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Rosette Disease of Groundnut
I. The Pattern of Spread of the Disease

by

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Introduction: India is one of the important groundnut growing countries in the world. Tamilnadu occupies the third place in India as for as groundnut is concerned. Rosette disease of groundnut caused by a virus is gaining importance in India. Sundararaman (1926) first reported the occurrence of the disease at Palur and called it "clump disease". Storey (1935) is of the opinion that natural spread of rosette virus is by the vector *Aphis laburni*. Storey and Ryland (1955) pointed out the importance of apterous and alate aphids in spreading the disease under field conditions. Rogur Hull (1964) has pointed out the effect of spacing on the primary spread by winged aphids before secondary spread.

A thorough knowledge of the source of infection, rate, distance and mode of spread of any disease is essential for devising control measure for the disease. Information on the sources of infection can often be gained by studying the distribution of infected plants within a crop which may in turn, suggest the method to be adopted in controlling the disease. Van der Plank (1946) has distinguished two kinds of spread, namely, random distribution and distribution in groups. He has suggested a formula for estimating random distribution of the disease within a crop. Using this formula studies were made on the pattern of spread of rosette disease in irrigated crop of TMV-2 variety of groundnut in the 1964 season at Coimbatore and Bhavanisagar.

Materials and Method: Two trials were laid out one at the Agricultural Research Station, Bhavanisagar and another at the Millet Breeding Station, Coimbatore during the irrigated season, 1964 to find out the mode of spread of groundnut rosette disease. The crops were sown on 4-4-64 and 10-2-64 at Coimbatore and at Bhavanisagar respectively. There were sixty four plots of 9′ × 9′ each. TMV-2, a bunch variety of groundnut with a short duration of 105 days was sown with a spacing of 6″ × 6″. A basal dressing of 5 tons of farm yard manure, 10 pounds of N as ammonium sulphate, 30 pounds of of P as super phosphate and 50 pounds of potash as muriate of potash per acre were applied to the soil. Timely irrigation was given throughout the period of the experiment and weeding was carried out as and when necessary.

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Observations were carried out at an interval of fifteen days. The number of diseased plants showing typical rosette symptom in each plot was recorded on a graph sheet. The population of aphids (*Aphis craccivora*) both alate and apterae was recorded in each plot on 5 plants selected at random in the trial laid out at the Millet Breeding Station, Coimbatore, at an interval of 15 days. Van der Plank's (1946) equation, $p=\frac{x(x-1)}{n}$, for estimating the number of random groups of adjacent diseased plants in a homogenious field was used to determine the mode of spread of the disease; where n, was the number of plants examined, x, the number of infected plants and p, the number of pairs to be expected at random and for higher values of n, p will have a standard error of $\sqrt{p}$. If the observed value for p differs significantly from the calculated, that is $p \pm \sqrt{p}$, then spread from plant to plant within the crop can be assumed. All larger groups of diseased plants are reduced to doublets, three adjacent diseased plants being two doublets and so on.

Result: The rosette disease was first seen when the crop was 45 days old in both the trials as seen in Tables I-B and II-B. There was a gradual rise in the incidence of the disease and the maximum incidence was seen when the crop was about 75 days old and thereafter there was a decrease in the incidence of the disease. (Vide Tables I-B and II-B). The incidence of rosette disease was 0.14 and 0.05% to start with and the incidence gradually increased to 1.29 and 0.25% when the crop was about 75 days old and thereafter there was a decrease in the incidence of the disease at the Agricultural Research Station, Bhavanisagar and at the Millet Breeding Station, Coimbatore, respectively.

On the whole resette disease incidence was more (3.86%) in the trial laid out at the Agricultural Research Station, Bhavanisagar in comparison with that laid out at the Millet Breeding Station, Coimbatore, where the incidence of the disease was only 0.75%.

Rosette disease was found to spread from an initial focus, that is from neighbour to neighbour in both the trials. In the trial laid out at the Agricultural Research Station, Bhavanisagar the observed pairs were 249 as against $p+\sqrt{p}$, that is 35.62 (Vide Table I-A). The observed pairs were 44 as against $p+\sqrt{p}$ that is 2.15 in the trial laid out at the Millet Breeding Station, Coimbatore (Vide Table II-A). It could therefore be concluded that the disease spread in groups from foci within the crop from neighbour to neighbour.

There was a positive correlation between the percentage of plants infested by aphids and the incidence of rosette disease. The percentage of plants infested by aphids was only 39.06 to start with, that is when the crop was 15 days old. There was steady increase in the percentage of plants infested by aphids till the crop was 2 months old (87.81) and thereafter there

was a decrease. Incidence of rosette disease was only 0.05% to start with and maximum incidence was reached when the crop was 75 days old (0.25%) after which there was a decrease. Maximum incidence of rosette disease occurred 15 days after the maximum percentage of plants infested by aphids (Vide Table II-C).

A positive correlation was also found between average number of aphids per plant and the incidence of rosette disease. Aphid infestation was only 0.93% when the crop was 15 days old and thereafter there was a steady rise till the crop was 60 days old, (43.74%) after which the percentage of aphid infestation declined. Here also maximum incidence of the disease occurred 15 days after the maximum aphid infestation of the crop (Vide Table II-D).

Among the aphids, the percentage of alatae infesting the crop was more to start with (27.96) and there after there was a gradual decrease; whereas in the case of apterae it was lower to start with (72.04%) and reached a maximum when the crop was 90 days old (94.29%). Hence rosette disease might have originated in the crop by a few incoming viruliferous alatae and further spread within the crop might have occurred by the viruliferous apterae moving from plant to plant.

TABLE I-A. *The pattern of spread of rosette disease of groundnut at the Agricultural Research Station, Bhavanisagar*

Stand n	Number of plants infected in 64 plots x	Number of pairs observed in 64 plots
20271	782	249

Number of pairs expected = P

$$P = \frac{x\,(x-1)}{n} = \frac{782 \times 781}{20271} = 30.13$$

$$P + \sqrt{p} = 30.13 + 5.489 = 35.61$$

The number of pairs observed (249) is more than the number of pairs expected+standard error (35.61)

TABLE I-B. *The incidence of rosette disease of groundnut at the Agricultural Research Station, Bhavanisagar*

Particulars	Groundnut plants rosette diseased on different dates of observation					Total
	25-3-64	9-4-64	25-4-64	10-5-64	25-5-64	
Incidence of rosette disease in number	28	109	261	197	187	782
Incidence of rosette disease in percentage	0.14	0.54	1.29	0.97	0.92	3.86

TABLE II-A. *The pattern of spread of rosette disease of groundnut at the Millet Breeding Station, Coimbatore*

Stand n	Number of plants infected in 64 plots x	Number of pairs observed in 64 plots
19977	149	44

Number of pairs expected = P

$$P = \frac{x\,(x-1)}{n} = \frac{149 \times 148}{19977} = 1.103$$

Standard error = $\sqrt{1.103} = 1.05$

$P + \sqrt{p} = 1\ 103 + 1.05 = 2.15$

The number of pairs observed (44) is more than the expected number of pairs + standard error (2.15)

TABLE II-B. *Incidence of rosette disease of groundnut at the Millet Breeding Station, Coimbatore*

Particulars	Groundnut plants rosette diseased on different dates of observation					Total
	18-5-64	2-6-64	17-6-64	2-7-64	17-7-64	
Incidence of rosette disease in number	10	32	50	37	20	149
Incidence of rosette disease in percentage	0.05	0.16	0.25	0.185	0.10	0.75

TABLE II-C. *The percentage of plants infested by aphids (Aphis craccivora) on different dates of observation at the Millet Breeding Station, Coimbatore*

Particulars	Plants infested by aphids on different dates					
	19-4-64	3-5-64	18-5-64	2-6-64	17-6-64	2-7-64
The percentage of plants infested by aphids	39.06	60.63	70.63	87.81	66.88	65.63

TABLE II-D. *The average number of aphids (alatae and apterae) on different dates of observation at the Millet Breeding Station, Coimbatore*

Average of 320 plants	Aphid population in number on different dates of observation					
	19-4-64	3-5-64	18-5-64	2-6-64	17-6-64	2-7-64
Alatae	0.26	1.29	2.13	4.90	1.65	0.50
Apterae	0.67	3.94	12.51	38.84	19.83	8.26
Total	0.93	5.23	14.64	43.74	21.48	8.76
	Percentage out of total number of aphids					
	Dates of observation					
	19-4-64	3-5-64	18-5-54	2 6-64	17-6-64	2-7-64
Alatae	27.96	22.75	14.54	11.20	7.68	5.71
Apterae	72.04	77.25	85.46	88.80	92.32	94.29

Discussion and Conclusion: Incidence of rosette disease was maximum when the crop was about 75 days old and thereafter there was a decrease in the incidence of the disease in both the trials. Hull (1964) showed that there was a gradual increase in the incidence of the rosette disease up to 10 weeks after sowing in both closely and widely spaced plots at Uganda. This is in confirmity with the findings reported here.

Rosette disease of groundnut spreads from an initial focus and diseased plants are mostly found in groups around an early infected plant. In both the trials the observed doublets are more than the calculated value ($p+\sqrt{p}$). Evans (1954) observed in one varietal trial, three examples of much secondary spread of rosette disease from one source and the number of groundnut plants infected from a single source was 78, 100 and 142. Booker (1963) found the rosette diseased plants in groups around an early infected groundnut plant. He found 1356 pairs of adjacent diseased plants within a crop to an expected number of 269 $\pm$ 16. Cadman and Chambers (1960) found that in the case of potato leaf roll and Y viruses, potato plants adjacent to the infectors became infected more frequently than those more distant. They also suggested that infection by both the viruses spread from infected plants and not from sources outside the crop. Hollings (1960) stated that the spread of potato leaf roll virus within a crop was much greater than from external sources.

There is a positive correlation between the percentage of plants infested with aphids and the incidence of rosette disease. Cadman and Chambers (1960) stated that the extent of leaf roll virus spread was influenced by the rate at which crops became infested by *Myzus persicae* and there was some indication that spread of leaf roll virus was influenced by the rate at which aphid infestation build up in crops and was least in crops which became colonised late in the season. Hollings (1960) stated that there was a close correlation between the spread of leaf roll and Y viruses and the activity of the aphid, *M. persicae*. A correlation (significant at P = 0 01) was shown by Booker (1963) between total number of infested groundnut plants during the season and the number of rosetted plants. He also stated that many alates and many infested plants did not always coincide and a few infested plants could support a large number of aphids.

There is a positive correlation between the aphids population and the incidence of rosette disease. Gregory (1943) found in many fields, high population of *Myzus persicae* associated with the large increase of leaf roll. Fisken (1959) stated that the potato crops free from infection by leaf roll and Y viruses reflected the scarcity of the aphid vectors mainly *M. persicae*. Hem Singh Pruthi and Samuel (1942) found a close positive correlation between the incidence of leaf curl disease of tobacco and the population of

the white fly, *Bemisia tabaci*. Allen, Tucker and Nelson (1960) stated that the period of maximum incidence of the leaf crumple disease of cotton corresponded to the earlier period of white fly activity. Tarr (1951) stated that once the leaf curl disease was established in cotton crop, its spread will depend largely upon the numbers and activity of the white flies present.

A close positive correlation is also found between aphid infestation and the percentage of plants infested by aphids. This is in confirmity with the findings of Fisken (1959) in the case of *M. persicae* and potato crop. He plotted the mean number of aphids per plant and the mean percentage of plants infested against time and found that the two curves followed each other closely and that the trends were similar in 1955 and 1956.

Among the aphids, (*Aphis craccivora*), the percentage infestation of alatae is more to start with thereafter there is a gradual decrease, whereas in the case of apterae it is lower to start with and reached a maximum when the crop was 90 days old. This clearly indicates that the initial incidence of rosette disease is caused by the few incoming viruliferous alatae and secondary spread by the viruliferous apterae moving over the soil surface and playing a predominent role in the spread of the disease. Storey and Bottomley (1928) stated that the diseased group was originated by a winged infective aphid, which settling upon a young seedling of the crop, infected it with rosette and that later the disease was carried to adjacent plants by aphids which had crawled from colonies established upon this central diseased plant. Evans (1954) attributed the primary spread of the disease to the viruliferous alate aphids, coming from overwintering hosts like self-sown groundnut plants and secondary spread to the wandering of apterae within the crop causing typical patchiness. Storey and Ryland (1955) pointed out the importance of apterous and alate aphids in spreading the disease under field condition. Broadbent (1957) postulated that the cauliflower mosaic and cabbage black ringspot viruses spread within cauliflower crops by short flights of the incoming aphids and such short flights from infected to healthy plants resulted in "Pools" of infected plants. He was also of the opinion that many of the plants that were infested by the aphids were not near the infected plants. Bitancourt and Fawcett (1954) found in the case of Psorosis of citrus that spread of the disease round a central diseased tree was more than around a healthy tree.

From the results obtained we can conclude that the rosette disease is introduced in the field by the viruliferous alatae coming from infected self-sown groundnut plants or from infected fields or from alternate hosts. Further spread within the crop in a field appears to be probably by viruliferous apterae crawling from plant to plant. The maximum incidence of rosette disease correspond to the greatest activity and population of *A. craccivora* and to the maximum percentage of plants infested by the aphids.

Discovery of the source of primary inoculam would be important in controlling the disease.

Summary: Two trials were laid, one at the Agricultural Research Station, Bhavanisagar and another at the Millet Breeding Station, Coimbatore, to find out the mode of spread of rosette disease of groundnut during the irrigated season, 1964. Rosette disease was found to spread in groups around an early infected plant in both the trials. Rosette disease incidence was found to be more at the Agricultural Research Station, Bhavanisagar than at the Millet Breeding Station, Coimbatore. Maximum incidence of the disease was found when the crop was 75 days olds. There was a positive correlation between the percentage of aphids infesting the crop, aphid infestation and the incidence of rosette disease. The initial incidence of rosette disease appeared to be caused by the few incoming viruliferous alatae and secondary spread within the crop probably by the viruliferous apterae.

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