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Effect of Spacing, Roguing and Weeding on the Incidence of Rosette Disease of Groundnut with observations on the Aphid Vector, *Aphis craccivora* Koch.

by

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Introduction: Rosette disease of groundnut was first reported in Tanganyika territory by Zimmerman in 1907. Sundararaman (1926) reported the occurrence of a virus disease of groundnut at Palur Agricultural Experimental Station, Madras State. He named it as 'clump disease'. Storey and Bottomley (1928) concluded that the 'clump disease' reported by Sundararaman (1926) in Madras State was similar to rosette disease of South Africa.

Rosette disease is one of the virus diseases affecting groundnut crop in Tamil Nadu. The incidence of the disease varies from 0–25 0%. A scheme was initiated at the Agricultural College and Research Institute, Coimbatore with the financial assistance of The Indian Central Oilseeds Committee and later of the Indian Council of Agricultural Research to study the various aspects of the virus diseases occurring in groundnut crop.

Review of Literature: Hayes (1932) reported that postponement of weeding was highly effective in controlling rosette disease in Gambia. Storey (1935) was of the opinion that rosette infection can be greatly reduced by adopting a close sowing distance in Uganda and Gambia. Storey and Ryland (1950) stated that there was a reduction in the number of rosette virus infected groundnut plants as well as percentage of rosette virus infection per unit area in closely spaced plants. Booker (1963) remarked that there was no significant differences in the numbers of rosette virus infected plants per unit area at harvest. Booker (1963) reported that close spacing gave more yield per acre than wide spacing though individual widely spaced plants yielded considerably more than the close spaced ones. The number of rosette virus infected plants and those infested by the vector, *Aphis craccivora* Koch. were reduced by early planting or close spacing at Mokwa, N. Nigeria (Brook, 1964).

Materials and Methods: TMV2, a bunch variety of groundnut was selected for field studies.

I. Two trials on a split plot design were laid, one at the Agricultural Research Station, Bhavanisagar and another at the Millet Breeding Station,

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Coimbatore during summer season, 1964, to find out the effect of spacing, roguing and weeding on the incidence and control of rosette disease of groundnut. Nine spacings were taken for main plot treatments and four combinations of roguing and weeding were taken for sub-plot treatments. The nine spacings adopted were, 6"×6", 6"×9", 6"×12", 9"×6", 9"×9", 9"×12", 12"×6", 12"×9" and 12"×12". The sub-plot treatments were, roguing+weeding; roguing+no weeding; no roguing+weeding and no roguing and no weeding. Roguing of rosette virus infected plants and weeding of the groundnut plots were carried out at an interval of fifteen days from the time of sowing. On the whole, weeding and roguing out virus infected plants were carried out four times and six times, respectively. Population counts of the aphid vector, *Aphis craccivora* Koch. were recorded on ten per cent of the plant population selected at random at an interval of fifteen days till the crop was 105 days old. Seven observations on the incidence of rosette disease were carried out at an interval of fifteen days.

II. The same trials were repeated during the monsoon season, 1964 at the Agricultural Research Station, Bhavanisagar and at the Cotton Breeding Station, Coimbatore but with one modification in one of the sub-plot treatments, namely, late weeding was adopted instead of no weeding since the yield was considerably reduced in non-weeded plots. In weeded plots weeding was carried out once in 15 days and in late weeded plots once in 30 days. Weeding was carried out 4 times and 2 times in weeded and late weeded plots, respectively, on the whole. The other observations and cultural operations were carried out as for the trials conducted in summer season, 1964.

Results: *I. A.* Main and sub-plot treatments as well as their interaction revealed significant differences on the incidence of rosette disease in the trial laid out at the Agricultural Research Station, Bhavanisagar during summer season, 1964. The incidence of the disease was significantly less (10.31) in 6"×6" spaced plots though it was on a par with 6"×9" and 9"×6" spaced plots. Highest incidence (20.64) of the disease was recorded in 12"×12" spaced plots (Table 1). In rogued and non-weeded plots the incidence of the disease was significantly less (12.32). The results are shown in Table 2.

6"×6" spaced plots recorded the highest yield (595.88 grams) and the poorest yield was recorded in 12"×12" spaced plots (180.250 grams) vide Table 1. The yield obtained from rogued and weeded plots was found to be significantly more (475.58 grams) than in other treatments (Table 2). The interaction between main plot and sub-plot treatments were also found to be significant with regard to yield.

Though the aphid infestation was found to be negligible, yet maximum number of aphids was found in plots where wider spacing was adopted, namely 12"×12" and in plots where roguing and weeding was carried out (Table 2).

TABLE 1. *Comparison of main plot means*

Particulars 1.	6″×6″ M1 2.	6″×9″ M2 3.	6″×12″ M3 4.	9″×6″ M4 5.	9″×9″ M5 6.	9″×12″ M6 7.	12″×6″ M7 8.	12″×9″ M8 9.	12″×12″ M9 10.	S.ED 11.	C.D. 12.	Conclusion 13.
I. A. *Agricultural Research Station, Bhavanisagar - Summer season, 1964*												
a) Aphid population in numbers	—	—	0.5	—	1.75	1.50	0.69	3.81	4.19	—	—	Negligible infestation
b) Incidence of rosette disease (Transformed values)	10 31	11.72	15.1	12.58	16.02	19.64	14.79	20.26	20.64	1.833	2.6749	M1 M2 M4 M7 M9 M5 M6 M8 M3
c) Yield in grams	595.88	415.94	291.56	407.13	298.63	215.69	294.25	213.31	180.250	22.55	46.363	M9 M8 M6 M3 M7 M5 M4 M2 M1
I. B. *Millet Breeding Station, Coimbatore - Summer season, 1964*												
a) Aphid population in numbers	—	—	—	—	0.69	1.44	—	2.56	2.63	—	—	Negligible
b) Incidence of rosette disease in percentage	0.05	0.16	0.67	0.15	0.74	1.21	0.67	1.87	1.87	—	—	Negligible
c) Yield in grams	154.63	144.06	151.94	163.56	195.88	208.06	165.81	148.81	190.31	—	—	Not significant
II. A. *Agricultural Research Station, Bhavanisagar - Monsoon season, 1964*												
a) Aphid population in numbers	—	—	—	—	0.44	2.19	—	1.75	3.06	—	—	Negligible
b) Incidence of rosette disease in percentage	0.05	0.08	0.09	0.07	0.32	0.33	—	0.45	0.61	—	—	Negligible
c) Yield in grams	458.5	415.4	321.9	395.8	323.8	245.1	344.6	243.6	188.6	13.7	28.2	M1 M4 M3 M7 M5 M8 M6 M9 M2
II. B. *Cotton Breeding Station, Coimbatore - Monsoon season, 1964*												
a) Aphid population in numbers	1.37	1.59	1.97	1.61	1.96	2.45	1.90	2.57	2.77	0.119	0.2452	M1 M2 M4 M7 M5 M8 M6 M3 M9
b) Incidence of rosette disease (Transformed values)	3.225	3.968	5.040	4.393	6.020	8.545	7.140	10.710	11.045	1.207	2.487	M1 M2 M4 M8 M5 M7 M6 M3 M9
c) Yield in grams	761.8	525.2	456.7	535.6	412.0	359.9	442.6	336.3	281.7	28.4	56.8	M1 M4 M2 M8 M7 M5 M3 M6 M9

TABLE 2. *Comparison of sub-plot means*

Particulars	R+W S_1	R+No W S_2	No R+W S_3	No R+No W S_4	SED	CD	Conclusion
I. A. *Agricultural Research Station, Bhavanisagar - Summer season, 1964*							
a) Aphid population in numbers	2.33	1.36	1.50	0.28	—	—	Negligible
b) Incidence of rosette disease (Transformed values)	15.41	12.32	19.84	15.11	0.4376	0.6198	S_2 S_4 S_1 S_3
c) Yield of grams	475.58	184.81	452.42	181.69	7.34	14.60±7	S_1 S_3 S_2 S_4
I. B. *Millet Breeding Station, Coimbatore - Summer season, 1964*							
a) Aphid population in numbers	1.61	0.47	1.085	0.195	—	—	Negligible
b) Incidence of rosette disease in percentage	0.568	0.235	1.858	0.623	—	—	Negligible
c) Yield in grams	190.2	135.6	213.3	137.9	13.4	26.8	S_2 S_4 S_1 S_3

	R+W S_1	R+LW S_2	No R+W S_3	No R+LW S_4			
II. A. *Agricultural Research Station, Bhavanisagar - Monsoon season, 1964*							
a) Aphid population in numbers	1.36	0.36	1.31	0.28	—	—	Negligible
b) Incidence of rosette disease in percentage	0.30	0.04	0.335	0.213	—	—	Negligible
c) Yield in grams	315.7	325.8	319.6	338.7	4.5	9.0	S_1 S_3 S_2 S_4
II. B. *Cotton Breeding Station, Coimbatore - Monsoon season, 1964*							
a) Aphid population in numbers	2.207	1.598	2.413	1.852	0.114	0.2278	S_2 S_4 S_1 S_3
b) Incidence of rosette disease (Transformed values)	7.201	4.498	8.667	6.339	1.19	2.368	S_2 S_4 S_1 S_3
c) Yield in grams	449.2	455.3	457.1	465.9	3.7	7.4	S_1 S_2 S_3 S_4

R+W=Roguing+weeding
R+No W=Roguing+No weeding
No R+W=roguing+weeding
No R+No W=No roguing+No weeding

R+W=Roguing+weeding
R+LW=Roguing+Late weeding
No R+W=No roguing+weeding
No R+LM=No rouging+Late weeding.

3. The incidence of rosette disease was negligible in the trial laid out at the Millet Breeding Station, Coimbatore during summer season, 1964. Minimum incidence of the disease (0.05%) was found in 6″×6″ spaced plants and maximum (1.87%) in 12″×12″ and 12″×9″ spaced plots (Table 1). Among sub-plots, the lowest incidence was noticed in rogued and non-weeded plots (0.235%) (Table 2).

With regard to yield, main plot treaments did not show any significant difference (Table 1). Among sub-plots weeding significantly increased yield over non-weeding irrespective of roguing of virus diseased plants was carried out or not (Table 2).

Aphid infestation was found to be negligible in this trial and maximum infestation was seen in 12″×12″ spaced plots (2.63).

II-A. Negligible incidence of rosette disease was found in the trial laid out at the Agricultural Research Station, Bhavanisagar during monsoon season, 1964. However, the incidence of the disease varied from 0% (12″×6″ spacing) to 0.61% (12″×12″ spacing) (Table 1). The disease incidence was minimum (0.04%) in rogued and late weeded plots and maximum (0.335%) in un-rogued and weeded plots (Table 2).

Significant differences were exhibited by main and sub-plot treatments with regard to yield while their interaction was not significant. The yield obtained from 6″×6″ spaced plots was significantly higher (458.5 grams) whereas that obtained from 12″×12″ spaced plots was the poorest (188.6 grams) (Table 1). Late weeding was found to increase the yield irrespective of roguing of diseased plants was carried out or not. Results are shown in Table 2.

Aphid infestation was found to be negligible in this trial.

B. Aphid population varied significantly both among main plot and sub-plot treatments in the trial laid out at the Cotton Breeding Station during monsoon season 1964. 12″×12″ and 12″×9″ spacings recorded the highest aphid population while 6″×6″, 6″×9″ and 9″×6″ recorded the lowest population, statistically. The other spacings were intermediary (Table 1). Weeding with or without roguing appeared to favour aphid infestation while late weeding combined with roguing out of virus diseased plants helped to minimise aphid infestation (Table 2).

Main and sub-plot treatments were found to influence the incidence of the disease while their interaction was not significant. The incidence of rosette disease was found to increase with wider spacing and maximum incidence of the disease was found in 12″×12″ spacing (11.045) (Table 1). With regard to sub-plot treatments, late weeding in combination with roguing was found to be

the best in minimising the incidence of the disease while the other sub-plot treatments were alike in their efficiency (Table 2).

2. The same trend as for aphid population is noticeable in the case of the incidence of the disease also. The analysis of regression of disease incidence on aphid population was highly significant thereby indicating that the incidence of rosette disease can be predicted with a fair amount of accuracy from a knowledge of the aphid population (Table 3).

Main and sub-plot treatments revealed highly significant differences in the case of yield. The yield obtained from 6″×6″ spacing was significantly more (761 8 grams) than from other main plot treatments. 12″×12″ spacing recorded the lowest yield (Table 1). Maximum yield (465.9 grams) was obtained from sub-plots where late weeding and no roguing were carried out (Table 2).

Discussion: The population of aphids was found to be maximum in wider spacing, namely, 12″×12″ which is in confirmity with the findings of Hull (1964), Brook (1964) and Farrell and Adams (1966). According to Hull (1964) in wider spacing the apical bud and young leaves of each shoot are exposed and thus more attractive to alate aphids which visit in larger numbers than in closer spacing where the buds and young leaves are hidden under a canopy of mature leves. Brook (1968) stated that *Aphis craecivora* Koch. and *A. gossypii* landed more frequently on wide than on close spaced groundnuts.

The incidence of rosette disease was found to be significantly less in 6″×6″ spaced plants in comparison with 12″×12″ spaced plants. These results are in confirmity with the findings of Hayes (1932), Storey (1935), Storey and Ryland (1950), Booker (1963) and Brook (1964). Compactness of the growth of celery was deterrent to the spread of celery virus (Wellman, 1935). Storey and Ryland (1950) reported that there was a reduction in the number of rosette virus infected groundnut plants as well as percentage of rosettee virus infection per unit area in closely spaced plants. Booker (1963) was of the opinion that spacing had no effect on the number of rosetted plants per acre or per unit area but significantly higher percentage of rosetted plants occurred in widely spaced plots. The trials laid out at Coimbatore and at Bhavanisagar are in confirmity with the findings of Booker (1963). Spacing influences the incidence of viruses in other crops also. Vander Plank (1947) suggested close planting and thinning out later, the diseased tomato plants, for the control of spotted wilt of tomato in South Africa. Reestman (1960) advocates close planting and thinning later to reduce virus infection in potatoes. When the percentage of infection is low, systemic diseases could be controlled by close planting which reduces the size of plants and increases the number per unit area. (Vander Plank, 1947 and Ramakrishnan, 1963).

TABLE 3 A. *Incidence of rosette disease (Transformed values) – Interaction table.*

Spacing, roguing and weeding at the Agricultural Research Station, Bhavanisagar during summer season, 1964

Main plot \ Sub-plot		R+W (S_1)	R+No W (S_2)	No R+W (S_3)	No R+No W (S_4)	
6″×6″	(M_1)	10.380	8.253	12.245	10.365	
6″×9″	(M_2)	11.725	8.863	14.428	11.870	
6″×12″	(M_3)	14.593	12.640	19.36	13.775	
9″×6″	(M_4)	12.133	10.918	15.535	11.720	
9″×9″	(M_5)	16.205	12.393	19.765	15.706	SED=0.8986
9″×12″	(M_6)	19.195	15.590	24.840	18.925	
12″×6″	(M_7)	13.430	11.590	19.458	14.678	CD=1.8505
12″×9″	(M_8)	19.710	15.470	26.265	19.590	
12″×12″	(M_9)	21.283	15.193	26.705	19.378	

SED=1.5667 CD=3.1179

Conclusion

Main plots	Sub-plots	Sub-plots	Main plots
M_1	S_2 S_4 S_1 S_3	S_1	M_9 M_8 M_6 M_5 M_3 M_7 M_4 M_2 M_1
M_2	S_2 S_1 S_4 S_3	S_2	M_6 M_8 M_9 M_3 M_5 M_7 M_4 M_2 M_1
M_3	S_2 S_4 S_1 S_3	S_3	M_2 M_5 M_6 M_8 M_7 M_5 M_4 M_2 M_1
M_4	S_2 S_4 S_1 S_3	S_4	M_8 M_9 M_6 M_5 M_7 M_3 M_2 M_4 M_1
M_5	S_2 S_4 S_1 S_3		
M_6	S_2 S_1 S_4 S_3		
M_7	S_2 S_1 S_4 S_3		
M_8	S_2 S_4 S_1 S_3		
M_9	S_2 S_4 S_1 S_3		

(Transformed values are arranged in an ascending order

R+W = Roguing+Weeding; R+No W = Rouguing+No weeding;

No R+W = No roguing+Weeding; No R+No W = No roguing+No weeding

TABLE 3 B. *Yield (Grams) Interaction table*

Main plot \ Sub-plot		R+W (S_1)	R+No W (S_2)	No R+W (S_3)	No R+No W (S_4)	
6″×6″	(M_1)	850.00	387.50	768.50	377.50	
6″×9″	(M_2)	572.70	247.50	587.00	256.50	
6″×12″	(M_3)	419.00	170.25	405.25	171.75	
9″×6″	(M_4)	571.5	240.50	575.25	232.25	
9″×9″	(M_5)	432.75	174.00	410.50	177.25	
9″×12″	(M_6)	326.75	116.50	307.00	112.50	SED=21.29
12″×6″	(M_7)	440.00	160.75	423.00	153.25	
12″×9″	(M_8)	354.00	96.75	311.75	90.75	CD=43 858
12″×12″	(M_9)	313.50	60.50	283.50	63.50	

SED = 22.496 CD = 44.768

Conclusion

Main plots	Sub-plots	Sub-plots	Main plots
M_1	S_1 S_3 S_2 S_4	S_1	M_1 M_2 M_4 M_7 M_3 M_5 M_8 M_6 M_9
M_2	S_3 S_1 S_4 S_2	S_2	M_1 M_2 M_4 M_3 M_5 M_7 M_6 M_8 M_9
M_3	S_1 S_3 S_4 S_2	S_3	M_1 M_2 M_4 M_7 M_6 M_5 M_8 M_6 M_9
M_4	S_3 S_1 S_2 S_4	S_4	M_1 M_2 M_4 M_5 M_8 M_7 M_6 M_8 M_9
M_5	S_1 S_3 S_4 S_2		
M_6	S_1 S_3 S_2 S_4		
M_7	S_1 S_3 S_2 S_4		
M_8	S_1 S_3 S_2 S_4		
M_9	S_1 S_3 S_4 S_2		

R+W = Roguing+Weeding; R+No W = Roguing+No weeding;
No R+W = No roguing+Weeding; No R+No W = No roguing+No weeding.

TABLE 4. *Spacing, roguing and weeding trial conducted at the Cotton Breeding Station, Coimbatore - during monsoon season, 1964*

Aphid infestation and incidence of rosette disease

Prediction equation
$y - \bar{y} = byx\,(x-\bar{x})$
$y = 0.614\,x - 0.3024$
$r = 0.660^{**}$

where x is the aphid population and y is the expected percentage of disease incidence. ($r=0.660^{**}$)

A positive correlation was seen regarding aphid infestation and incidence of rosette disease and these two factors were found to be influenced by spacing. Brook (1964) also stated that the number of rosette virus infected plants and those infested by the vector, *Aphis craccivora* Koch. was reduced by early planting or close spacing. Goss (1929) reported that the spread of mild mosaic, rugose mosaic and leaf roll of potato were dependent on aphid population. A positive correlation between the incidence of the disease and its vector was noticed by Pruthi and Samuel (1942) in the case of leaf curl of tomato and *Bemisia tabaci*, by Gregory (1943), leaf roll of potato and *Myzus persicae* and by Tarr (1951) leaf curl of cotton and *Bemisia tabaci*.

Closer spacing (6″×6″) gave more yield than widely spaced plants (12″×12″) though each individual widely spaced plant yielded more than the closely spaced ones. This is in confirmity with the findings of Booker (1963).

Roguing of rosette diseased groundnut plants was found to be beneficial in reducing the incidence of the disease which was found to be the most satisfactory method of control of the disease in Gambia (Anon, 1926). Roguing of virus diseased plants was found to be effective in the control of leaf curl of tobacco (Pal and Tandon, 1937), broccoli mosaic (Caldwell and Prentice, 1942), potato viruses (Pushkarnath, 1943), vein clearing of bhendi (Capoor and Varma, 1951) and marginal chlorosis of peanuts (Van Velson, 1961).

The incidence of rosette disease was found to be significantly less in non-weeded or in late weeded plots. Postponement of weeding was highly effective in controlling rosette disease in Gambia (Hayes, 1932). Storey (1935) recommended mulching soil surface with dry grass and encouraging weed growth during the early period for the control of rosette disease. Heavy growth of weeds depressed the yield considerably in non-weeded plots which is in confirmity with the findings reported in Nigeria (Anon, 1937). There was a significant increase in yield in late weeded plots in comparison with weeded plots, probably due to the lesser interference with the proper growth and establishment of the pegs.

Summary and Conclusion: Four trials, namely, two at Coimbatore and two at Bhavanisagar were conducted on a split plot design to test the efficacy of spacing, roguing and weeding on aphid *(Aphids craccivora* Koch.) infestation, incidence of rosette disease and yield of groundnut. The nine main plot treatments were 6″×6″, 6″×9″, 6″×12″, 9″×9″, 9″×12″, 12″×6″, 12″×9″, and 12″×12″ spacings and the four sub-plot treatments were roguing+weeding, roguing+no weeding or late weeding, no roguing+weeding and no roguing+no weeding or late weeding. Closer spacing (6″×6″) and late weeding (weeding twice at an interval of 30 days) was found to be effective in reducing aphid infestation, incidence of rosette disease in percentage and in increasing the

yield. A positive correlation was found between aphid infestation and the incidence of rosette disease. A negative correlation was found between the number of plants per unit area and the percentage incidence of the disease or the aphid infestation, closer spacing (6" × 6") gave more yield than wider spacing (12" × 12") though each individual widely spaced plant yielded more than the closely spaced ones. Postponement of weeding (weeding twice at an interval of 30 days) was highly effective in reducing the incidence of the disease and increasing the yield. Roguing of rosette diseased plants was found to be effective in reducing the incidence of the disease.

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