

A STUDY OF THE BEHAVIOUR OF SOME COMMON VARIETIES OF
SUGARCANE IN REFERENCE TO THE ATTACK OF BORERS
AT PUSA (BIHAR) DURING 1935-36.

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INTRODUCTORY.

The cultivation of sugarcane has rapidly extended during the last ten years in almost all the cane-growing tracts of India. The extension in the cultivation of this valuable crop has naturally brought its insect pests into great prominence. Borers constitute the most serious pests. Reports from various parts of the country indicate that on an average about 10% of the crop is damaged by these pests every year. Recent work in several countries has shown that all cane varieties are not equally susceptible to damage by borers [Cleare, (1934); Holloway, (1935); Tucker, (1936); etc.]. In India numerous new varieties of cane are distributed periodically from Coimbatore for trial in the provinces and it is of great economic importance to ascertain, in addition to other factors, the behaviour of such varieties towards insect pests in different regions of the country. Observations on this aspect of the problem have been taken on several varieties at Pusa¹ and some localities in the Punjab¹ during the last five or six years and at Muzaffarnagar (United Provinces) for the last one year or so,¹ but in most cases the observations have been based on only a small number of canes of a few varieties at a time. As far as the available literature shows, hardly any critical large-scale investigation, to study the comparative susceptibility of the most common varieties of an area while grown side by side, has yet been undertaken at any station in the country. Therefore in the cane season of 1935-36, while the Imperial Agricultural Research Institute was still at Pusa, a study into the behaviour of the five common varieties of cane of North Bihar was made, the results of which are described in the following pages.

MATERIAL AND METHODS.

The varieties under study were Co. 210, 213, 299, 313, and 331. They were planted in a randomized plot about two acres in size in the Harpur jilli

¹ See the Annual Reports of the Imperial Entomologist, Pusa, and those of the Director of Agriculture, Punjab, for the years 1930-36. and of the Director of Agriculture, United Provinces, for 1935-36.

field of the Pusa Estate. The detailed plan of the layout (Fig. 1) was as follows :—

The plot was divided into eight blocks and each block was sub-divided into five divisions, each division measuring 60'×24', with a six feet broad passage all round. Each division contained one particular variety and the planting was done in such a way that each block contained all the five varieties, labelled A, B, C, D, and E, in the figure. Planting was done in all the divisions lengthwise (east to west) in rows three feet apart from one another as shown in D of block No. 8 in Fig. 1. Thus there were eight rows of each variety in a division and the various varieties were distributed in the blocks at random. Four (Nos. 1-4) out of the eight blocks were kept as controls,

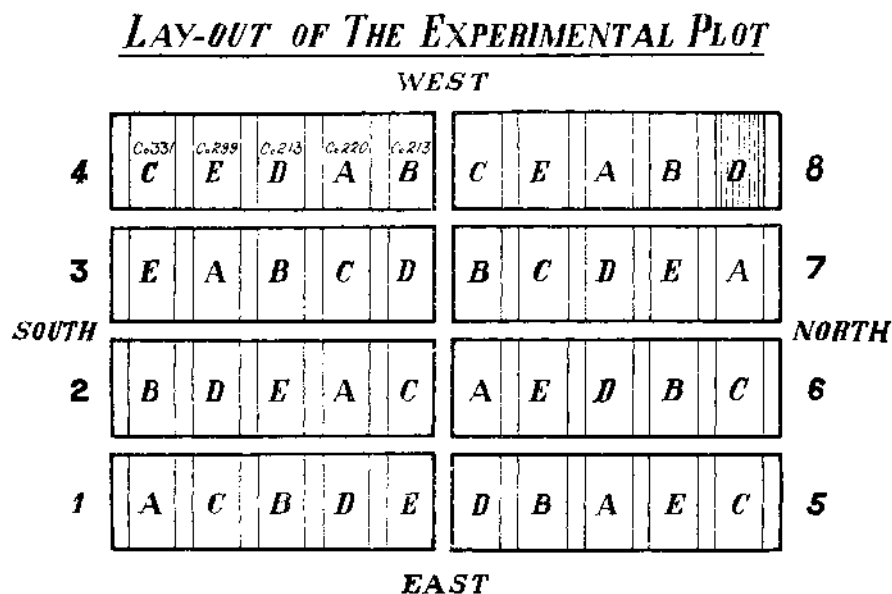


FIG. 1.

whereas in the other four (Nos. 5-8) the dead hearts (external symptoms of borer attack) caused by various borers were removed and their causal agent examined and determined every month. Thus data about the number of dead hearts appearing every month and the kind of borer or borers responsible for them were obtained. Two hundred canes of each variety from each division, viz. 800 canes of each of the five varieties, were thus examined every month. In the control blocks the total number of dead hearts observed every month was recorded but no dead heart was actually removed.

The borers found infesting the crop at Pusa were of the following species :—
Top-borer—*Scirpophaga nivella* Fab. Occasionally a few specimens of *S. monostigma* Zell. were also obtained.

Stem-borers—*Diatraea (Argyria) sticticraspis* Hmp. was the most common species (80–85%); *D. venosata* Wlk. was about 15% and *Chilo zonellus* Swinh. 3–5%. The seasonal history and habits of the three species were almost similar and therefore they were considered as one pest.

Root-borer—*Emmalocera depressella* Swinh.

OBSERVATIONS.

The observations on the incidence of pests on various varieties in different blocks throughout the year are detailed in Table I. The same observations are summarized in Table II, in which the data from different blocks have been pooled together. In Tables III–VII the observations on each of the five varieties under investigation have been tabulated separately, so that the behaviour of a particular variety at different times of the year can be examined readily. The data given in these five tables are graphically shown in Figs. 2–6, so that the reader can easily have an idea of the behaviour of various pests at different times of the year infesting a particular variety. In Figs. 7 and 8 the increase in the aggregate number of dead hearts during different months is shown graphically. The observations are summarized below.

THE STEM-BORER.

The stem-borer moths emerging from the hibernating larvæ of the previous season were first seen in the cane fields early in March and they started ovipositing soon afterwards. The young larvæ started boring into the stems within a week and dead hearts, the external symptoms of their attack, began appearing in April. The same was observed by the staff of the Imperial Entomologist during the previous five years. The percentages of dead hearts caused by this pest in various varieties during different months of the year are given in Table II, column 6. During April this percentage varied between 0·16 and 0·57. With the onset of summer the activity of this pest increased and the greatest number of dead hearts in all varieties caused by this borer were observed during June (2·75%–6·75%). From July onward the activity of stem-borer remained at a low ebb (Figs. 2–6), and the pest was not responsible for causing more than 2·5% of dead hearts in any month in any variety (Tables III–VII).

With regard to the comparative susceptibility of various varieties to the attack of stem-borer, Co. 213 proved to be the most susceptible. During June, when all the varieties had the highest number of dead hearts caused by this pest, Co. 213 had 6·75%, Co. 210 came next (5·33%), Co. 331 had 3·63%, and Co. 313 showed the least damage (2·75%). During the rest of the year also (Table II, column 6) the various varieties showed damage in the same order of intensity as above. Though Co. 299 and Co. 313 were equally damaged during June, the latter variety was however more damaged during the rest of the year, therefore keeping the whole year in view, Co. 299 proved to be the most resistant.

THE TOP-BORER.

As observed by the staff of the Imperial Entomologist during the previous five years or so, the top-borer moths also emerged and started laying eggs in March, and the dead hearts caused by the borer larvæ began appearing during April. The number of dead hearts caused by this pest gradually increased during May and June (Table II, column 5), but during July there was a sudden increase when the percentage of dead hearts in the various varieties varied between 5.38 and 9.63. After this month there was a fall in the case of all

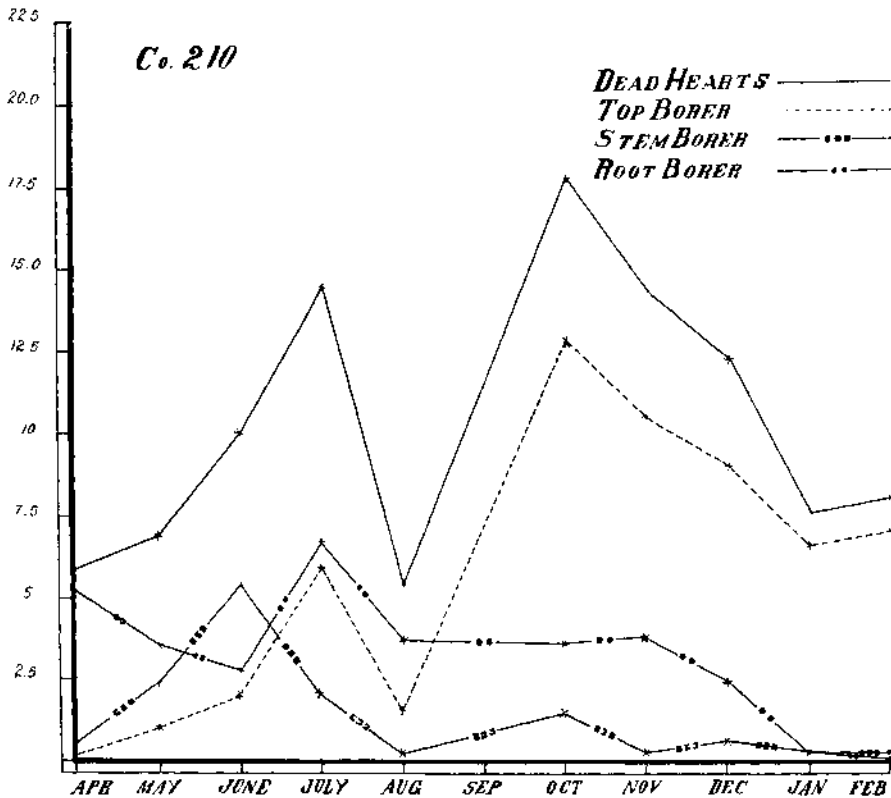


FIG. 2. Percentage of dead hearts caused by all borers (shown by straight line) and by various borers individually at different times of the year in Co. 210.

varieties (Tables II-VII), probably due to the monsoon, the highest percentage during August being 2.25. The number of dead hearts observed in October (9.13%–12.83%) represented figures for two months, as no observations had been taken during September due to floods. Even keeping this fact in view, the increase in the number of dead hearts in the beginning of autumn was evident, as during November the percentage varied between 5.88 and 11.38. There was a slight decrease after this month, but the percentage remained at

a high level throughout the winter. Thus unlike the stem-borer, the top-borer was active almost throughout the year except during the monsoon months, and was most serious at the height of summer and then again in autumn (Figs. 2-6).

As regards the comparative susceptibility of the various varieties, it will be evident from a perusal of Table II, column 5, that whereas up to the end of July this pest caused almost the same percentage of dead hearts in all the varieties, after the rains the variety Co. 210 suffered the most during the rest

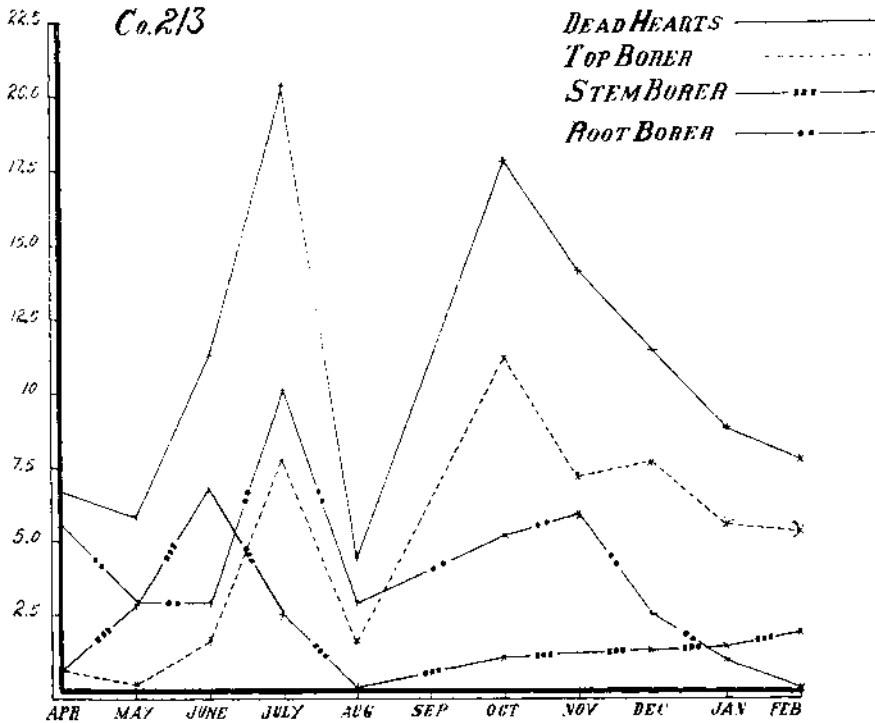


FIG. 3. Percentage of dead hearts caused by all borers (shown by straight line) and by various borers individually at different times of the year in Co. 213.

of the season. Co. 213 behaved slightly better than Co. 210, Co. 299 came next, and Co. 313 and 331 proved to be most resistant.

THE ROOT-BORER.

The moths of this pest as those of the previous ones were observed in fair numbers in the field in the first week of March and dead hearts caused by the borer larvæ appeared in April. At this time the root-borer was responsible for causing a much higher percentage (3.63 to 5.75) of dead hearts in all varieties than stem- and top-borers taken together (Table II, cf. column 7 with 6 and 5 :

and Tables III-VII). During May the position was almost unchanged. In June the percentage of dead hearts went down slightly, but it considerably increased again during July (5.25-11.75%), obviously due to the attack by the second brood of the pest. At this time again, of the dead hearts examined, more were caused by the root-borer than by the top- and stem-borers together. During the monsoon months the damage caused by this pest was less, as was the case with other borers described above. There was a slight increase during October and November, but it was never so high as during the summer months

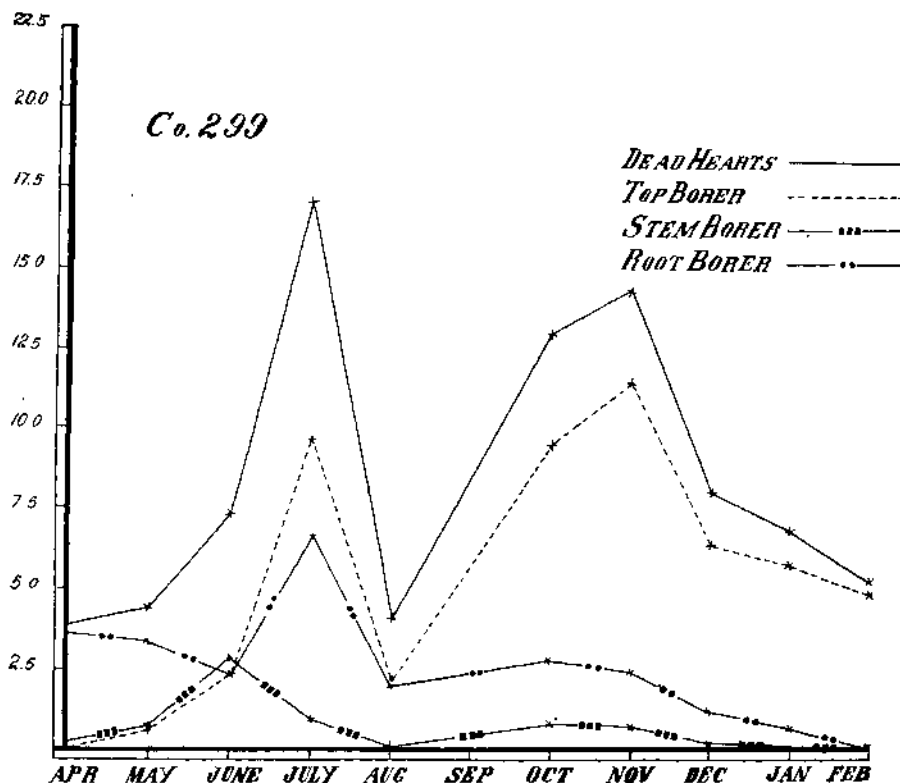


FIG. 4. Percentage of dead hearts caused by all borers (shown by straight line) and by various borers individually at different times of the year in Co. 299.

(Table II, column 7 and Figs. 2-6). From the beginning of December onwards there was very little damage by the root-borer (0.38%-2.5%).

As regards the relative susceptibility of various varieties, Co. 331 proved to be the most susceptible to the attack of this pest throughout the year. Co. 213 was slightly less susceptible. During July, when the percentage of dead hearts caused by the root-borer was the highest, these two varieties had 11.75% and 10.23% of dead hearts, whereas in each of the other three varieties dead hearts were about 6.5% only. Though in July these three varieties had

almost the same percentage of dead hearts, their behaviour studied throughout the year (Tables II-VII) showed that of the three Co. 210 suffered the most. Thus Co. 299 and Co. 313 proved to be the least susceptible to the attack of this pest.

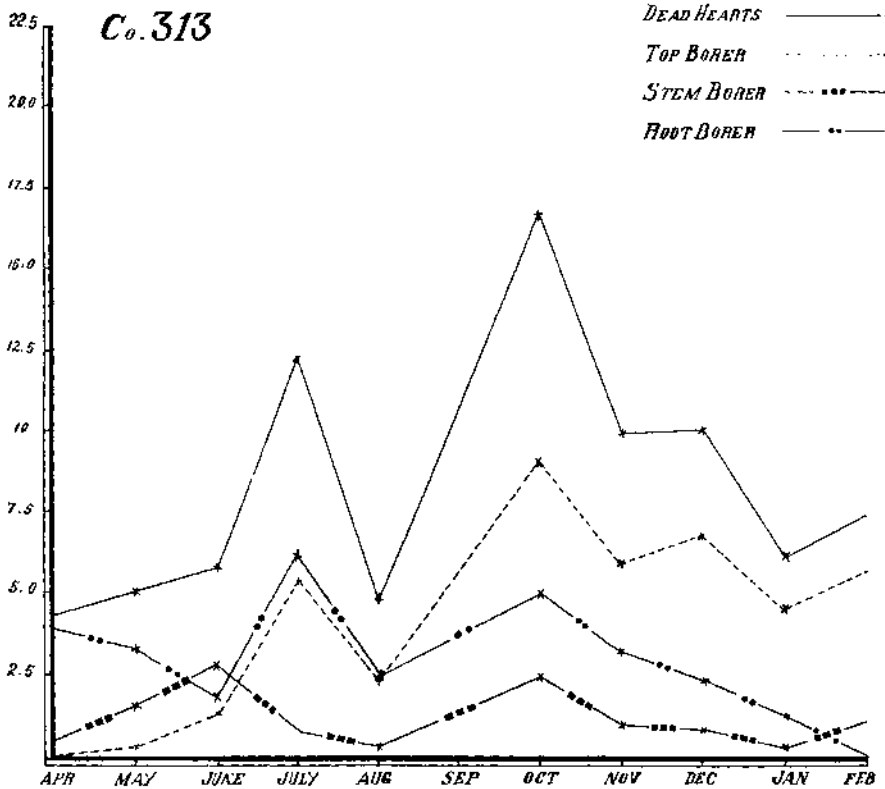


FIG. 5. Percentage of dead hearts caused by all borers (shown by straight line) and by various borers individually at different times of the year in Co. 313.

AGGREGATE DEAD HEARTS IN THE CONTROL PLOTS.

As has been stated in the beginning of this article, 800 canes of each variety were examined every month also from the control blocks, in the same way as from the experimental blocks, except that in the former case the dead hearts after counting were not removed and their casual agents not determined. The control plots therefore presented the natural condition. The percentage of accumulating or aggregate dead hearts in various months in different varieties is graphically shown in Fig. 7, whereas the monthly increase in dead hearts every month is shown graphically in Fig. 8. It will be observed that as the season advanced the number of dead hearts increased and did so suddenly in June and July (see Fig. 8) and then rapidly decreased in

the succeeding months. Figure 7 shows that Co. 210 suffered the greatest amount of damage, and Co. 299 the least.

Furthermore, it appears from Fig. 8 that the new dead hearts that were formed each month in the control blocks were not so numerous as those which appeared in the experimental blocks in which all the new dead hearts were removed every month. This suggests that the removal of dead hearts from a particular field does not help much to check the damage if similar action is not taken in the surrounding fields from where the pests can have free access to the fields which are made practically pest free.

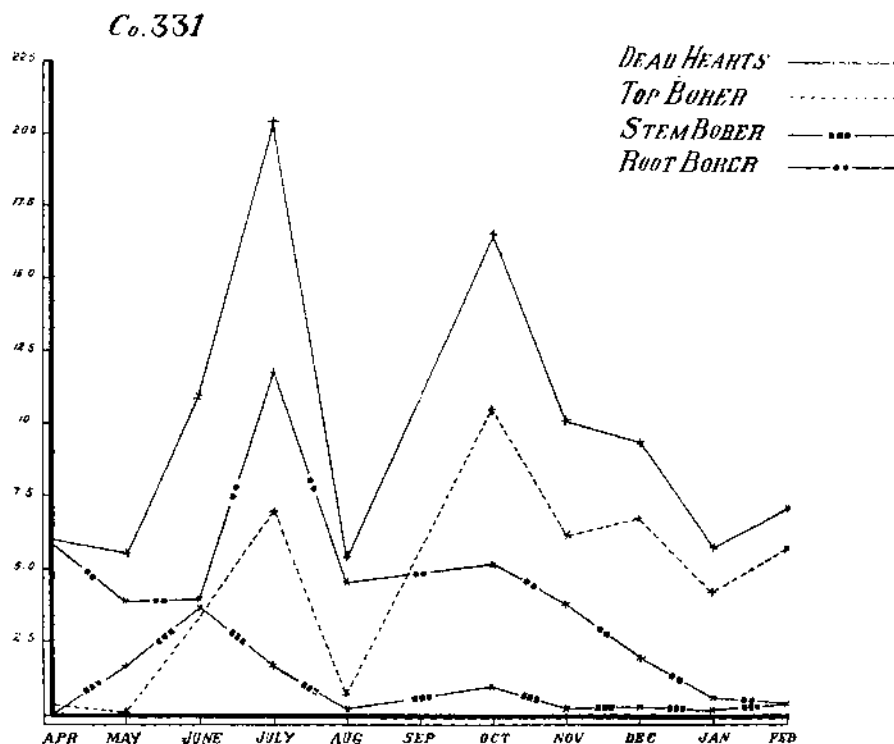


FIG. 6. Percentage of dead hearts caused by all borers (shown by straight line) and by various borers individually at different times of the year in Co. 331.

CONCLUSIONS AND SUMMARY.

From the foregoing it will be observed that all the three borers begin their activity at Pusa during March. They become more numerous with the approach of the hot weather. This might be due to the normal increase in the number of the pest, inasmuch as early in May there is a second brood of the moths in the field which is naturally much bigger than the initial one, or it may be due to the influence of the hot dry weather. During the monsoon months the damage by all borers decreased but increased again soon after

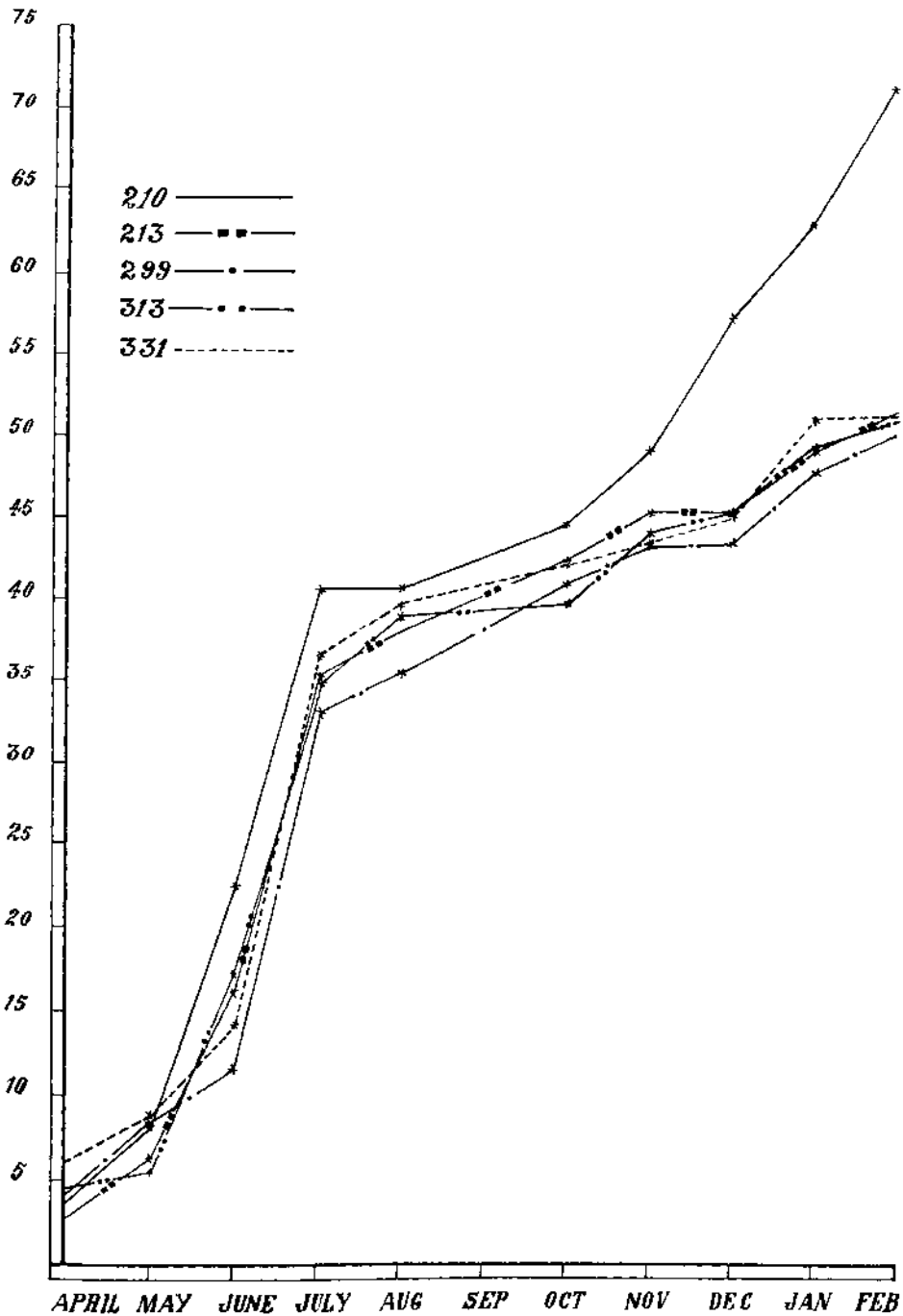


FIG. 7. Percentage of aggregate dead hearts at different times of the year in various varieties.

the rains were over. The increase in the activity of borers during autumn was especially well marked in the case of the top-borer, which caused in almost all the varieties examined more damage at this time than even at the height of summer. Furthermore, when the winter set in, whereas there was considerable decrease in the damage caused by stem- and root-borers, the damage by top-borer remained at a fairly high level. These observations confirm those already taken by the staff of the Imperial Entomologist during 1930-35 (*op. cit.*).

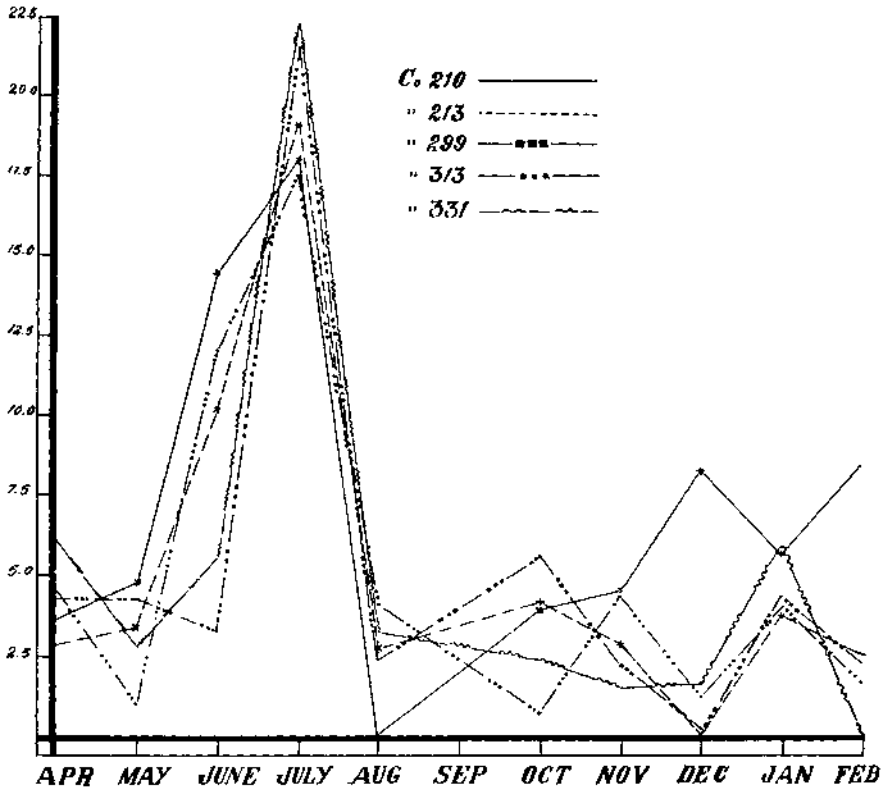


FIG. 8. Monthly increase in dead hearts in various varieties.

As to the cause of the difference in behaviour of the various borers, apart from the peculiar biology of individual pests, the stage of growth of the cane seems to play a very important part. As the top-borer attacks the growing region of the plant, it is active throughout the growth of the cane. The stem- and root-borers which attack the stem and basal parts of the plant as long as they remain soft, cause most damage in the early stages of the crop, viz. till the onset of the monsoon. After this period they mostly attack the tillers, which are usually given out up to the end of November.

As regards the relative susceptibility of the various varieties under investigation, only tentative conclusions can be drawn at present, as extensive and properly planned observations have been taken during one season only. The data collected and summarized in the previous pages indicate that a particular variety may be resistant to one borer and susceptible to another. For example, the variety Co. 331 was found to be most susceptible to the attack by the root-borer but very resistant to that by the top-borer. In the following table the various varieties have been arranged in order of merit, in reference to their susceptibility to the attack of different borers, as observed in 1935-36.

	Stem-borer.	Top-borer.	Root-borer.
Least susceptible	[Co. 299 Co. 313 Co. 331 Co. 210	[313 331 299 213	[299 313 210 213
Most susceptible	Co. 213	210	331

Taking all the borers into consideration, the varieties Co. 313 and Co. 299 seemed to be most resistant, Co. 331 intermediate, and Co. 213 and Co. 210 the least resistant.

ABSTRACT.

The fact that certain varieties of crops are resistant to insect attack has been established on general lines for some time past. Sugarcane which is one of the most valuable crops in India is seriously damaged by certain moth borers every year. In other countries, e.g. the West Indies, etc., where this crop is also attacked by borers, belonging to allied species, it has been found that certain varieties are more resistant to the attack of these pests than others. In India a large number of Coimbatore cane varieties are distributed every year and are tested in various provinces with regard to their yield, etc. Only occasional observations have been taken on their behaviour in reference to insect pests. Therefore, a detailed study from this view-point of the most common cane varieties of North Bihar was made at Pusa during 1935-36, the results of which are described in the paper.

The five common varieties Co. 210, Co. 213, Co. 299, Co. 313 and Co. 331 were critically studied. They were grown side by side in a randomized plot and about 800 canes of each variety selected from various parts of the field were examined every month for dead hearts (the external symptoms of borer attack), which were dissected and their causal borer determined. The number of fresh dead hearts appearing in each variety during different months of the year were noted. Examination of the data thus collected lead to the following general conclusions :—

Moths of all the three borers, viz. top-, stem- and root-borers emerge in the field in March. They lay eggs soon afterwards and the young borers hatching therefrom attack different parts of the cane and cause dead hearts

which appear during April. As the season advances all the three borers become more active and cause the maximum number of dead hearts during June or July. During the monsoon months their activity decreases but soon after the rains are over it increases again. The damage by the top-borer is especially very heavy during autumn. This pest remains active almost throughout the year, whereas the dead hearts caused by the stem- and root-borers during winter are comparatively few. These results are in accordance with the observations taken by the staff of the Imperial Entomologist during the last five years or so.

As regards the comparative susceptibility of various varieties, the conclusions derived are yet only tentative as the varieties have been studied on a large scale and under properly planned experiments for one season only. Taking all the borers into consideration, Co. 313 and Co. 299 seem to be the most resistant, Co. 331 intermediate, and Co. 213 and Co. 210 the least resistant.

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TABLE

The number of dead hearts caused by different borers in various varieties in

Time of year	Varieties	BLOCK 5						BLOCK 6					
		No. of plants examined	Dead hearts %	Top-borer %	Stem-borer %	Root-borer %	Borers in combination %	No. of plants examined	Dead hearts %	Top-borer %	Stem-borer %	Root-borer %	Borers in combination %
1	2	3	4	5	6	7	8	9	10	11	12	13	14
April	Co 210	200	1.5	0.5	0.5	0.5	..	..	..	..	..	..	..
	Co 213	200	11.0	1.5	1.0	8.5	..	100	3.00	..	..	3.00	..
	Co 299	200	1.5	..	0.5	1.0	..	33	9.90	..	..	9.90	..
	Co 313	200	2.0	..	0.5	1.5	..	57	3.51	..	1.76	1.76	..
	Co 331	200	7.0	1.0	..	6.0	..	200	5.0	..	..	5.0	..
May	Co 210	200	4.0	1.0	2.5	0.5	..	..	..	..	..	..	..
	Co 213	200	7.0	0.5	3.5	3.0	..	200	5.0	..	3.0	2	..
	Co 299	200	2.0	..	0.5	1.5	..	131	6.11	2.29	..	3.82	..
	Co 313	200	6.5	0.5	2.5	3.5	..	200	5.0	0.5	2.0	2.5	..
	Co 331	200	7.0	..	2.5	4.5	..	200	2.5	..	0.5	2.0	..
June	Co 210	200	2.0	..	1.0	1.0	..	200	..	..	..	..	..
	Co 213	200	6.0	1.5	3.5	1.0	..	200	6.5	..	3.5	3.0	..
	Co 299	200	7.5	4.5	2.5	0.5	..	200	8.0	1.5	3.5	3.0	..
	Co 313	200	10.0	3.0	3.5	3.5	..	200	2.5	..	2.5	..	..
	Co 331	200	10.0	4.0	..	6.0	..	200	9.5	1.5	6.0	2.0	..
July	Co 210	200	12.0	5.0	1.5	5.5	..	200	..	..	..	..	..
	Co 213	200	20.5	9.5	3.0	8.0	..	200	20.0	9.0	3.5	7.5	..
	Co 299	200	13.0	7.0	..	6.0	..	200	22.5	20.5	2.0	..	..
	Co 313	200	14.0	5.5	1.5	7.0	..	200	9.5	5.5	1.0	3.0	..
	Co 331	200	29.5	17.0	4.0	8.5	..	200	20.5	2.0	2.0	16.5	..
August	Co 210	200	4.0	1.5	0.5	2.0	..	200	..	..	..	..	..
	Co 213	200	3.5	2.0	..	1.5	..	200	5.0	1.0	..	4.0	..
	Co 299	200	4.0	1.0	..	3.0	..	200	5.5	2.5	..	3.0	..
	Co 313	200	6.5	4.5	0.5	1.5	..	200	3.0	1.0	..	2.0	..
	Co 331	200	4.5	..	..	4.5	..	200	4.5	1.5	..	3.0	..
September		No observations taken											
October	Co 210	200	9.5	6.0	1.0	2.0	0.5	200	..	..	..	..	..
	Co 213	200	17.0	10.5	..	5.0	1.5	200	19.0	10.5	1.0	7.5	..
	Co 299	200	8.0	8.0	..	..	..	200	10.5	7.5	1.5	1.5	..
	Co 313	200	9.5	5.5	1.0	3.0	..	200	21.5	9.5	4.5	7.0	0.5
	Co 331	200	9.0	7.0	0.5	1.5	..	200	16.0	9.0	..	7.0	..
November	Co 210	200	9.5	7.5	0.5	1.5	..	200	..	..	..	..	..
	Co 213	200	10.0	5.5	..	4.5	..	200	21.0	8.5	4.5	8.0	..
	Co 299	200	10.5	10.0	..	0.5	..	200	9.5	6.0	0.5	3.0	..
	Co 313	200	9.5	6.5	1.5	1.5	..	200	10.0	4.5	..	5.5	..
	Co 331	200	7.0	4.5	..	2.5	..	200	10.0	6.0	0.5	3.5	..
December	Co 210	200	11.0	7.5	0.5	2.0	1.0	200	..	..	..	..	..
	Co 213	200	12.0	8.5	3.0	2.5	..	200	9.0	6.5	0.5	2.0	..
	Co 299	200	9.0	7.0	..	1.0	1.0	200	6.0	6.0	..	..	..
	Co 313	200	11.0	7.0	0.5	3.5	..	200	7.5	5.5	0.5	1.5	..
	Co 331	200	9.5	7.5	..	1.5	0.5	200	5.5	4.5	..	1.0	..
January	Co 210	200	11.0	9.0	0.5	0.5	1.0	200	..	..	..	..	..
	Co 213	200	9.0	6.0	1.5	0.5	1.0	200	8.0	4.5	2.0	1.5	..
	Co 299	200	5.0	4.5	..	0.5	..	200	4.5	4.5	..	..	..
	Co 313	200	5.5	5.0	0.5	..	..	200	4.0	3.5	..	0.5	..
	Co 331	200	3.0	2.5	..	..	0.5	200	5.0	4.5	..	..	0.5
February	Co 210	200	7.5	6.5	..	..	1.0	200	..	..	..	..	..
	Co 213	200	7.5	5.0	2.5	..	..	200	7.5	3.0	3.5	..	1.0
	Co 299	200	7.5	6.5	1.0	200	2.5	2.5
	Co 313	200	9.5	6.0	2.5	..	1.0	200	8.5	6.5	1.0
	Co 331	200	9.5	6.5	0.5	1.5	0.5	200	5.5	5.0	0.5

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individual blocks at different times of the year.

BLOCK 7						BLOCK 8						CONTROL (BLOCKS 1-4)	
No. of plants examined	Dead hearts %	Top-borer %	Stem-borer %	Root-borer %	Bores in com- bination %	No. of plants examined	Dead hearts %	Top-borer %	Stem-borer %	Root-borer %	Bores in com- bination %	No. of plants examined	Dead hearts %
15	16	17	18	19	20	21	22	23	24	25	26	27	28
200	13.0	..	1	12.0	..	200	3.0	..	..	3	..	800	3.63
200	8.0	0.5	1	6.5	..	200	3.0	..	..	3	..	800	2.85
200	5.0	..	..	5.0	..	200	4.0	..	..	4	..	800	4.25
200	3.5	..	..	3.5	..	200	7.5	..	0.5	7	..	800	4.5
200	6.0	..	..	6.0	..	200	6.0	..	..	6	..	800	6.13
200	12.0	2	2.5	7.5	..	200	4.5	..	2.0	2.5	..	800	8.38
200	5.0	..	3.5	1.5	..	200	6.0	..	1.0	5.0	..	800	6.25
200	3.0	..	..	3.0	..	200	7.0	0.5	1.5	5.0	..	800	8.5
200	5.5	..	1.5	4.0	..	200	3.0	..	..	3.0	..	800	5.5
200	4.0	..	..	4.0	..	200	8.5	..	3.5	5.0	..	800	8.88
200	18.0	4.0	10.5	3.5	..	200	10.0	2.0	4.5	3.5	..	800	22.75
200	16.0	2.5	8.5	5.0	..	200	16.5	2.5	11.5	2.5	..	800	16.38
200	4.5	1.0	1.5	2.0	..	200	9.0	2.0	3.5	3.5	..	800	11.75
200	6.0	1.0	3.0	2.0	..	200	4.5	1.0	2.0	1.5	..	800	17.5
200	6.0	0.5	4.5	1.0	..	200	18.0	7.5	4.0	6.5	..	800	14.38
200	14.0	5.0	2.0	7	..	200	17.5	7.5	2.5	7.5	..	800	40.75
200	15.5	5.0	2.5	8	..	200	25.5	7.5	1.0	17.0	..	800	35.50
200	16.5	7.0	0.5	9	..	200	16.5	4.0	1.0	11.5	..	800	33.25
200	13.0	5.0	..	8	..	200	12.5	5.5	..	7.0	..	800	35.0
200	16.0	6.5	0.5	9	..	200	15.5	2.5	..	13	..	800	36.63
200	3.0	1.0	..	2.0	..	200	9	8.5	..	0.5	..	800	40.78
200	5.0	1.5	..	3.5	..	200	4	1.5	..	2.5	..	800	38.25
200	3.0	2.5	..	0.5	..	200	3.5	2.5	..	1.0	..	800	35.63
200	5.5	2.5	..	3.0	..	200	4	1	..	3.0	..	800	39.13
200	7.0	0.5	0.5	6.0	..	200	5.5	1	..	4.5	..	800	39.88

due to floods.

200	20.5	15.5	1.5	3.5	..	200	23.5	17.0	1.5	5.0	..	800	44.75
200	17.5	13.0	1.0	3.5	..	200	17.5	11.0	2.0	4.5	..	800	42.63
200	12.0	6.0	0.5	5.5	..	200	21.5	16.5	1.0	4.0	..	800	41.25
200	21.0	13.0	0.5	7.5	..	200	14.5	8.5	3.5	2.5	..	800	39.88
200	20.5	11.5	2.0	7.0	..	200	20.5	14.5	1.0	5.0	..	800	42.25
200	11.0	7.0	..	4.0	..	200	22.5	17.0	..	5.5	..	800	49.25
200	13.5	6.5	..	7.0	..	200	12.0	8.0	..	4.0	..	800	45.5
200	10.5	7.0	1.50	2.0	..	200	27.0	22.5	0.5	4.0	..	800	43.5
200	9.5	8.5	0.5	2.5	..	200	10.5	6.0	1.5	3.0	..	800	44.25
200	9.0	4.0	..	5.0	..	200	14.0	10.0	..	4.0	..	800	45.38
200	10.5	7.5	0.5	2.0	0.5	200	15.5	12.0	0.5	3	..	800	57.5
200	11.5	9.0	1.0	1.5	..	200	13.0	8.5	0.5	4	..	800	45.4
200	8.5	6.5	..	1.5	0.5	200	8.5	6.0	0.5	2	..	800	43.63
200	11.5	7.0	0.5	3.0	1.0	200	10.0	7.5	1.5	1	..	800	45.5
200	9.0	7.0	..	2.0	..	200	13.0	8.0	1.0	3	1	800	45.38
200	5.0	5	..	..	..	200	6.5	5.5	..	..	1	800	63.13
200	10.5	7	0.5	1.0	2	200	7.5	4.5	1.5	0.5	1	800	49.25
200	9.0	7	..	2.0	..	200	9.0	7.0	..	..	2	800	48
200	7.5	4	..	3.5	..	200	7.0	5.5	..	0.5	1	800	49.50
200	5.5	3	0.5	2.0	..	200	9.0	7.0	..	..	2	800	51.25
200	9.0	7.5	0.5	..	1.0	200	7.5	7.0	..	..	0.5	800	71.50
200	8.5	7.0	1.0	..	0.5	200	7.5	6.0	0.5	..	1.0	800	51.50
200	5.5	5.5	..	..	..	200	5.5	5.0	..	..	0.5	800	50.25
200	7.0	5.5	0.5	..	1.0	200	4.5	4.5	..	..	..	800	51.13
200	8.5	7.0	1.0	..	0.5	200	4.5	4.5	..	..	..	800	51.25

TABLE II.

The total number of dead hearts caused by borers in various varieties in all the experimental and control blocks.

Time of year.	EXPERIMENTAL BLOCKS.							CONTROL BLOCKS.	
	Varieties.	No. of plants examined.	Total % of dead hearts.	Dead hearts caused by top-borer %.	Dead hearts caused by stem-borer %.	Dead hearts caused by root-borer %.	Dead hearts caused by borers in combination %.	Aggregate dead hearts %.	Remark
1	2	3	4	5	6	7	8	9	10
April	Co 210	800	5.83	0.17	0.50	5.17	..	3.63	In the control blocks 800 plants were examined every month.
	Co 213	700	6.71	0.57	0.57	5.56	..	2.85	
	Co 299	633	3.79	..	0.16	3.63	..	4.25	
	Co 313	657	4.26	..	0.46	3.81	..	4.5	
	Co 331	800	6.00	0.25	..	5.75	..	6.13	
May	Co 210	600	6.83	1.00	2.33	3.50	..	8.38	
	Co 213	800	5.75	0.13	2.75	2.88	..	6.25	
	Co 299	731	4.38	0.55	0.55	3.28	..	8.50	
	Co 313	800	5.00	0.25	1.50	3.25	..	5.50	
	Co 331	800	5.50	..	1.63	3.87	..	8.8	
June	Co 210	600	10.00	2.00	5.33	2.67	..	22.75	
	Co 213	800	11.25	1.63	6.75	2.88	..	16.38	
	Co 299	800	7.25	2.25	2.75	2.25	..	11.75	
	Co 313	800	5.75	1.25	2.75	1.75	..	17.5	
	Co 331	800	10.88	3.38	3.63	3.88	..	14.38	
July	Co 210	600	14.50	5.83	2.00	6.67	..	40.75	
	Co 213	800	20.38	7.75	2.50	10.13	..	35.50	
	Co 299	800	17.13	9.63	0.87	6.63	..	33.25	
	Co 313	800	12.35	5.38	0.63	6.25	..	35.00	
	Co 331	800	20.38	7.00	1.63	11.75	..	36.63	
August	Co 210	600	5.33	1.50	0.17	3.67	..	40.78	
	Co 213	800	4.38	1.50	..	2.88	..	38.25	
	Co 299	800	4.00	2.13	..	1.87	..	35.63	
	Co 313	800	4.75	2.25	0.13	2.38	..	39.13	
	Co 331	800	5.38	0.75	0.13	4.50	..	39.88	
September	No observation taken due to floods.								
October	Co 210	600	17.83	12.83	1.33	3.50	..	44.75	
	Co 213	800	17.75	11.25	1.00	5.13	..	42.63	
	Co 299	800	13.00	9.50	0.75	2.75	..	41.25	
	Co 313	800	16.63	9.13	2.38	5.00	..	39.88	
	Co 331	800	16.50	10.50	0.88	5.13	..	42.25	
November	Co 210	600	14.33	10.50	0.17	3.67	..	49.25	
	Co 213	800	14.13	7.13	1.13	5.88	..	45.50	
	Co 299	800	14.38	11.38	0.63	2.38	..	43.50	
	Co 313	800	9.88	5.88	0.88	3.13	..	44.25	
	Co 331	800	10.00	6.13	0.13	3.75	..	43.75	
December	Co 210	600	12.33	9.00	0.50	2.33	0.5	57.50	
	Co 213	800	11.38	7.63	1.25	2.50	..	45.50	
	Co 299	800	8.00	6.38	0.13	1.13	0.38	43.63	
	Co 313	800	10.00	6.75	0.75	2.25	..	45.50	
	Co 331	800	9.25	6.75	0.25	1.80	..	46.38	
January	Co 210	600	7.50	6.50	0.17	0.17	0.67	63.13	
	Co 213	800	8.75	5.50	1.38	0.88	1.00	49.25	
	Co 299	800	6.88	5.75	..	0.63	0.50	48.00	
	Co 313	800	6.00	4.50	0.13	1.13	0.25	49.50	
	Co 331	800	5.63	4.25	0.13	0.50	0.75	51.25	
February	Co 210	600	8.00	7.00	0.17	..	0.83	71.50	
	Co 213	800	7.75	5.25	1.88	..	0.63	51.50	
	Co 299	800	5.25	4.88	..	..	0.38	50.25
	Co 313	800	7.38	5.63	1.00	..	0.75	51.13	
	Co 331	800	7.00	5.75	0.38	0.38	0.50	51.25	

TABLE III.

Number of dead hearts during different months in Variety Co. 210.

Time of year.	EXPERIMENTAL BLOCKS.						CONTROL BLOCKS.		Remarks.
	No. of plants examined.	Dead hearts during the month %.	Dead hearts caused by top-borer %.	Dead hearts caused by stem-borer %.	Dead hearts caused by root-borer %.	Dead hearts caused by borers in combination %.	Aggregate dead hearts %.		
April ..	600	5.83	0.17	0.50	5.17	..	3.63	In the control blocks 800 plants were examined every month.	
May ..	600	6.83	1.0	2.33	3.50	..	8.38		
June ..	600	10.00	2.0	5.33	2.67	..	22.75		
July ..	600	14.50	5.83	2.0	6.67	..	40.75		
August ..	600	5.33	1.5	0.17	3.67	..	40.78		
September	No observations taken due to floods.								
October ..	600	17.83	12.83	1.33	3.5	0.17	44.75		
November	600	14.33	10.50	0.17	3.67	..	49.25		
December	600	12.33	9.00	0.50	2.33	0.50	57.5		
January ..	600	7.50	6.50	0.17	0.17	0.67	63.13		
February ..	600	8.00	7.00	0.17	0.83	0.78	71.5		

TABLE IV.

Number of dead hearts during different months in Variety Co. 213.

Time of year.	EXPERIMENTAL BLOCKS.						CONTROL BLOCKS.	Re- marks.
	No. of plants examined.	Dead hearts during the month %.	Dead hearts caused by top-borer %.	Dead hearts caused by stem-borer %.	Dead hearts caused by root-borer %.	Dead hearts caused by borers in combination %.	Aggregate dead hearts %.	
April ..	700	6.71	0.57	0.57	5.56	..	2.85	In the control blocks 800 plants were examined every month.
May ..	800	5.75	0.13	2.75	2.88	..	6.25	
June ..	800	11.25	1.63	6.75	2.88	..	16.38	
July ..	800	20.38	7.75	2.50	10.13	..	35.50	
August ..	800	4.38	1.50	..	2.88	..	38.25	
September	No observations taken due to floods.							
October ..	800	17.75	11.25	1.00	5.13	0.38	42.63	
November	800	14.13	7.13	1.13	5.88	..	45.5	
December	800	11.38	7.63	1.25	2.50	..	45.50	
January ..	800	8.75	5.50	1.38	0.88	1.00	49.25	
February ..	800	7.75	5.25	1.88	..	0.63	51.50	

TABLE V.

Number of dead hearts during different months in Variety Co. 299.

Time of year.	EXPERIMENTAL BLOCKS.						CONTROL BLOCKS.	Remarks.
	No. of plants examined.	Dead hearts during the month %.	Dead hearts caused by top-borer %.	Dead hearts caused by stem-borer %.	Dead hearts caused by root-borer %.	Dead hearts caused by borers in combination %.	Aggregate dead hearts %.	
April ..	633	3.79	..	0.16	3.63	..	4.25	In the control blocks 800 plants were examined every month.
May ..	731	4.38	0.55	0.55	3.28	..	8.50	
June ..	800	7.25	2.25	2.75	2.25	..	11.75	
July ..	800	17.13	9.63	0.85	6.63	..	33.25	
August ..	800	4.00	2.13	..	1.87	..	35.63	
September	No observations taken due to floods.							
October ..	800	13	9.5	0.75	2.75	..	41.25	
November	800	14.38	11.38	0.63	2.38	..	43.5	
December	800	8.00	6.38	0.13	1.13	0.38	43.63	
January ..	800	6.88	5.75	..	0.63	0.50	48.00	
February ..	800	5.25	4.88	..	..	0.38	50.25

TABLE VI.

Number of dead hearts during different months in Variety Co. 313.

Time of year.	EXPERIMENTAL BLOCKS.					CONTROL BLOCKS.		Re- marks.
	No. of plants examined.	Dead hearts during the month %.	Dead hearts caused by top-borer %.	Dead hearts caused by stem-borer %.	Dead hearts caused by root-borer %.	Dead hearts caused by borers in combination %.	Aggregate dead hearts %.	
April ..	857	4.26	..	0.46	3.81	..	4.50	In the control blocks 800 plants were examined every month.
May ..	800	5.00	0.25	1.50	3.25	..	5.50	
June ..	800	5.75	1.25	2.75	1.75	..	17.50	
July ..	800	12.25	5.38	0.63	6.25	..	35.00	
August ..	800	4.75	2.25	0.13	2.38	..	39.13	
September	No observations taken due to floods.							
October ..	800	16.63	9.13	2.38	5.00	0.13	39.88	
November	800	9.88	5.88	0.88	3.13	..	44.25	
December	800	10.00	6.75	0.75	2.25	0.25	45.5	
January ..	800	6.00	4.50	0.13	1.13	0.25	49.5	
February ..	800	7.38	5.63	1.00	..	0.75	51.13	

TABLE VII.

Number of dead hearts during different months in Variety Co. 331.

Time of year.	EXPERIMENTAL BLOCKS.						CONTROL BLOCKS.		Remarks.
	No. of plants examined.	Dead hearts during the month %.	Dead hearts caused by top-borer %.	Dead hearts caused by stem-borer %.	Dead hearts caused by root-borer %.	Dead hearts caused by borers in combination %.	Aggregate dead hearts %.		
April ..	800	6.00	0.25	..	5.75	..	6.13	In the control blocks 800 plants were examined every month.	
May ..	800	5.55	..	1.63	3.87	..	8.88		
June ..	800	10.88	3.38	3.63	3.88	..	14.38		
July ..	800	20.38	7.00	1.63	11.75	..	36.63		
August ..	800	5.38	0.75	0.13	4.50	..	39.88		
September	No observations taken due to floods.								
October ..	800	16.5	10.5	0.88	5.13	..	42.25		
November	800	10.00	6.13	0.13	3.75	..	43.75		
December	800	9.25	6.75	0.25	1.80	0.38	45.38		
January ..	800	5.63	4.25	0.13	0.50	0.75	51.25		
February ..	800	7.00	5.75	0.38	0.38	0.50	51.25		



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