

more heavily manured nursery, the difference in favour of plots receiving 134 lbs. nitrogen as against these receiving 106 lbs. nitrogen was only 0.77 per cent.

Summarising, it may be stated that

- (1) Sugarcane responds best to nitrogenous manuring.
- (2) a mixture of cake and Ammonium sulphate in the proportions of 4 : 1 or 3 : 2 is the most profitable.
- (3) 100–150 lbs. nitrogen is the optimum dose per acre.
- (4) phosphates do not directly contribute to increase in yields, but are necessary for the proper ripening of cane and the production of good jaggery.
- (5) potash depresses yields.
- (6) using 100 lbs. nitrogen with or without phosphates, the quality of juice, as judged by analysis, is not appreciably affected.
- (7) large applications of nitrogenous manures specially Ammonium sulphate tend to produce soft jaggery with poor keeping qualities.
- (8) the use of setts from a crop raised on a well manured plot gives a better crop and permits reduction of the quantity of manure for the planting area.

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SUGAR-CANE INSECTS IN SOUTH INDIA *

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Our Sugarcane Pests

Sugarcane is no more free from the attentions of insect-pests than the other major crops cultivated in South India. The setts that are planted are attacked by white ants; very often the joints are eaten up until they are reduced to mere shells, and the germination of buds is affected. The shoots are liable to attack by, at least, three kinds of caterpillar borers, which kill them outright. These borers may also attack the joints of canes during their growth and cause a decrease in the yield of sugar. The leaves may be infested with various kinds of sucking insects: mealy-wings (*Aleurodes*), mealy-bugs, plant-lice and leaf-hoppers. In some tracts, the Paddy grass-hopper—*Hieroglyphus*—may invade the crop and reduce the leaves to mid-ribs. Cockchafer grubs may in some places damage the planted crop. Rats, squirrels and jackals are also known to carry their depredations into the cane crop.

Sugarcane Pests in other Lands

Although South India has a goodly share of ills due to insect-agency, still she has upto now been free from various insect foes known to infest other countries of the world. In Hawaii, one finds the serious leaf-hopper pest—*Perkinsiella saccharicida*—which has been, after long-continued efforts, brought under control by biological agency i.e., by the introduction of parasites. Secondly, there is the weevil-borer, *Rhabdocnemis obscura*, found also in some of the islands of the Lesser Antilles, and thirdly, Hawaii has the stemborer—*Diatraea saccharalis*—different from the Indian species. In Fiji, the major pests are the wireworms and certain beetle borers. In Queensland, the chief

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pest is the cockchafer larva—the so-called 'whitegrub' of the planters; army worms are also reported to occur sometimes in serious numbers. In Mauritius, three different borers are present. In Java, the roots are damaged by the grubs of the 'wawalan' beetle—*Apogonia destructor*—while the stems are attacked by the 'kantjoek' beetle—our familiar friend—*Oryctes rhinoceros*. In addition, three borers are also present. In Egypt, sugarcane is seriously affected by a mealy-bug. In Trinidad, the control of the froghopper—*Tomaspis varia*—has proved a serious problem. British Guiana and Trinidad are the home of the giant borer—*Castnia licus*. The moth-borer—*Diatraea saccharalis*, is an insect of great consequence in Argentina, Louisiana, and Mexico, where it is sought to be controlled by the biological method.

India has thus to beware of the danger of importation of various foreign insects, the introduction of which is day by day becoming more and more imminent owing to the progressive quickening of the means of transport, especially by the extensive development of the air-ways. Chief among them are the weevil-borer, the moth-borer and scale-insects, and stringent quarantine regulations have to be enforced to keep them out, especially as there are, in addition, various very serious diseases of cane, such as the Fiji disease, the Sereh disease, and the bacterial leaf scald,—not recorded at present in India—liable to be introduced.

The Pests of Cane in South India

Of the Cane insects of South India, the most important economically are the moth-borers and the white ants, and it is on these that some detailed work has been done in this province. Of the others, however, there are a good many that are locally important. This is the case with the Cane Hopper—*Dictyophara pallida*, the Cane mealy-wing—*Aleurodes*, and mealybugs—*Pseudococcus sacchari*, but in most cases, these pests become abundant only when ratoon crops are raised, and as far as possible it is advisable to avoid ratoon crops. Plant-lice—especially *Aphis maidis*—have assumed importance as carriers of the Mosaic disease, but are otherwise not serious pests of cane in South India. The Paddy Grasshopper—*Hieroglyphus banian*—has been reported to be causing damage to cane in Ganjam and Vizagapatam districts. The attack is, however, generally of the nature of an overflow from the surrounding Paddy crop. In the case of a heavy outbreak noted at Anakapalle in 1923, the only practicable method of dealing with the pest was found to be the organization of a general drive with the help of coolies towards one end of the field and their subsequent destruction. Cockchafer grubs have been reported from North Arcot damaging the roots of cane, but no reliable measures could be recommended in the absence of a detailed study of the insect.

The Major Pests of Cane

The borers share with the white ant the distinction of being pre-eminently the major pests of sugar-cane. Since 1927, a detailed study of the cane-borers has been made in all its various aspects by Assistant Mr. V. Tirumal Rao at Anakapalle at the instance of Mr. A. C. Edmonds—the Deputy Director of Agriculture, I Circle, Vizagapatam; and fairly interesting results have been obtained thereby, and it is the object of this paper to indicate briefly some of the results obtained.

The Borers: There are four species of borers present in South India, of which only one is really important, viz. *Argyria sticticraspis*. The other

borers are (1) *Sesamia inferens*—the maize-borer, also breeding in maize, ragi and sorghum. This usually appears on cane during the dry month of January–April. (2) *Diatraea venosata*, appearing as a shoot-borer on the half-grown crop in June–July, and (3) *Scirpophaga aurillua* and *S. monostigma*, the top-shoot borers of the maturing crop, rather rare in South India.

The borer, *Argyria sticticrasis*, attacks the shoots of the young cane crop in April–May and causes the formation of ‘deadhearts’ in the primary shoots to the extent of 10 to 50 per cent according to the variety concerned, B. 208 being found to be the most susceptible to attack. The secondary shoots are also attacked, but to a smaller extent—2 to 20 per cent. In order to estimate the extent of the losses caused by borer attack, clumps that had had such attack were carefully kept marked and compared as regards yields at the time of harvest with their controls—known to be absolutely free from deadhearts. The results have shown significant differences upto 10 per cent in favour of borer-free canes. Secondly, the borer has also been found to attack the internodes of cane during the growing period, viz., July–September, the second and third generations of the pest being concerned in such damage. Ten to fifteen per cent has been recorded, the quantity and quality of cane-juice being thereby found affected. Thirdly, it has been customary to advise cultivators to discard all joints attacked by borer in planting the new crop. Careful observations made in experiments, where the use of such setts was tested, have shown that there is no harm really in using them, unless (1) the buds are actually damaged, (2) there is live borer in the setts, and (3) the joints show fungus attack.

As to methods of control, (1) dusts of sodium fluosilicate, levosol fluosilicate, lead arsenate and lime, and Paris Green and lime were tried at Anakapalle and also at Coimbatore with the aim of reaching the very young caterpillars that usually live a free life scraping the green matter of the leaves before they begin to bore in. This was, however, only partially effective as but a small percentage of borers was found thereby affected. There was in addition a certain amount of scorching of leaves, especially at the axils. (2) Light traps were ineffective. (3) Trash traps—were tried according to Dr. Kunhikannan’s method. It was observed that the moths hid themselves, under the conditions of the Circars, in cracks in the soil and under clods, instead of in the trash heaps placed in the newly planted field; on the other hand, on days succeeding an irrigation fairly good catches were obtained. (4) Trials of *handpicking of eggmasses* showed that it was not a very practicable affair, for the eggs of *Argyria* hatch in 3–4 days and are difficult to detect; and an inspection of the crop at sufficiently close intervals to serve the needs of efficiency is not an economic proposition.

It was also noted that the September plantings showed very much lower infestation than the April–May ones.

As to the utilization of the natural enemies, the borer is found subject to the attacks of three different parasites: 1. A Braconid attacking the full-grown caterpillar in the stem;—not very efficient, as the highest percentage of parasitisation noted was about 10 per cent. 2. There are two small parasites breeding in the eggs of the borer: (1) *Phanurus* sp.—found active in the dry months with an effectiveness ranging upto 30 per cent, and (2) *Trichogramma* sp.—flourishing during the rains and showing 90 per cent efficiency in the later stages. Propagation of these parasites artificially on a large scale in the laboratory has not yet been attempted, but will doubtless give good results ultimately, as in America and West Indies.

The Termite problem : At the Thick-cane Breeding Station of the Imperial Department of Agriculture, Coimbatore, three different species of Termites were noted to be responsible for damage : 1. *Eutermes biformis*—The workers emerge from holes in the ground, cut portions of cane leaves—especially of the seedlings—and carry the bits into their nests. The grass-cutting habits of this species is, of course, well-known, but this is the first time that they are recorded as damaging cane. The spraying of deterrents like, Crude oil emulsion, was effective in keeping them off. 2. *Odontotermes obesus* and *Calotermes sp.* have been recorded to be destructive to planted setts in many parts of South India. Their depredations are specially serious in the case of cane seedlings raised in the Cane Breeding Station, in view of their potential value as the *canes of the future*. 1. A soaking application of Crude oil emulsion or tar emulsion to the base of the affected seedlings with a watering can, after a preliminary hoeing, was found very effective. 2. It was also found that when trash was buried in shallow trenches among the affected rows, the attentions of the termites could be diverted from the canes. 3. In certain cases the nests of the white ants were located in the narrow bunds of the wetland fields, and could be easily dug out and destroyed.

THE DISEASES OF SUGARCANE *

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The diseases of Sugarcane may be broadly classified according to their origin under the following heads :

- (1) Fungus diseases.
- (2) Bacterial diseases.
- (3) Virus diseases.
- (4) Physiological diseases.

As usual, fungus diseases out-number diseases of other origin and the number of fungi recorded on sugarcane aggregates over 200 which constitutes a record for any one single species in cultivation by man. Fortunately, only a small fraction of this vast number causes any disease of economic importance and of this small number not all are let free by wise Nature to appear in one and the same part of the globe where sugarcane is grown. There are over two dozen parasitic diseases on record in India but it is not possible even to make a passing mention of all of them in the purview of a short paper and I would therefore confine my attention to the more important diseases of sugarcane occurring in the Madras Presidency.

FUNGUS DISEASES

Red-rot (*Colletotrichum falcatum*). The most important fungus disease of cane in Madras is 'Red-rot' caused by the fungus *Colletotrichum falcatum*. It has a cosmopolitan distribution in almost all the tropical cane growing countries and is known throughout the cane tracts of India. As the name implies, the most characteristic symptom of the disease is the reddening of the internal tissues which is noticed when an infected cane is split open.

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