer needed for the crop.

Fuel for operating the sirup evaporators; approximately 1 cord of wood for each 100 gallons of sirup made or 3 to 5 cords to make sirup from cane from 1 acre. This estimate should be increased by approximately one half cord where steam evaporators are used and the mill operated by steam power.

Fuel for a gasoline or kerosene engine for operating a mill; 20 to 30 gallons. A gasoline engine suitable for operating a mill with a capacity of 10 tons of cane per 10-hour day would consume approximately 12 gallons of gasoline per day, or approximately 24 gallons for a yield of 20 tons of cane per acre. In many instances small mills are operated by animal power.

Containers for the sirup; 11 to 15 barrels, with a capacity of 33 gallons each, or 8 to 10 barrels with a capacity of 50 gallons each. If the sirup is to be packed in cans, 70 to 95 cases, each case containing six 10-pound cans, twelve 5-pound cans, or twenty-four 2½-pound cans.

The cost of a sirup-making outfit, including cane mill, sirup evaporator, and suitable shelter varies from about $150 for the simplest small-scale type to several thousands of dollars for a large-scale type equipped with a large-capacity mill operated by means of a large gasoline, kerosene, or steam engine, multiple direct-fired, open-pan sirup evaporators or multiple open-pan steam evaporators, suitable piping and valves, large capacity juice and sirup tanks, and hoists for unloading and handling the cane.

The sirup producer who grows from 1 to 3 acres of cane finds it economical to use a small animal-power cane mill with a capacity of 3 to 5 tons of cane per day and a 10-foot pan evaporator having a capacity of 75 to 100 gallons of sirup per day of 12 hours (fig. 15). A mill of this type is wasteful in that it does not afford a high extraction of juice from the cane, but the initial cost of such equipment is low and the cost of upkeep very little. The cost of an outfit of this type in 1932, including a simple shed for the evaporator, was around $150.

Sirup producers who grow from 5 to 10 acres of cane generally use a power-driven mill with a capacity of 10 or 12 tons of cane per day and a pan evaporator with a capacity of 200 or more gallons of sirup per day of 12 hours. The cost of an outfit of this capacity varies from one locality to another and from year to year, but the approximate cost in 1932 was about as follows:

3-roll cane mill of standard make	$250
Gasoline or kerosene engine of about 8 horsepower	200
Pan evaporator of galvanized iron, 15 feet long and about 42 inches wide, equipped with baffle plates and skimming troughs	21
Materials (approximately 2,500 bricks, 2 barrels of lime, sand, grate, juice tanks, juice pipe and valves, sirup-collecting tank, belt for cane mill, and miscellaneous small items) and labor for constructing the furnace and installing the evaporator	150
Material for shelter and cost of labor for construction	100
Total	721

FIGURE 15.—Sirup-making outfit of type widely used by farmers who grow from 1 to 3 acres of cane. An outfit of this type has a capacity of 75 to 100 gallons of sirup per day and costs $150 to $200. The cost of larger capacity outfits equipped with power-driven cane mills is proportionately greater.

LABOR AND WORK-ANIMAL REQUIREMENTS

The labor and work-animal requirements, together with supplies, fixed charges like taxes and interest, and depreciation of equipment go to make up the costs of production, which must be balanced against receipts to determine whether the operation has resulted in profit or loss.

Cost of producing the succession of plant and stubble crops from a single planting and the profits therefrom cannot well be considered separately by individual crop years. It is obvious that there would be no stubble crop without a preceding plant-cane crop and, therefore, the planting costs should really be distributed through the whole period instead of being charged to the plant-cane crop alone.