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Observations on the Effect of Manuring and Irrigation on the Incidence of the Cotton leaf hopper, *Empoasca devastans* Dist., and the Cotton aphid, *Aphis gossypii* G. at different periods of Crop Growth*

by

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Synopsis: Observations made during the 1962–63 season on the effect of the macro-elements N, P and K, individually and in combination and of cattle manure and three levels each of manure and irrigation on the incidence of the jassid and aphid on cotton are recorded in this paper.

Introduction: Among the pests of cotton in India during the preflowering stage, the leafhopper, *Empoasca devastans* Dist., and the plant lice, *Aphis gossypii* G., are probably the worst. Heavy populations of these insects are found on the tender shoots and often lead to curling and yellowing of the leaves leading to blighted appearance followed by premature leafdrop. Both the leafhopper and the aphid require favourable environmental conditions for their prolific multiplication and among these manuring and irrigation, which have a direct bearing on the growth of the host plant and therefore have an indirect effect on the insect, seem to be of importance. Analysis of data on pest incidence and the corresponding agronomic factors over extended periods of time have often led to definite correlations. This may pave the way for the effective cultural control of the insects concerned. With this end in view, observations were made on the incidence of the leafhopper and the aphid in relation to the manuring and irrigation at different periods of crop growth.

Review of Literature: It was Parnell (1927) who pioneered in this field of study, but found little difference in the effect of various fertilisers on the cotton leafhopper, *Empoasca fascialis* (Jac.). Mumford and Hey (1930) have indicated that a highly nitrogenous diet stimulates reproduction in sugar-beet leafhopper, *Eutettix tenellus* (Bak.). The same opinion was held by Sloan (1938) for the cotton leafhopper. Similarly, the chinch bug multiplied well under excess nitrogenous conditions and laid more eggs on Sorghum plants growing in solutions high in nitrogen or low in phosphorus (Dahms and Fenton, 1940., Dhams, 1947). On the contrary Mathur (1941) found severe attack of white fly on sugarcane leaves with low nitrogen. The cotton leafhopper, *Empoasca devastans* Dist., has been found to thrive better under excessive manuring in Andhra Pradesh (Balasubramanian and Iyengar, 1950., Appa Rao *et al*, 1959). Similar results have been obtained by Ananthanarayanan and Abraham (1956) and Abraham (1957) in the case of rice leafhopper, *Nephotettix bipunctatus* F. and fulgorid, *Nilaparvata lugens* S. The rice stem-borer too has responded well by showing increased infestation in plots receiving high doses of nitrogen (Gosh, 1962). Hussey and Gurney (1960) found no significant influence by nitrogen on

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the fecundity of whitefly which, however, was influenced by phosphorus. Aphids also respond positively to increased elements, particularly nitrogen. This is true of the bean aphid, *Aphis fabae* Scop. (Davidson, 1925), the cabbage aphid, *Brevicoryne brassicae* L. (Evans, 1938), and the cotton aphid, *Aphis gossypii* G. (Mc Garr, 1942, 1943). However, Taylor *et al* (1952) were not able to find significant differences in the reproductive capacity of either the pea aphid [*Macrosiphum pisi Harr.*] or the potato aphid [*Myzus persicae* Sulz.] under conditions of varied N, P or K supply.

As regards the influence of irrigation on the incidence of insects not much information is available. Lees (1926) found that heavy irrigation and heavy rainfall resulted in increased susceptibility of the plant to insect attack. Conversely, Parnell (1927) observed that drought conditions which decreased the vigour of cotton increased the susceptibility to *Empoasca fascialis* (Jac.). Similarly plants suffering from water shortage were definitely more attractive to the attacking thrips (Mumford and Hey, 1930). Hargreaves (1934) found dry conditions to favour the rapid increase of *Aphis gossypii*. Afzal and Ghani (1949) noticed increased population of *Empoasca devastans* with the increase in the amount of water applied to cotton.

Materials and Methods: (i) *Experimental details:* For purposes of these studies observations were made in two sets of plots, one belonging to the New Permanent Manurial experiments of the Agricultural Chemist and Associate Professor of Soil Science started in 1925, and the other belonging to the Agronomical experiments of the Agronomist and Associate Professor of Agronomy, Agricultural College and Research Institute, Coimbatore. Observations on the effect of the macro-elements N, P and K, individually and in combination, and of cattle manure on the incidence of the jassid and aphid were made in the New Permanent manurial plots during the 1962–1963 season. The object of the second set of observations was to assess the influence of irrigation and manuring on the abundance of these pests on cotton.

(ii) *Treatments:* The first experiment included ten treatments viz. control, N, P, NP, K, NK, PK, NPK, cattle manure (C. M.) and cattle manure residue (CMR). Nitrogen was applied as ammonium sulphate at 1 cwt per acre (5·6 lb per 5 cent plot)., Phosphorus as super phosphate at 3 cwt per acre (16·8 lb per 5 cent plot)., potash as Potassium sulphate at 1 cwt per acre (5·6 lb per 5 cent plot)., cattle manure at 5 tons per acre (560 lb per 5 cent plot), and the plot C M R-cattle manure residue received cattle manure at 5 tons per acre (560 lb per 5 cent plot) for alternate crops. The plot CM will be the CMR for the next crop.

In the second experiment, the main plot treatments included three levels of irrigation viz., I_1 – 2 acre inches, I_2 – $2\frac{1}{2}$ acre inches and I_3 – 3 acre inches, the plots receiving a total of 20, 25 and 30 acre inches respectively in 10 irrigations once in a fortnight during the crop period. If any rainfall was recorded in the fortnight the irrigation was proportionately adjusted. The sub plot treatments were three levels of manure viz. M_1 – 300 lb, M_2 – 400 lb, and M_3 – 500 lb of the standard fertiliser No. II which consisted of NPK in the ratio of 12 : 6 : 6. The

source of NPK was the same as in the first experiment. However, half of the quantity was applied as basal dressing along with 5 tons of farm yard manure and the other half as top dressing three months after sowing.

(iii) *Experimental design:* The first experiment was of a simple replicated trial with two replications and ten treatments, the net area of each plot being 5 cents. The second experiment was of a split plot design with irrigation as the main plot treatment and manure as sub plot treatment. There were six replications and the gross area of each plot was 1 cent.

(iv) *Method of counting:* In the first experiment nine plants were selected at random in each plot and the counts of jassid nymphs, and aphid nymphs and adults present on the first five leaves from the terminal end of the main shoot in each plant were recorded. Thus counts were made from a total number of 90 leaves, five in each of the 18 plants (9 plants in each replication) in each treatment at one time. In the second experiment three plants were selected at random in each plot. the total number of plants being 18 in six replications for each treatment. The insects on the 90 leaves per treatment, five leaves from the top in each plant, were counted as in the previous experiment. Observations were made at weekly intervals from November, 1962 to January 1963, the counts being taken early in the mornings between 6 a. m. and 8 a. m., when the jassid nymphs were inactive.

Results: *Influence of N, P, K and cattle manure on the incidence of cotton jassid and aphid*

The population data concerning *Empoasca devastans* Dist. and *Aphis gossypii*, G. in the different treatments are furnished below in Table I.

TABLE I.

Population data.

(Total counts on 90 leaves from 18 plants, 9 in each replicate).

S. No.	Treatment	*Empoasca devastans*	*Aphis gossypii*
1.	Control	188	1259
2.	N	239	1663
3.	P	188	1654
4.	NP	233	1389
5.	K	236	1876
6.	NK	267	1468
7.	PK	191	1672
8.	NPK	255	1580
9.	CM	190	1296
10.	CMR	194	1374
	Treatments		
	N	Significant ** S. E. 0·84, C. D. (P=0·05) 2·34	Not significant.
	P, K, NP, NK, PK		
	NPK, CM, CMR	Not Significant	Not significant.

** Significant at 1% level.

The analysis shows that there are marked fluctuations in the population of both the pests in the different growth phases of the crop. Further in the case of *Empoasca devastans*, the application of nitrogen in the mineral form has influenced the incidence of the pest. None of the other nutrients seems to have influenced the incidence of either of the pests.

TABLE II.

Comparison of incidence of jassids and aphids at different growth periods of the crop.

Period after sowing	Mean population	
	E. *devastans Dist.*	*A. gossypii G.*
1. 8th week	13·15	17·05
2. 9th week	12·05	17·80
3. 10th week	10·35	118·25
4. 12th week	9·30	171·20
5. 14th week	16·70	215·55
6. 15th week	23·50	128·05
7. 16th week	24·00	108·65
Between periods	Significant ** S. E. 1. 41, C. D. (P=0·05) 3·92	Significant ** S. E. 11·8, C. D (P=0·05) 32·7
Conclusions	$\overline{7,6},5,\underline{\overline{1,2},3,4}$,	$5,4,\overline{6,3,7},\underline{2,1}$

** Significant at 1% level.

From the 8th to 12th week after sowing the crop, there seems to be a gradual decline in the population of the jassids. However, there is a sudden increase in the population in the 14th week with further increase in the 15th and 16th weeks.

Unlike as in the case of jassids, the aphid population gradually increases from the 8th week and reaches a maximum in the 14th week. Thereafter, there is a sudden reduction in the incidence in the 15th and 16th weeks of crop growth.

II. *Influence of irrigation and manuring on the incidence of cotton jassid and aphid.*

The population data concerning the jassid and aphid in relation to the different levels of irrigation and manure is given in Table III.

TABLE III.

Population data.

(Total on 90 leaves from 18 plants, i. e. three each from 6 replicates)

Treatments	*Empoasca devastans*	*Aphis gossypii*
Irrigation		
I_1—2 Acre inches	353	3717
I_2—2½ Acre inches	382	3526
I_3—3 Acre inches	380	3394
Manure		
M_1—300 lb/acre (N : P : K) (12 : 6 : 6)	387	3349
M_2—400 lb/acre ,,	369	3301
M_3—500 lb/acre ,,	359	3987
Between levels of irrigation	n. s.	n. s.
Between levels of manure	n. s.	n. s.
Irrigation x Manure	n. s.	n. s.
Between periods of counts	Significant **	Significant **
Irrigation x Periods	n. s.	n. s.
Manure x Periods	n. s.	Significant **
Irrigation x Manure x Periods	n. s.	n. s.

n. s. Not significant
** Significant at 1% level.

In this experiment also, the incidence of both the jassid and aphid pests eems to fluctuate with the growth period of the crop. The peak incidence of assid was noticed in the 18th week and that of aphid in the 14th week after owing as in the previous experiment. Further, in the case of aphids alone, he manure seems to have conditioned the incidence of the pest in the different rowth phases of the crop. No other relationship is noticeable.

In all the three manurial treatments the incidence of aphids is compara-ively light upto the 11th week. In Manure$_1$ (300 lb./acre) and Manure$_3$ (500 lb./ cre), the maximum incidence is reached during the 14th week and a marked eduction thereafter, while in Manure$_2$ (400 lb/acre) there is a further though angible rise upto the 15th week and a gradual reduction during the subsequent reeks.

Discussion: The present studies have clearly indicated that nutrition of the otton plant has a definite bearing on the incidence of the leafhopper, *Empoasca evastans* Dist. Among the nutrients nitrogen in the mineral form has been found o substantially influence its infestation as observed by the previous workers. It s evident from Table I that the population of the leafhopper is uniformly more

in plots receiving nitrogen individually and in combination with phosphorous and potash. However, the incidence in the plots receiving P alone is as low as in the control. Application of cattle manure has not affected the incidence in any way. The trend of preference of the jassid for high levels of nitrogen and low phosphorus is in conformity with the preference of Sorghum chinch bugs (Dahms and Fenton, 1940., Dahms, 1947). The sugar beet leafhopper (Mumford and Hey, 1930) and cotton leafhopper (Sloan, 1938) have also favoured high levels of nitrogen, while the whitefly was found to have preference to higher phosphorus and no preference to nitrogen (Hussey and Gurney, 1960).

None of the nutrients had significant relationship with the infestation of *Aphis gossypii G.* But from the table I it can be seen that the trend of aphid preference is influenced most by potash than by nitrogen and phosphorous. Contrary to the leafhopper incidence, nitrogen does not seem to have any influence on the aphid.

The incidence of the cotton leafhopper and aphid during the different growth periods of the crop has not been studied well previously. The present observations show that the leafhopper infests the crop abundantly during the 16th week after sowing and the aphid during the 14th week. The reasons for this may be attributed to the stage of the crop growth at which the plant sap is more palatable and nutritious to these insects, or the incidence might have been influenced by environmental conditions like the weather factors, or yet another plausible explanation may be the disturbance of the "biotic potential" in the inter-relationship of host-parasite-predator complex. It is however interesting to note that manures as well as crop growth periods had a profound effect on aphid population and also that the three levels of manure affected aphid build-up to a different degree on each of the crop growth period.

There were no significant differences in the infestation of the jassid and aphid in the given levels of irrigation and manure. However, from Table II it can be observed that while the trend of jassid preference is towards the medium and highest levels of irrigation for its development, that of the aphid is more attracted towards the lowest level of irrigation. Conversely, the trend of jassid preference is towards the lowest level of manure and highest for the aphid. It is presumed, based on these observations, that the aphid requires more concentrated forms of nutrition than the leafhopper. The interaction between the soil moisture and nutriton also did not have significant relationship with these insects. Despite the fact that the results were not statistically significant the trend in these findings agree with that of the earlier workers, that *Aphis gossypii* thrives better under dry conditions (Hargreaves, 1934) and *Empoasca devastans* prefers increased amount of water supply (Afzal and Ghani, 1949). The fact that there is no significant relationship between the moisture levels and pest incidence is in conformity with the results of Mc Murtry (1962) who could not find significant differences in the reproduction of the spotted alfalfa aphid, *Therioaphis maculata* (Bukton), between watered or unwatered plants. However Kennedy *et al* (1958)

had previously demonstrated that populations of *Aphis fabae* (Scop.) on potted plants left unwatered had a lower reproductive rate than aphids on watered plants

Summary: Experiments were conducted during the winter season of the year 1962–63 to study the influence of N, P, K, cattle manure and three levels each of irrigation and manure on the incidence of the cotton leafhopper and the cotton aphid. The results showed that nitrogen in the mineral form at 22·4 lb. N/acre could significantly increase the incidence of the leafhopper, *Empoasca devastans Dist.* None of the other nutrients seemed to have influenced the incidence of either of the pests.

Irrigation and manure, individually and in combination, did not have significant relationship with the incidence of both the pests. However, the three levels of manure affected the aphid build-up to a different degree on each of the crop growth period.

The peak incidence of the leafhopper was observed during the 16th week after sowing and that of the aphid during the 14th week which are the palatable stages for their infestation eventhough the possibility of influence by weather factors and parasite-predator factors are not excluded.

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