

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.

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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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The discoloration is intense in the vascular bundles and often red blotches with white transversely elongated centres are found. Usually the disease exhibits itself in a crop approaching maturity and the first external symptom is the marginal drying of the mature leaves. With the progress of the disease the whole crown of leaves withers and dries up as if from drought. The disease occurs in patches and usually all the canes in a diseased clump are infected. It is our experience that the disease is more serious in thick canes than in thin ones. Usually the reddening proceeds from the base upwards, though infection of a few internodes in the middle caused by local infection may rarely occur.

As the disease progresses, the mycelium penetrates the pith which dries up and the rind of the cane collapses causing longitudinal hollows on the surface. The mycelium subsequently forms acervuli of the fungus which burst through the rind and bear spores of the fungus particularly on either side of the nodes. Fructifications of the fungus are also formed on the dried up leaves and leaf-sheaths.

Effects. The effect of the disease on sugarcane is two-fold. First there is a distinct loss in tonnage through withered clumps. Secondly, in the unwithered canes the quality of juice gets deteriorated with the result that the juice on boiling does not set or produces a poor quality of jaggery.

The chief agencies in the spread of the disease are (1) diseased setts and (2) infected soil and (3) airborne spores.

(1) *Sett infection.* This is the agency in spreading the disease from infected to healthy areas or fields and for multiplying the disease in an already infected field. The mycelium of the fungus present in infected setts gives rise either to infected shoots which die an early death or causes the development of the fungus in whole clumps. It also leads to the infection of the soil from the fungus developed on the plant debris such as roots, stumps, leaves, etc. Under Indian conditions infection through setts has been found to be the most important source of disease.

(2) *Soil infection.* As a rule, the fungus is incapable of making its entry through the unwounded host. The most common method of entry into the uninfected host is through the cut ends of the setts. Once the entry is effected the fungus penetrates the sett, its progress being very rapid in the ripe setts rich in sugar. Very often the fungus spreads so rapidly that the setts fail to germinate or when germinated the seedlings are killed outright.

(3) *Aerial infection.* Aerial infection takes place mostly through the adventitious roots and root-eyes. But compared with the other sources of infection this is less important.

Control. The methods of control are preventive, aiming at the reduction of the sources of infection to a minimum. Firstly the seed used for planting should be free from disease. This is done best by selecting setts from an uninfected field. Selection of setts from fields entirely free from disease is an ideal rarely attainable, so that one often has to direct one's attention to the selection of his planting material from clumps which are free from the disease. The experiments conducted by this Department on the Samalkota Agricultural Research Station (Godavari delta) have shown that when setts are selected from disease-free clumps, the percentage of infection is reduced to a minimum. The practice was to reject canes which showed the slightest trace of disease and when in a stool a single cane showed the reddening, to reject the whole stool of cane. Steeping the sets in Bordeaux mixture before planting and

dipping the cut ends in tar were tried at the Samalkota Agricultural Research Station during the years 1906-07 with satisfactory results.

The only practical method of preventing soil infection is the practice of rotation of crops. The fungus is known to live saprophytically in the debris of sugarcane and some intervening crops like paddy or plantains on which the fungus cannot live will starve out the fungus.

Varietal resistance. There is a wide range of variation in the susceptibility to disease among different varieties of cane. The experience in Godavari shows that the indigenous canes were, as a rule, highly susceptible, while the exotic varieties were able to withstand the disease better. The latter after a time became susceptible and were in turn replaced by varieties from other localities.

The disease occurs more in low lying water-logged fields than in well drained ones. A water-logged soil increases the susceptibility to the disease and therefore attention to drainage is as important as the other precautions above mentioned. With this end in view, cane culture should as far as possible be confined to the top plots in wetland areas where good facilities exist for drainage.

*Smut (*Ustilago Sacchari*).* The fungus is known throughout the oriental cane growing countries. In India it is of common occurrence in the thin cane tracts of Northern India, though it is not unknown in the thick cane tracts of the South.

Symptoms. The disease is characterised by the production either from the growing apex or from the side shoots of a long, black, sooty, whip-like appendage which on its emergence is enclosed in a thin white papery sheath which encloses the spore-bearing shoot, but which is later torn asunder exposing the mass of fine black powder which constitutes the spores of the fungus.

As a rule in a newly planted seedling crop the disease occurs when the canes are approaching maturity, but infection may also occur from the seedling stage onwards. In a ratoon crop, shoots growing from smutted clumps are invariably affected. There are two distinct forms in which smut occurs. In the first the terminal shoot is infected, while in the second, one or more side shoots developing from the stem are infected. Infection has been proved to take place in three ways. Firstly through infected setts cut from infected canes which contain the mycelium. Secondly through spores which come in contact with the cut ends of setts and thirdly through spores which on germination effect an entry into the growing cane through vulnerable points, e.g. the bud hairs, root eyes, wounds, etc.

Losses. The disease is not regarded as one of very serious consequence. Except when the disease is multiplied year after year both through sett infection and spore infection, the loss from it is negligible.

The writer has succeeded in getting infections by injecting a spore suspension in water into a hole made in a growing cane with the aid of a cork borer and also by pouring a spore suspension into the cavity of the emerging terminal shoot.

Though no variety is totally immune to it, a very wide range of variation in resistance exists among different varieties of cane. Butler records that the varieties *khari*, *nanal*, *saretha*, *sanabili* and *katha* suffer very severely at times. Among thick canes, as a rule, the disease is seldom severe. At Palur the variety J 247 has, however, been found to be very susceptible.

Control. The chief method of control is the cultivation of resistant varieties. To prevent spore infection, infected shoots should be collected and burnt as soon as they emerge. In view of the fact that the fungus produces spores in great profusion, the practice reduces the chances of spore infection of growing cane as also the possibility of infection of the soil by viable spores.

Pine apple disease (*Thielaviopsis paradoxa*). This disease takes its name from the peculiar odour of the ripe pine apple which the infected canes emit, and possibly also from the fact that the same fungus is a parasite of the pine apple also. The most characteristic symptom of the disease is the occurrence of a hollow tube through the axis, which is dark coloured and sooty black when fully developed. The dark discoloration is brought about by the profuse formation of dark coloured spores. The identification of the disease can therefore be easily confirmed by the microscopic test.

The disease is essentially a wound parasite which cannot gain access to uninjured cane. The greatest loss from this disease in other cane-growing countries is from its attack on planted cane setts. The fungus enters through the cut ends and rapidly pervades the tissue. It causes the wide spread death of the germinating sett thus producing several failures in sprouting. To a lesser extent, the disease occurs on standing cane the attack being near the ground level. Once the fungus has gained its entry, it kills the cane in the course of a few weeks.

Though it has been found in some parts of the South, it has not so far been reported to have taken epidemic form anywhere. The researches in Coimbatore have shown that the same fungus causes the 'bleeding disease' of the coconut, the arecanut and the palmyra palms. This disease being of very common occurrence in this country, a great danger lies lurking at our doors awaiting opportunity to invade cane and no effort should be spared to stamp it out.

VIRUS DISEASES

There are two virus diseases which have come into importance during recent years and these are 'Mosaic' and 'Streak'. Of these, Mosaic has gained entry into almost all the cane growing countries of the world and has therefore obtained international importance. Streak is still but meagrely studied and is apparently less widely distributed than Mosaic.

Mosaic disease. As the name implies the disease is characterised by a peculiar mottling of the leaves. From a distance a badly infected field shows a dull green or yellowish tint instead of the healthy dark green colour. A close examination of infected plants shows that there exists on the leaf surface innumerable whitish or yellowish elongated blotches possessing wavy margins. The pale areas alternating with the normal green colour form a distinctive pattern the details of which vary with different varieties of cane. There are however two distinct types of markings known in South India. In the first which is the commoner type and in which the majority of varieties fall, the green colour forms a background for irregular white blotches. In the second type, e.g., Java-Hebbal and *Vellai* the normal dark green colour appears as a few irregular islands on a pale green background. As a rule the disease is most conspicuous on the leaves but in advanced cases of infection a mosaic pattern is formed on the internodes also. Such patterns are conspicuous on the dark-rinded varieties, and their colour contrast is intensified after the leaf sheath which encloses the internode falls off.

Distribution. The disease is recorded in almost every sugarcane growing countries of the world, viz., Java, Cuba, Hawaii, Argentine, Porto Rico, Trinidad, Jamaica, Louisiana, Natal, Queensland and India. Mauritius alone stands out as a singular exception among the world's important cane fields, thanks to the vigorous quarantine measures in vogue in that country. In India it is known to exist in all the provinces to a greater or lesser extent. As a result of a survey of the disease made in Madras, it has been recorded from portions of Godavari, South Arcot, Coimbatore, Trichinopoly and Malabar districts.

The effect of the disease. Mosaic may be rightly described as a wasting disease which does not kill the cane outright, but it causes material reduction in the tonnage of cane per acre. The loss due to the disease varies according to the intensity of the disease and according to varieties. Some varieties like Red Mauritius and Java-Hebbal do not show perceptibly marked ill effects while varieties like B 208 are distinctly stunted in growth. The loss from Mosaic has been estimated to be up to 40 per cent in Porto Rico and 50 per cent in Hawaii. Losses up to 70 per cent have been recorded in individual varieties. Chemical analysis of healthy and infected canes side by side failed to show any difference in the quality of juice and in jaggery making the quality of the finished product did not suffer. But in advanced cases of infection the stem gets shrunk, the rind cracks and the percentage of juice falls.

Control. Based on the knowledge of the disease attained so far, three methods of control can be recommended. These methods severally and in combination have proved to produce very salutary results.

- (1) Planting of setts from Mosaic-free clumps.
- (2) Systematic weeding of infected stools.
- (3) Planting of resistant varieties.

The idea underlying the first recommendation is the prevention of primary infection, i.e., the elimination of diseased setts which in turn give rise to diseased seedlings. Sett selection is rendered easy in tracts like Kallakurichi where the cultivators reserve a portion of their fields for setts and all portions of the cane are utilized for planting. An attempt has been made in this direction during the current season in the villages of Mudianur and Pennadam (Kallakurichi taluk) where J 247 has been recently introduced by the department.

The 'roguing' of infected stools is meant to prevent secondary infection, i.e., the elimination of diseased material from which the insect vector carries infection to the healthy plants. The selection of resistant varieties involves a knowledge of the relative resistance of several varieties. All attempts made at Coimbatore to correlate morphological and histological characters with disease-resistance have failed. However, a reliable method of testing the relative resistance of sugarcane varieties has been developed in Coimbatore by means of which the relative resistance could be gauged with a desirable amount of precision and the results made available in the course of a year. The method consists in planting uniform rows of the varieties to be tested in a serial order interlined with Mosaic-infected rows of cane, thus providing equal opportunities for all the varieties to take secondary infection. Periodical counts are then taken of the number of infected stools and percentages struck of the progressive totals. Under Coimbatore conditions, it is found that secondary infection takes place during the first 5 months of the crop i.e., between the months of February and June. As such, the relative resistance

of cane varieties could be judged with fair accuracy within a period of 5 months.

The adjoining tables give the results of varietal trials conducted in Coimbatore during the last two years.

Varietal Trials 1929

Variety	Plot A.			Plot B.		
	No. of infected clumps.	Total No. of clumps.	Percentage of infection.	No. of infected clumps.	Total No. of clumps.	Percentage of infection.
Co 205 ...	0	30	0	0	29	0
Co 210 ...	31	35	91.5	34	34	100
Co 213 ...	24	25	96.0	30	30	100
Co 214 ...	0	35	0	0	30	0
Co 223 ...	27	29	93.1	29	31	93.5
Co 244 ...	0	28	0	0	36	0
Co 250 ...	23	25	92.0	36	37	97.3
Co 281 ...	24	32	75.0	27	35	77.1
Co 287 ...	33	38	86.8	29	35	82.9
Co 290 ...	19	36	52.8	19	33	57.6
Kassoer ...	0	35	0	0	36	0
Chunnee ...	27	28	96.5	30	31	96.8
P.O.J. 2714 ...	0	30	0	1	31	3.3
P.O.J. 2727 ...	2	26	7.7	3	28	10.7
Pattapatti ...	20	32	62.5	14	25	55.0
H 109 ...	15	26	57.5

Varietal trials, June 1930

No.	Name of variety	Percentage of infection	
		May	June
1	Co 205	Nil	Nil
2	Co 213	91	96
3	Co 214	Nil	Nil
4	Co 244	Nil	Nil
5	Co 290	2.5	43.5
6	Co 299	42	62
7	Co 312	54	79
8	Co 313	85	90.5
9	Co 314	1.25	1.25
10	Co 315	Nil	Nil
11	Co 316	Nil	Nil
12	Co 317	45	57.5
13	Co 318	Nil	Nil
14	Co 330	80	95
15	Co 334	87	91.5
16	Co 335	Nil	Nil
17	P.O.J. 2878	Nil	Nil
18	Kassoer	Nil	Nil
19	P.O.J. 2714	2	5

It is apparent from a cursory glance at these tables that some of the varieties which possess desirable qualities from the agriculturist's point of view are defective in disease resistance and the need for infusing mosaic-resistant blood into them is a problem which the breeder has to face.

It would be interesting in this connection to mention that stray cases of mosaic have very recently been observed on maize, ragi and elephant grass on the Central Farm. The external symptoms of the disease are very similar to cane mosaic. The fact that these host plants were in fields within close proximity to the mosaic experimental plot has given room for the suspicion that the disease has passed to these plants from cane. In the case of ragi and maize which are raised from seeds, it is found that the mosaic is not transmitted through seed. Experiments are now in progress to see whether elephant grass mosaic is transmitted vegetatively through slips.

Streak disease. Streak disease is in several respects very much allied to mosaic. Like mosaic primary infection takes place through infected setts and secondary infection has been reported to take place through the agency of an insect. The difference lies in the dissimilarity in the patterns which the two viruses form on the leaf. While mosaic forms blotches of irregular margins, streak forms patterns of straight lines whose margins are clearly defined. The disease is found in Pusa and a case of streak has recently been recorded on Co 213 in Coimbatore; but it appears to be of very rare occurrence in India.

PHYSIOLOGICAL DISEASES

The only disease of distinctly physiological origin that is of common occurrence in South India is Chlorosis. It is a common observation that it takes some years before sugarcane gets accustomed to the land in which the crop was not raised before, and in some localities the first few crops show a lack of chlorophyll development which results in a subnormal development of the cane. Sometimes the whole leaf is affected but at other times longitudinal bands of chlorotic areas parallel to the veins are observed. This phenomenon is more conspicuous in garden lands newly planted to cane and in varieties whose mother stock was for several generations planted under different soil conditions. For instance, canes brought from the wetland areas of Kuniathur and from Malabar when raised in Coimbatore garden lands gave a chlorotic crop. The exact cause of this disease is unknown, but the general consensus of opinion is that chlorosis is associated with iron starvation.

DISCUSSION

After the reading of the last paper the subject was thrown open for discussion in which a large number of the District Officers took part. Mr. C. S. Seshagiri Ayyar desired to be enlightened on the following points :

1. Methods of planting canes with reference to spacing of setts,
2. The quantity of phosphoric acid to be added for clarifying the juice during boiling,
3. The yielding power of the short duration cane hybrid variety, mentioned by Rao Bahadur T. S. Venkatraman.

Mr. K. Krishnamurti Rao then narrated his experiences in the Bellary tract, where boiling was done in very large pans and where the Scindwahe furnace could not be successfully demonstrated. He also said that experience at the Cane Breeding Station showed that sugarcane manured with *Kolinji* gave a better coloured jaggery than that manured with *Daincha*.

Mr. K. M. Venkatachalam Pillai in giving his experiences in Salem District pointed out the difficulties of growing cane in *Padugai* (lands adjoining rivers and liable to inundation) lands, which become submerged for two months in the year, due to floods in the Cauvery and wanted to know therefore, whether a nine to ten months variety could be obtained for that tract. Mr. K. Suryanarayana said, that application of Ammonium sulphate could not be done in the Anakapalle area as no rains were received after planting, and late applications delayed maturity. Mr. Bhairya Shiva Rao pointed out that the Scindwahe furnace was very successful in the Chittoor District; the chief difficulty there for the cane grower, was water scarcity during some periods of the growing season, irrigation being mainly from wells; this hastened arrowing and ripening of the canes. Mr. M. R. Balakrishnan incidentally pointed out that colour of jaggery was evidently not a very important factor in the Vellalore tract of the Coimbatore District, because, the weekly shandies ensured speedy disposal of the produce whatever be its quality. Mr. Venkatachalam Pillai however remarked that colour was certainly considered to be an important factor in the Mohanur tract of the Salem District. Rao Bahadur D. Ananda Rao speaking on this aspect, referred to certain varieties like Fiji B, being rejected by the ryots because they produced jaggery of unfavourable colour. In regard to phosphoric acid as a clarifying agent, he said that more information on this head was wanted,

He also stressed on the necessity for investigations to be made, to find out the most suitable time for, and the number of doses of application of, manures to cane. With reference to width of planting, he said that it was dependent upon facilities for irrigation, and remarked that the possibility of minimising irrigation by cultural operation or otherwise, was a problem worth investigating into. He concluded by referring to rapid propagation trials at Páalur which showed that J 247 and canes with long internodes proved most suitable for this purpose.

Mr. T. V. Rajagopalachariar in his reply to the points raised in the discussion, remarked that in Java about 500 lbs of Ammonium-sulphate were applied to the lands every year without any adverse effect, showing that much depended upon the nature of the soil. According to him, trials with fish guano were worth continuing. With reference to the question whether nurseries, as in paddy, could be raised, his opinion was, that it could be adopted only for filling up blanks and even then it was not very successful. Regarding the statement that vitality in setts is improved by liberal doses of manure to the nursery, it seemed to him, to be more due to the high content of glucose in the setts from nurseries manured liberally. Liberal application of manure to the crop he said, would result in vigorous growth and would retard flowering. With reference to the colour of the jaggery—a point raised by some speakers—he said that as a factor of importance it varied largely with the tracts. He also referred in his reply to a point which he had mentioned earlier in his paper viz. the invention and adoption of suitable pans for boiling juice under low pressure, and said that if the Research Engineer could evolve a suitable device, it would become a factor of great economic importance in jaggery industry.

Rao Bahadur T. S. Venkataraman observed that on the face of it, it would be unfair to compare a short-duration hybrid with a normal crop, with reference to yield, but said that the hybrid could be included in the rotation in the place of other short-duration crops. He pointed out that canes flowered in Java also but were not condemned for that reason, if at the same time the varieties were good. The work started and conducted by his colleague Mr. Nandalal Dutt on this aspect of the problem, made him feel quite optimistic as regards the future of thick canes in this part of the country. His experience was that sheep-penning and application of nitrogenous and organic manures delayed flowering, while phosphatic manures proved otherwise. He stressed on the importance of proper planting material, and said that the attention paid to this, by the cane grower in Java was something remarkable. He said that good manuring decidedly improved the vitality of setts. With reference to filling up blanks, he remarked that the seedlings could be made to catch up if done properly, and even with tillers as was done in Louisiana. He concluded by saying that purity essentially depended on variety, and the Hospet tract could profitably try better varieties obtained from the Imperial Cane Breeding Station.

Rao Bahadur B. Viswanath rising next, explained that the figures he gave were an analysis of those for the last 25 years and not averages for those years. In regard to the number of doses of manure, he said that much data were not available but from what was available it would appear that 2 or 3 applications were better than a single one. Phosphatic manure, though it did not contribute to appreciable increase in yield as nitrogenous manure did, was essential for enriching the qualities of juice and jaggery. This however, required further investigation. He had no experience of the use of phosphoric

acid as a clarifying agent, and hoped to conduct tests at Anakapalle on this. He concluded by pointing out that setts obtained from better manured plots do have a better vitality.

To a question put by Mr. M. Gopala Chetti, Rao Sahib Y. Ramachandra Rao replied that J 247 was less susceptible to borer attack than other varieties.

For want of time the discussion had to be closed at this stage and the president in winding up the proceedings said that he was glad to see that the discussions centred round the cost of production, which was the one point that they had to tackle, if, as they all desired, the area under the crop and the yield per acre should increase. He said that what they had learnt that afternoon, was by no means exhaustive and made a forcible appeal that contributions on the subject might be made to the *Madras Agricultural Journal*.