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Bio-chemical factors involved in the resistance of the cotton plant to the attack of the stem-weevil §

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It is proposed to give here a short account of the investigations conducted in the chemical laboratories at Coimbatore on bio-chemical factors involved in the degree of resistance offered by the cotton plant to the attack of stem-weevil which is one of the most important pests on that crop.

Before entering on the bio-chemical side of the question, it may not be out of place to describe how the damage is actually caused. The stem weervil thrusts its small eggs just underneath the thin bark of the cotton plant; the egg hatches into a grub which burrows and eats up the material between the bark and the main stem leaving irregular tunnels of all shapes. It causes a heavy drain on the plant-sap going up the stem. When young plants are attacked they are in most cases killed. Where the plant is vigorous enough to maintain itself in spite of the drain caused by the grub, it develops characteristic nodular swellings. A strong wind might break the stem near the swelling and some more plants die as a consequence. The extent of damage therefore depends on the largeness of the gaps left over, when young plants succumb to the stem-weevil attack and when bigger plants die after the winds break off the stem.

Among the methods of controlling the pest, insecticides are of no use as the grub is an internal feeder. Burning of attacked plant is to be taken up by cotton growers if the damage is to be reduced.

Yet another method available for the control of the pest is artificially to set up in the plant certain conditions unfavourable to the normal vigorous growth of the insect; or conditions which enable the plant to survive the attack at the earlier stages. This involves firstly a thorough study of the bio-chemical relationships between the constituents of the various parts of the attacked and healthy plants; secondly the relationship between the constitution of the plant and the plant sap on the one side and the soil-solution on the other and thirdly, the influence of cultural and manurial treatment on the base exchanges and consequently on the composition of the soil solution and of the plant.

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These have been under investigation for four years now. But in this paper attention will be directed to the more important aspects of the inter-relationship that appears to exist between the soil and the plant with reference to stem weevil damage.

(a) In 1923, the Government Entomologist observed in Virudupatti that in Mr. Osborne's, field 50 per cent of the cotton plants were killed by stem weevil, while in a neighbouring ryot's field there were practically no deaths.

The absolute quantities of the chemical ingredients as revealed by the usual soil and plant analysis did not indicate any notable differences but on studying the intake of Potash relatively to that of Phosphoric acid, the following results were obtained.

The ratio Available Potash Available Phosphonic acid = 1·46 in Osb's field whileit is about 1 in ryot's field.

The ratio (k) intake/(p) intake of plants in Osb's field = 4·96 ; Ryot's field = 9.64.

Thus the state of health of the plant may be traced to the intake of Potash relative to that of Phosphoric acid. The ratio of Potash to Phosphoric acid thus seems to have something to do with a plant's ability to survive an attack by the stem weevil.

(b) The next step in the investigation was the examination of plants, healthy and killed and those attacked by stem weevil but not killed, obtained from Feld No. 13 of the Central Farm, growing Karunganni cotton.

The ratio of Potash to Phosphoric acid in plants attacked but living = 5·56.

The ratio of Potash to Phosphoric acid in plants healthy = 4·95

The ratio of Potash to Phosphoric acid in plants killed by stem weevil = 4·50.

Statistical examination of the results point to the conclusion that in the attacked plants Potash to Phosphoric acid is significantly higher than in the killed plants. The surviving plant appears to absorb more potash or in general more bases to counteract the damage caused by the grub.

(c) A large set of healthy and stem-weevil attacked plants C 440 were collected from field No. 4 of the Cotton Station. Those with distinct swellings and showing galleries made by the insect were cut up into their constituent parts and analysed. The healthy plants which were free from any such galleries were similarly examined.

Examining the ratio Potash to Phosphoric acid and Potash plus Lime plus Magnesia to Phosphoric acid :—

	$K_2^0/P_2^0{}_5$	$K_2^0+Cao+Mgo/P_2^0{}_5$
Healthy minus Attacked in Leaf	= 0·30	1·69.
in Stem	= 0·62	— 3·14.

Assuming that normal absorption and assimilation obtains in the healthy plant, it will be noticed that in the attacked plants, there is a defect of the basic constituents in the leaves, and an excess of the same in the stem. In the case of phosphoric acid, the reverse is the case. Thus it would appear that there is a tendency to the movement of the basic constituents from the leaf to the stem which is the seat of injury.

(d) Agreeably to this view the hydrogen-ion-concentration in the extracts of the leaves and the stems gives the following results.

	Healthy.	Attacked.
	av-pH	av-pH
Stem	... 6·11	6·18
Leaves	... 5·37	5·41

There seems to be a tendency on the part of the attacked plant to get less acid.

(e) If there should be any difference in the absorption and assimilation of mineral matter by the cotton plant as a result of stem weevil attack and if the bulb or the nodular swelling is the damaged portion requiring urgent repair there should occur the most prominent differences in the mineral constituents of the stem and its bulb

(Per cent in stem.—Percent in bulb.)

Potash	...	0·064	not significant.
Phosphoric acid	...	−0·030	do.
Lime	...	0·98	Significant.
Potash/Phosphoric acid in stem minus Potash/Phosphoric acid in bulb.	...	0·52	do.
Magnesia.	...	−0·10	not significant.

Whether attack of the stem weevil is the result of a certain pre disposition of the plant either as a result of the increased acidity of the sap is too premature to say. It would appear that the stem weevil has no particular choice among cotton plants and that the unattacked ones are those that have escaped by accident. The eggs having been laid, the grub goes on feeding the plant and unless the plant is vigorous enough to repair the losses and damage done and still maintain the supply of sap to the leaves, it succumbs

(f) Manuring and incidence of weevil C. 440 was grown in the old and New Permanent Manurial plots involving differential manurial treatments with N, K, P singly and in combination with No manure and Cattle Manure plots. Whereas in the old set of plots there is emphasised manurial action as a result of 15 years of continuous treatment, the new set received such treatment only for 3 years. Counts of attacked and dead plants were made by the Government Entomologist.

In the old permanent manurial plots, the percentage of attacks is highest in the plot continously receiving cattle manure while the deaths therein are the lowest. The next lowest deaths occurred in plots receiving potash. Wherever Potash occurred in combination with Nitrogen or phosphoric acid, the deaths are correspondingly lower than with nitrogen and phosphoric acid either individually or in combination.

In the new manurial plots where the conditions may be said to be similar to the ordinary irrigated cotton crop, potash stands only next to cattle manure in low deaths on account of stem weevil.

The analysis of the kappas from these different manurial plots shows that application of potash resulted in a relatively greater intake by the plant, not only of potash, but also of lime thus enabling the plant to set up a reaction by increasing its basic constituents namely, Potash, Lime, and Magnesia.

(g) Yet another experiment conducted in big pots placed in Field No. 75 shows that C. 440 when manured with potash gives the minimum deaths due to stem-weevil. Next come no manure and cattle-manure. Where the phosphoric acid content of the soll is high, the deaths are great and the bolling capacity is low.

	No.	C. M.	K. P.	K. P.
Weight of plant ...	3.77	4·01	5·66	5·68
Weight of kappas ...	15·84	18·04	19·22	11·66

I beg to tender my thanks to the Government Agricultural Chemist for affording the facilities for conducting thispiece of work and for his constant guidance.

AVERAGE ANALYSES OF SAMPLES.

	No. of Samples.	Nitrogen.	Ash.	Insolubles.	Potash.	Phosphoric acid.	Lime.	Magnesia
1. Leaves of healthy plant ...	13	4·33	16·47	1·06	2·12	0·83	5·63	1·63
2. „ stemweevilled.	13	4·22	16·15	1·00	2·02	0·87	5·31	1·13
3. Stems of (1) ...	13	1·08	8·89	0·34	1·46	0·46	1·68	1·01
4. Stem of (2) ...	13	1·10	7·64	0·30	1·52	1·52	0·39	1·59
5. Swellings ...	12	1·21	4·87	0·38	1·46	0·42	0·61	0·65