The Rhizosphere Microflora of Tomato as Influenced by the Age of the Plant*

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It is now a well established fact that there is an intimate relationship between plant roots and the micro-organisms present in the soil. This relationship is physiological as well as ecological. The rhizosphere of plants harbours a higher microbial population which differs quantitatively and qualitatively in different plants and even in the same plant during the different periods of its growth. Further, any modification that may be brought about in the growth and physiological behaviour of the plant will also usually be reflected in the rhizosphere microflora. Age of the plant also exerts a remarkable influence on the development of the rhizosphere microflora. Starkey (1929), Agnihothrudu (1953), Rangaswami and Venkatesan (1963) and many others have observed a relatively small number of micro-organisms in the early stages of the plant growth which showed a tendency to rise with the age of the plant till flowering and afterwards to decline.

A study of the rhizosphere microflora in three varieties of tomato was undertaken in order to gain a comparative idea of the influence of age of the plant on the rhizosphere population. The changes in the population of the different groups of micro-organisms in the rhizosphere of these plants throughout the complete growth period was followed. The three varieties selected were having the common character that they were all highly susceptible to bacterial wilt caused by *Pseudomonas solanacearum*. These varieties were selected out of eight varieties which were used in a field experiment designed to determine their comparative resistance to bacterial wilt. All the eight varieties were found almost equally susceptible to the wilt under field conditions, the maximum wilt incidence occurring when the plants were 30-60 days old. The varieties selected for the rhizosphere studies were therefore all susceptible ones and a resistant variety could not be included for comparative purposes since such a variety was not available.

Materials and Methods

Marglobe, *Bonnybest* and *Redcherry* were the three varieties of tomato selected for the study. In a separate field experiment it was found that 60-90% of the plants of these varieties wilted when they were 30-60 days old.

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Seeds of the above varieties were sown in different beds of size 15′ x 3′. Soon after germination the beds were thinned out. Assessment of the rhizosphere microflora was started from the 5th day after sowing when the cotyledons were fully emerged. Germination usually started on the 3rd day after sowing.

The method adopted in the present study for the assessment of the microbial population was the soil dilution and plate counts described by Timonin (1940). The concentration of the final dilution used was one in million for bacteria, actinomycetes and fungi.

For the first 20 days after sowing the rhizosphere population was determined every fifth day and thereafter once in ten days. A total of twelve samples were collected during the life of the crop. Plants required for the study were selected at random from the three varieties. Non-rhizosphere soils were also collected simultaneously from the same field, but away from the influence of the root system to serve as the control. To collect the rhizosphere soil the plants were pulled out carefully and the whole root system was used for making the dilutions. The roots of tomato plants were found upto a depth of 3″–4″ when the plants were 20 days old, Thereafter they were found at lower depths also and when the plants were fully mature the roots were found upto a depth of 10*. At the flowering stage the roots were seen upto a depth of 6″–8″. The non-rhizosphere soil was collected from the same depth from which the roots were collected at each time.

Soil extract agar was used for the isolation of bacteria, peptone-dextrose agar with rose bengal and streptomycin for fungi and Jensen's medium for actinomycetes. One ml aliquots of the final dilution were added to about 15 ml of the appropriate media and were plated in sterile Petri-dishes.

The plates were incubated at room temperature (30–32°C) for about 14 days for bacteria and actinomycetes. Counts of fungi were taken 6-7 days after plating.

Results

A definite rhizosphere population was found to be established within 5 days after sowing when the first sample was taken. The population continued to increase steadily till the flowering period when the peak was attained. Then, there was a gradual fall. This trend was observed in all the three varieties.

Quantitative assessment of the microbial population

Bacteria.—There was a marked tendency for the bacterial population in the rhizosphere to increase along with the growth of the plant. The highest population was observed during the flowering stage. (Fig. 1)

A fairly high bacterial population was noted in the rhizosphere even on the fifth day after sowing. The R:S ratios for *Marglobe*, *Bonnybest* [and *Redcherry* at this stage were 7.37, 9.91 and 9.03 respectively. From the fifth day onwards there was a steady rise in the population till the flowering stage. In *Bonnybest* the flowering commenced 46 days after sowing, where as in *Marglobe* and *Redcherry* it commenced only on the 52nd day. The R:S ratios for these varieties during this period were 12.05, 13.64 and 12.60 respectively. After attaining this maximum, the population was found to decrease gradually and on the 100th day the population was almost half of that found during the flowering period. This decrease was more or less uniform for all the varieties. (Table I).

TABLE I

Bacterial population in the rhizosphere of three varieties **of tomato at different** stages of growth

(Population in 10^6 **per** gram of dry sample)

Age of plants in days	5	10	15	20	30	40	50	60	70	80	90	100
Control soil	3·5	4·5	5.6	7·5	9 4	13·2	13.3	11.5	12.9	9 9	9.1	9.8
Marglobe	25.8	53.4	83.1	114.3	128.8	152.0	181 4	168.1	146.5	112.5	97.9	98 9
R:S ratio	7.37	11,86	14.84	15.24	13.70	11.52	13.64	1461	11.35	11.36	10.75	10.09
Bonnybest	34.7	50.00	76.6	92.3	138.4	159.1	152.7	1466	1364	121.0	92.2	87.9
R:S ratio	9·91	11.11	13.68	12.30	14.72	12·05	11.48	12.74	10.57	12.22	10.13	8.97
Redcherry	31.6	45.3	68.5	105.4	123·6	147·8	167.6	160.2	135.3	101.5	89.8	84.4
R:S ratio	9,03	10.06	12.23	14,05	13.15	11.19	12.60	13.93	10.48	10.25	9.87	8.61
S. E,	4.24	5.95	10·57	15.39	11.43	13.92	12.05	12.23	12·85	488	8.20	7.06
C. D. at 5% level	9,78	13.72	24.37	35.49	26.36	32.10	27.79	28.20	29·63	11.25	18.91	16.28

TABLE II

Fungal population in the rhizosphere of three varieties of tomato at diiferent stages of growth

(Population in 10^6 per gram of dry sample)

Age of plants in days	5	10	15	20	30	40	50	60	70	80	90	100
Control soil	0.06	0.11	0,09	0.14	0.19	0.19	0.20	0.26	0.26	0.25	0.24	0.22
Marglobe	0.10	0.20	0.26	0.34	0.33	0.32	0.33	0.32	0.31	0.33	0.41	0.32
R:S ratio	1.66	1.81	2.88	2.43	1.75	1.69	1.65	1,23	1.19	1.32	1.79	1.45
Bonnybest	0.09	0.22	0.32	0.33	0.33	0.32	0.30	0.28	0.35	0.33	0.39	0.35
R:S ratio	1,50	2.00	3.55	2.35	1.75	1.69	1.50	1.08	1.35	1.32	1.62	1.59
Redcherry	0.14	0.15	0.28	0.29	0.34	0.33	0.30	0.31	0,48	0.43	0.36	0.33
R:S ratio	2.33	1.36	3.33	2.08	1.79	1.75	1.50	1.19	1 85	1.72	1.50	1.50
S. E.	0.13	0.61	1.40	1.61	1.63	1.46	1.45	0.53	2.11	0.71	0.78	2.74
C. D. at 5% level	0.29	141	323	3.71	3.76	3.37	3.34	3.22	4 87	1.64	1.80	6.32

TABLE III

Actinomycctes population in the rhizosphere of three varieties of tomato at different stages of growth

(Population in 10^6 per gram of dry sample)

Age of plants in days	5	10	15	20	30	40	50	60	70	80	90	100
Control soil	3·83	4.20	4 79	5·20	6.83	7.30	7.13	6.33	8·50	8.17	8·13	7·80
Marglobe	10·80	15 23	1643	19·03	17·70	18.07	17.00	1670	17.19	17·00	1850	18.13
R:S ratio	2.82	3.62	3.43	3·66	2·59	2.48	2.38	2·63	2.02	2·08	2.28	2·32
Bonnybest	12·70	16.53	17.13	1693	17.-20	16-83	17.60	18 73	19.50	18.57	19,23	19.00
R:S ratio	3·31	3.93	3.57	3.26	2.52	2.31	2.41	2·95	229	2.27	1.37	2.44
Redcherry	11·30	16·57	15.50	21.00	20.60	20.37	19.10	20.53	21.20	19.83	20.47	20.30
R:S ratio	2.95	3.94	3.23	4.04	3.02	2.79	2,68	3.24	2.49	2.43	2.52	2.60
S, E.	2.24	2.52	2.85	3.26	2.59	1.78	1.85	1.61	2.45	3.81	2.19	2.27
C. D. at 5% level	5.17	5.81	6.57	7.52	5.97	4.10	4.27	5.55	5.65	8.78	5.05	5.23

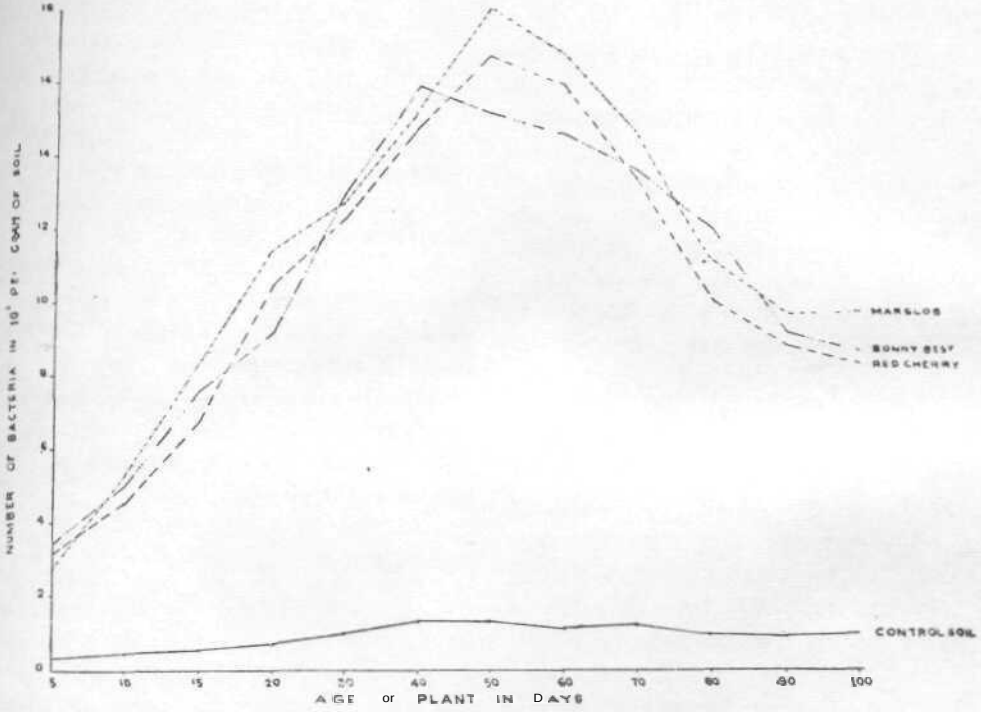

Fig. 1. Bacteria] populations in the rhizosphere of three varieties of tomato at different stages of growth in comparison with that ID the soil.

Fungi:—There was a steady increase in the fungal population of the rhizosphere upto the 15–20th day after sowing. Afterwards, there were only minor variations till the 80th day, when again an increase in population was noted. (Table II).

Aetinomycetes:—There was a marked increase in the actinomycetes population between the 5th and 20th day after sowing for all the varieties. Then, there were only minor variations (Table III).

Discussion

A very high microbial population, more than 7 times that of the surrounding soil was built up in the rhizosphere of all the varieties within 5 days after sowing. Timonin (1940) and Rouatt (1959) have also noted a similar rhizosphere effect in three day old seedlings. This marked rhizosphere effect which was evident within 2-3 days after germination indicates that a profound stimulating effect is exerted by root exudates of the you'ng seedlings on the microorganisms, resulting in their rapid multiplication.

In correlating the population with the age of the plant, it was found that the peak population coincided with the flowering stage of the crop. This was true for all the varieties. A simitar pattern was observed for other crops also by earlier workers like Starkey (1929), Timonin (1940) Agnihothrudu (1953) and others. The flowering period is the peak vegetative stage when the maximum production of root exudates and sloughed off tissues is expected. Regarding the individual groups of organisms, the bacterial population continued to increase steadily reaching the highest during the flowering period. In the case of actinomycetes and fungi, on the other hand, the peak was attained much earlier than that and these populations were then more or less steadily maintained with minor fluctuations. This may indicate that just before and at the flowering stage the root exudates were more favourable for the development of bacteria. This was also found to be the period when the highest number of plants wilted under field conditions in all the three varieties.

It is interesting that there is no significant difference in the total population of the different groups of organisms present in the rhizosphere of the three varieties of tomato during their entire life period. To what extent could this be due to the similarity of the root exudates of the three varieties cannot be said with certainty without having a fuller understanding of the nature and types of organisms present in the rhizosphere of these varieties,

Summary and Conclusions

An attempt was made to follow the quantitative changes in the rhizosphere microflora of three varieties of tomato plants in relation to the age of the plant. The three varieties selected for the study were highly susceptible to bacterial wilt caused by *Pseudomonas solanacearum*. A definite microbial population was established in the rhizosphere of 3 day old seedlings. There was a positive correlation between the age of the plant and the microbial population upto the flowering stage at which the maximum was recorded. Thereafter, there was a gradual reduction in the population.

The actinomycete and fungal populations increased steadily till the 20th day after which there were only minor variations. The bacterial population, on the other hand, continued to increase steadily reaching the highest during the flowering period. Maximum wilt was also noted in the crop during

this period under field conditions. There was no significant difference between the rhizosphere populations of the three varieties under study at different stages of growth.

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