Effect of tomato bunchy top virus disease on nutrition of tomato (*Lycopersicon esculentum* Mill)

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ABSTRACT

The effect of host nutrition on the plant growth as well as the concentration of bunchy top virus in tomato (*Lycopersicon esculentum* Mill) plants was studied. Two varieties of tomato *viz.*, Pearson and Pusa Ruby were selected for study. The effect of nutrition (N, P and K) on Bunchy top virus disease of tomato (*Lycopersicon esculentum* L.) had been studied on 25, 35 and 45 days to find out the signifcance of the data C.D. has been worked out for inoculated and uninoculated material. The effect of nitrogen, phosphorus and potassium on height (cm), fresh weight (g) and dry weight (g). The height at 210 ppm was 25.00 cm and at 630 ppm was recorded maximum as 31.24 cm. Similarly fresh weight at 210 ppm was 3.14 g and at 630 ppm 3.89g. Dry weight at 210 ppm was 0.361 g and at 630 ppm 0.442 g. The height at 93 ppm was 16.20 cm and at 237 ppm was recorded maximum as 32.38 cm. Similarly fresh weight at 93 ppm was 3.22 g and at 237 ppm 3.32 g. Dry weight at 93 ppm was 0.393 g and at 237 ppm 0.416 g. The height at 78 ppm was 13.63 cm and at 704 ppm was recorded maximum as 32.25 cm. Similarly fresh weight at 430 ppm was 3.23 g and at 704 ppm 3.57 g. Dry weight at 430 ppm was 0.325 g and at 704 ppm 0.405 g. The effect of N, P and K on innoculated and uninnoculated material has been shown.

Key words : Necrosis, Bunchy top, Virus disease, Aphids, White fly, Nitrogen, Phosphorus, Nutrients, Potassium

INTRODUCTION

Tomato suffers heavily from several fungal, bacterial and viral diseases which take a heavily toll of the crop. Only few virus diseases have been reported to occur on tomato in our country which are of economic importance. The crop is subject to various types of virus desease, like mosaic, necrosis, streak, leaf roll, bunchy top and leaf curl. Some of the diseases are seed borne and some are spread by insects, such as the white fly (*Bemisia gossypiperda* M. Th.), grasspoppers and aphids, which feed on the leaves of diseased tomato or other Solanaceous plants; even unrelated crops like cucumber and perennial weeds serve as alternate hosts. The diseases are sap-transmissible and in some cases they are so infectious that simple contact with diseased plants spreads the virus.

In recent years bunchy top virus disease of tomato have been reported to cause severe damage to tomato crop causing yield reductions in terms of fruits. Fresh or ripe fruits of tomato are refreshing and appetizing and are consumed raw in salads or after cocking. Unripe fruits are cooked and eaten. Large quantities of fruits are canned. Tomatoes are consumed also in the form of juice, paste, ketchup, souce, soup and powder (Girdhari Lal *et al.*, 1960).

Tomato bunchy top which had been found naturally occuring in Haryana, U.P., Punjab, Maharastra, Bihar, Himachal Pradesh and West Bengal (Ganguly and Misra, 1992).

Therefore, the present investigation was taken up with a view to determine the effect of different levels of nutrition on the growth of tomato plants and the biological activity of the inoculant virus and its morbid anatomy. As this knowledge would be of basic importance in understanding the behaviour of the virus in the tomato plants and for a divising effective management practice for the control of bunchy top disease of tomato.

MATERIALS AND METHODS

The present experiments were conducted at J.V. (P.G.) College, Baraut (Bhagpat) U.P. during the years 1990-1993. The culture of bunchy top virus was obtained from Division of Mycology and Plant Pathology, Indian Agricultural Research Institute, New Delhi. The inoculum was further multiplied by subculturing on tomato plant by serial transfer for the present studies.

All the experiments were conducted with plants grown from the seed and plants of the variety Pusa Ruby and Pearson susceptable to bunchy top virus were used. Young actively growing plants of the same age and approximately the same size as far as possible, were retained for each experiments.

The inoculations were conducted by the usual leaf inoculation method using fine carborundum powder of 600 mesh as an abrasive. The inoculum was prepared by crushing the fine pulp of bunchy top infected leaf of

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tomato in a sterilized pestal and mortar and passing it through sterilized cotton wool. Inoculation were made by rubbing the upper surface of the leaf of the host plant with a piece of sterilized cotton wool soaked in the inoculum, the leaf being supported on a piece of sterilized cardboard. Prior to rubbing a little carborundum powder (600 mesh) was sprinkled on the leaf surface which served as an abrasive. The inoculated leaves were washed with a fine jet of distilled water from a wash bottle immediately after inoculation. The inoculated plants were kept under observation.

The growth was judged by recording the height, fresh and dry weights of the plants and the virus was assayed by spectrophotometeric procedure using 260 mm wave length at which the optical density was found to be maximum.

Further study of the effect of nutrition, the virus was assayed spectrophotometrically on 15, 25 and 35 days after inocultion. To study the absorption curve and optical density of the virus alcoholic Hcl acid hydrolysis procedure followed by Lindner *et al*. (1952) and Krikpatric and Lindner (1954) was adopted for the extraction of the nucletic acids. A Beakman model DU spectrophotometer was used in the studies and absorption readings were taken ay 10 mu interval in the range from 240 mu to 300 mu.

As the virus under study did not have local lesions host for assay purpose and systemic host assayes discussed by Dean (1971) was not practicable. Spectrophotometer method had therefore, to be resorted for plant virus concentration. Plant virus concentration has been usually measured by spectrophotometer after the isolation by the virus for the plant.

The nutrient solution containing various level of nitroge, phosphorus and potassium were prepared according to the method described by Choe *et al*. (1952) and modified by Koyama *et al*. (1980).

Modified Hoagland's nutrient solution of 1.0 m concentration was used as balanced solution (Hoagland and Snyder, 1933). The chemical used were analytically pure and required concentrations were prepared and stored in corning glass wares.

The analysis of the plant material for toal nitrogen, phosphorus and potassium content was done after every 25, 35 and 45 day by the method mentioned.

Field experiments were carried out to know the effect of varying doses of nitrogen (kg/ha) on tomato bunchy top infected tomato plant. Randomized Block Design was used with four replications, both for inoculted and uninoculated plots. Individual plot consisted of six rows of tomato plant. Plant to plant distance was 25 cm and row to row distance was 180 cm. Nitrogen was added in the form of ammonium sulphate while a basal dose of phosphorus and potassium was also applied in the form of superphosphate and murate of potash respectively. Inoculation was done by the method described earlier. The plots were frequently sprayed with 0.1% Ektox-50 (an emulsion concentrate containing 50% parathion) to avoid insect infestation. Observations were taken by leaving two rows surrounding the net plot. Samples were taken after 35 and 45 days after inoculation for the analysis of nitrogen, phosphorus and potassium.

RESULTS AND DISCUSSION

Pandy and Summarwar (1982) described the tomato bunchy top disease for the first time from India. The first symptom of the disease is sudden cessation of growing crowding of leaves and at top giving bunchy appearance. Leaf margin is curled and tips are twisted showing puckering. The fruits are small and distorted. The virus is mechanically transmissible.

Slab gel electrophoresis of nucleic acid extract from bunchy top infectious tomato plants indicated presence of low molecular weight RNA band. It was highly infections producing characteristic disease symptoms of bunchy top disease on inoculating tomato plants. The disease was seen and mechanically transmitted and affects the quality and yield of the fruits very significantly (Saraswathi and Misra, 1989).

Effect of nitrogen :

From the results presented in Table 1, it is evident that the nitrogen level influenced the growth considerably in respect of inoculated/uninoculated factor, the maximum growth was obtained at 420 ppm during the first sampling interval. It reached maximum at 630 ppm in the second interval. However, there was no significant difference in growth at 420 and 630 ppm in both the intervals. The growth obtained at 420 and 630 ppm was significantly higher when compared to the lower and higher levels of nitrogen nutrition. Inoculation had no effect on growth characters *viz.*, height, fresh weight and dry weight at first interval, but it caused a significant reduction during the second interval.

The results therefore, indicate that as the plant matured the reduction in growth, as judged by height, fresh weight and dry weight, infected plants over healthy one's become more prominent. The maximum growth in general was obtained at 420 and 630 ppm and differences in growth between incoculated and uninoculated plants were also maximum at 420 and 630 ppm. The effect of nitrogen was seen on height, fresh and dry weights (Table 1). The height at 210 ppm was 25.00 cm while maximum height at 630 ppm was 31.24 cm. Similasrly fresh and dry weight were 3.14 g and 0.361 g at 210 ppm and 3.89 g and 0.442 g at 630 ppm respectively. Variations in height fresh and dry weight in different ppm have been given in Table 1.

Effect of phosphorus :

The data presented in the Table 1 indicate that the increase in phosphorus level enhanced the plant growth irrespective of inoculations. The growth reached maximum at 237 ppm in the inoculated and uninoculated plants at both the intervals. The increase in phosphorus level to 547 ppm did not have a favourable effects on plant growth. On the contrary the growth was arrested slightly. The reduction being not significant. The growth at 237 ppm, however, was significantly more when compared to the lower levels of phosphorus. The effect of phosphorus was seen on height, fresh and dry weights (Table 1). The height at 93 ppm was 16.20 cm while maximum height at 237 ppm was 32.38 cm. Similarly fresh and dry weight were 3.22 g and 0.393 g at 93 ppm and 3.32 g and 0.416 g at 237 ppm, respectively. Variations in height fresh and dry weight in different ppm have been given in Table 1.

Effect of potassium :

The results presented in Table 1 indicate that the growth of the plants increased gradually as there was increase in potassium level. The growth reached maximum at 704 ppm. The growth was constant in both the inoculated and healthy plants irrespective of sampling interval. The decrease in growth at 1408 ppm was found to be non-significant. The inoculation had no effect on height of the plants at both the intervals, but marked reduction was noticed in fresh and dry matter weight at second interval. The effect of potassium was seen on height, fresh and dry weights (Table 1). The height at 430 ppm was 15.63 cm while maximum height at 704 ppm was 32.25 cm. Similarly fresh and dry weight were 3.23 g and 0.325 g at 430 ppm and 3.57 g and 0.405 g at 704 ppm, respectively. Variations in height fresh and dry weight in different ppm have been given in Table 1.

Table 1 : Effect of nutrition (N, P and K) on bunchy top virus disease of tomato (*Lycopersicon esculentum* L.) at 35 days

Nitrogen in ppm	Height (cm)	Fresh weight (g)	Dry weight (g)
Effect of nitrogen on height, fresh weight and dry weight			
21	20.58	2.40	0.310
210	25.00	3.14	0.361
420	29.42	3.26	0.412
630	31.24	3.89	0.442
2100	27.02	3.19	0.395
C.D. = (P=0.05)	1.632	0.119	0.018
Effect of phosphorus on height, fresh weight and dry weight			
10	13.92	2.45	0.310
93	16.20	3.22	0.393
237	32.28	3.32	0.416
447	31.19	3.21	0.405
C.D. = (P=0.05)	1.626	0.131	0.019
Effect of potassium on height, fresh weight and dry weight			
78	13.63	2.84	0.322
430	15.63	3.23	0.325
704	32.25	3.57	0.405
1408	30.53	3.52	0.397
C.D. = (P=0.05)	1.655	0.103	0.018

The growth response of inoculated and uninoculated plants was similar at all the levels of potassium except at 704 ppm, (where maximum growth was observed) where there was marked reduction in the fresh and dry matter weight of inoculated plants. Therefore, it can be said that though the growth was maximum at 704 ppm of potassium the inoculation had also a marked effect at the same level of potassium.

Tomato bunchy top virus disease is an important virus disease of tomato under Indian conditions. The disease spreads in the field through various agencies (Misra, 1992). The virus can withstand an exporsure to 60^0C for 10 minutes but gets inarocuous when exposed to 70^0C for the same period dilution end point (DEP) of the virus being 1:1000. Longivity *in vitro* is 12 to 24 hours at room temperature. The virus has a restricted host range and being easily transmitted by mechanical means. The virus under study differ from all other viruses reported to be naturally occuring on tomato, in transmission, physical properties and host range.

Variation in supply of nutrient elements like nitrogen and phosphorus that serve as building material for virus particle would be expected to affect virus activity both directly and indirectly whereas, variation in nutrient elements like potassium that does not become a part of the virus molecule should only effect virus activity indirectly by upsetting the vital metabolic process such as photosynthesis. It was therefore, thought essential to study the effect of these nutrients on the virus activity in relation to the high growth and its nutrient composition. The present investigation, on the effect of different levels of nitrogen nutrition on virus activity presented here have shown that the growth of inoculated as well as uninoculated plants increased upto 420 ppm while the increase in nitrogen level upto 630 ppm did not effect the high growth during the first interval but with the advance in age though response was observed but it was of no

Table 2 : Effect of different levels of nitrogen, phosphorus and potassium on the height (cm), fresh weight (g) and dry weight (g) of inoculated and uninoculated tomato plants for bunchy top disease at 35 days

Nitrogen in	Height (cm)			Fresh weight (g)			Dry weight (g)		
ppm	Inoculated	Uninoculated	Average	Inoculated	Uninoculated	Average	Inoculated	Uninoculated	Average
21	20.84	20.94	20.58	2.38	2.43	2.40	0.300	0.321	0.310
210	24.57	25.44	25.00	3.32	3.56	3.44	0.346	0.376	0.361
420	27.80	31.04	29.42	2.62	3.91	3.26	0.401	0.423	0.412
630	29.87	32.60	31.24	3.70	4.08	3.89	0.430	0.455	0.442
2100	26.34	27.90	27.02	3.44	3.74	3.59	0.390	0.398	0.395
C.D. (P=0.05)									
Inoculated v/s unioculated			0.819		0.058			0.009	
Potassium levels			1.623		0.119			0.018	
10	25.00	25.00	25.00	2.43	2.48	2.45	0.304	0.316	0.310
93	30.97	31.74	31.35	3.20	3.24	3.22	0.398	0.388	0.393
237	31.40	33.37	32.38	3.29	3.35	3.32	0.413	0.420	0.416
447	30.54	31.84	31.19	3.19	3.24	3.21	0.402	0.408	0.405
C.D. (P=0.05)									
Inoculated v/s unioculated			0.939		0.076			0.011	
Potassium levels			1.626		0.131			0.019	
78	24.17	24.97	24.57	2.76	2.93	2.84	0.314	0.331	0.322
430	28.23	28.90	28.56	3.21	3.25	3.23	0.337	0.368	0.352
704	31.80	32.70	32.25	3.49	3.66	3.57	0.404	0.406	0.405
1408	30.67	30.40	30.53	3.47	3.52	3.49	0.390	0.404	0.397
C.D. (P=0.05)									
Inoculated v/s unioculated			1.064		0.065			0.011	
Potassium levels			1.655		0.103			0.018	

significant. Lower and higher levels of nitrogen affected the plant growth adversely (Table 2).

Inoculation with the virus reduced the growth of the plants at 420 and 630 ppm when compared with the healthy ones indicating that the infection had more pronounced effect only when the growth was at maximum as judged by highest fresh weight and dry matter weight (Cole *et al.*, 1968) and Mackenzie *et al.* (1970) reported that maize dwarf mosaic virus reduced the fresh weight and dry matter weight of corn plant. Pring and Timian (1969) reported a severe loss in fresh and dry matter weight in barley infected with stripe virus. Similar observations were made by Tu and Ford (1968) with maize dwarf mosaic virus in maize who also observed that at low and high levels of nitrogen, the growth of the plant was arrested.

The nitrogen content of the plants increased with the increase in nitrogen supply though the virus concentration reached maximum at 420 ppm level. Nitrogen content of the plants increased upto 630 ppm level, there after it decreased along with the virus concentration. Thus, the nitrogen content had not followed the growth curve as closely as virus concentration followed it. Tu and Ford (1968) observed similar trend with maize dwarf mosaic virus. Kendrick *et al.* (1953) while working with TMV, suggested that perhaps it was due to the available nitrogen that enhanced the nitrogen content of the plant whereas, Hills and McKinney (1942) while working with TMV in tobacco plants felt that the increase in nitrogen content might be due to water insoluble tissue protein.

Phosphorus like Nitrogen in an essential part of the virus protein and as such any variations in phosphorus would effect the virus activity in much the same manner as nitrogen. Increase in phosphorus upto a level of 237 ppm enhanced the growth to maximum while at 547 ppm level only negligible reduction in growth was noticed. Virus infection did not cause a greated reduction in growth and corresponded similarly to the result obtained for nitrogen nutrition.

The virus concentration was also maximum at 237 ppm indication that it followed the growth curve. However, it was interesting to note that phosphorus doses at higher levels did not affect the growth or virus concentration in any way concentration after virus was reduced at low phosphorus level where the growth was also depressed. Friend (1941), Ganguly *et al.* (1963), and Tu and Ford (1968) observed that high levels of phosphorus limited the TMV, potato virus X and Y and maize dwarf mosaic virus multiplication in tobacco, potato and maize respecively, On the contrary. Bawden and Kassanis (1950), Choe *et al.* (1952), Pound and Weathers (1953) and Wheathers and Pound (1954) while working with TMV, turnip mosaic and cucumber mosaic virus observed that the virus concentration increased with increase in phosphorus supply. Maximum being at excess levels of phosphorus where the growth was stunted.

Phosphorus content of the infected plant did not differ much from the healthy ones however it increased with increase in phosphorus level maximum being at 237 ppm, where growth and virus concentration were also maximum (Table 2). A similar observation was made by Tu and Ford (1968) with maize dwarf mosaic virus infected maize plants and by Bergman and Boyle (1962) with TMV infected tomato plants. Mackenzie *et al.* (1970) found an increase in phosphorus content of maize plants following inoculation by maize dwarf mosaic virus. Esau (1969) studied the relationship or TMV infection and phosphorus energetic metabolism and found a decrease in respiratory and oxydative phosphorylation parallel with the increase in enzyme activation. It was further observed in the present studies that the phosphorus content of the plant gradually decreased with the age of the plants.

Potassium is known to effect virus concentration indirectly. Maximum growth of the plants and maximum virus concentration were noticed at 764 ppm level. Virus infection did not cause any significant reduction in growth of the plants as also observed with nitrogen and phosphorus nutrition. The virus concentration was however, decreased at low and high levels of potassium where growth was not optimum, Wheathers and Pound (1952 and 1954), Pound and Wheather (1953), Tu and Ford (1968) while working with turnip mosaic virus, TMV and maize dwarf mosaic virus representative reported that different levels of potassium had no marked effect either on host growth or on virus concentration. Whereas Cheo *et al.* (1952) and Ganguly *et al.* (1963) observed that cucumber mosaic virus and potatoes virus X and Y concentration in squash and potato plants appeared to be directly correlated to high growth. Protsenko and Smirnova (1959) found that TMV concentration increased with the increase in potassium supply. While Bawden and Kassanis (1950) suggested that increase in potassium content might decrease the virus concentration irrespective of the effect on host growth.

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