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Study on Host Range, Mode Transmission of Tomato Mosaic Virus in three Districts of Uttar Pradesh

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Abstract: The present study was carried out the study on host range and mode transmission of Tomato Mosaic Virus (ToMV) in three Districts of Uttar Pradesh. Experiment was conducted *in vitro* to see the different host range, mode of transmission with different vector. The virus was found to be inactivated between temperatures higher the dilutions and the longevity *in vitro* (LIV) was found 24 hours at room temperature. Virus like symptoms were found on Tomato plants in all three districts surveyed. Two major categories of symptoms were encountered in surveyed Tomato fields i.e., leaf curl and mottling or mosaic. Secondly, various plants were tested to understand the host range of virus. Thirdly, leaf samples were taken from suspected virus-infected Tomato plants then these were analyzed to get unequivocal identification of viruses that occur in Tomato plants in areas surveyed. A number of bioassays, such as indicator plant inoculation and mechanical transmission as well as grafting were conducted to conform that leaf curl, mosaic and mottling symptoms were indeed due to virus infection.

Keywords: Tomato Mosaic Virus, leaf curl, Diseases. Symptoms, Transmission

INTRODUCTION

Plant Viruses are a major cause of loss in many Indian vegetable crops. Often the intricate relationships between the virus, host plants and the vector, or carrier, create problems in developing effective management systems. Plant viruses cannot generally be controlled prior to infection. This makes prevention the most important strategy for reducing virus damage. Risk of infection can be greatly reduced if a few important cultural for seed-transmitted viruses it is important to obtain clean seed. About 146 viruses infect tomato worldwide[1.] They are grouped into 33 genera, but 15 genera are of the most economic importance, i.e. *Alfalfamovirus, Begomovirus, Carlavirus, Crinivirus, Cucumovirus, Ilarvirus, Luteovirus, Nepovirus, Potexvirus, Potyvirus, Tobamovirus, Tombusvirus, Topocuvirus, Tospovirus, and Tymovirus*. As stated before, these fifteen genera belong to families *Bromoviridae, Bunyaviridae, Closteroviridae, Flexiviridae, Geminiviridae, Luteoviridae and Potyviridae*[2].

Tomato (*Lycopersicon esculantum*) is economically important and one of the most common vegetable crop in India. It is supposed to be native of Latin America and has become one of the most widely grown vegetables with ability to survive in diverse environmental conditions[3].According to FAO reports, tomato is now the most important vegetable in the tropics[4]. It is annually planted on almost 4 million ha worldwideImportant economic losses to Tomato producers in India are mostly due to poor agronomic practices, lack of improved varieties and also due to harmful pests and diseases[5]. Viral diseases have been ranked as the third most important constraint among Tomato diseases basically because of absence of enough information on them. Under field situations, the most obvious viral symptoms are mottling, mosaic and leaf distortions[1]. On the other hand host range studies play important role in indexing the plants for various purposes viz., viral diagnosis, virus infectivity (by culture or maintenance) and propagation of the viral species. Determination of physical properties has been considered essential for the characterization of virus particles. It is known that vectors spread viruses from one infected host to another especially due to their transient feeding behaviors, as well as vector host range and preference and life history.

The tomato crop is highly susceptible to viruses, including specially for the Tomato mosaic virus (ToMV). Tomato mosaic virus (ToMV) is economically damaging in glasshouse and outdoor tomato crops in many countries. The virus is readily spread by handling and cultural operations. It also contaminates seeds and soil, but no natural vector is known. It is readily sap-transmissible to a fairly wide range of herbaceous plant species. The virus is widespread and often epidemic in tomato crops. Disease symptoms are greatly influenced by temperature, day length, and light intensity, age of plant, virus strain and cultivar of tomato. Many Solanaceous species are susceptible to the virus. Most suspects produce necrotic local lesions, sometimes followed by systemic mosaic-mottling and necrosis. Most species tested in the family's Aizoaceae, Amaranthaceae, Chenopodiaceae and Scrophulariaceae are also susceptible. The present study was carried out study on host range and mode transmission of Tomato Mosaic Virus (ToMV) in three Districts of Uttar Pradesh.

MATERIALS AND METHODS

Field Survey During the mature stage of Tomato crop, a survey was conducted to cover major tomato growing districts in Uttar Pradesh , i.e., Agra, Aligarh and Firozabad,

1. Preparation of inoculums and isolation of the virus: The isolate used in this study was isolated from systemically infected Tomato (*Lycopersicon esculentum*) plants growing under surveyed fields of Agra, Aligarh and Firozabad districts of Uttar Pradesh and showing severe mosaic and malformation. The twocylindrical was prepared by grinding young infected leaves in 0.1 M Phosphate buffer (pH 7.0) with mortar and pestle. The homogenate was expressed through cheesecloth and the obtained crud sap was used for mechanical inoculation of 600 mesh carborundum dusted leaves of *Chenopodium amaranticolor* as diagnostic host plant under an insect proof green house at 28^0C. Local lesions were observed after 10 days of incubation period. Single local lesions were cut out and macerated with few drops of buffer on a glass slide and inoculated onto the diagnostic host as described. Finally, extracts from the well developed local lesions were used to inoculate Tomato plants. Plants showing mosaic symptoms were kept in the green house as a source of virus in inoculums throughout this study.

2. **Host Range**: To study the host range of this virus isolate different species and cultivars belonging to 26 different families, i.e., *Amaramthaceae, Apocynaceae, Chenopodiaceae, Compositae, Convolvulaceae, Cruciferae, Cucurbitaceae, Euphorbiaceae,Graminae, Labiate, Leguminosae, Liliaceae, Malvaceae, Nyctaginaceae, Oleaceae, Papaveraceae, Polygonaceae, Solanaceae, Umbelliferae, Urticaceae, Zyjophyllaceae* were tasted. Ten plants of each tested plants species were mechanically inoculated and observed for a long period (3-4 Weeks) under an insect prove green house. All the inoculated plants with or without visible symptoms were tested by back inoculations on indicator and essay host to ascertain the presence or absence of the virus and to avoid possibilities for anyone to act as symptom less carrier of the virus. The plants that failed to give any evidence of viral multiplication were considered to be immune.

3. **Mode of Transmission**: (a) **Mechanical Transmission**: The mechanical transmission of this virus isolate were assayed by sap inoculation using 0.1 M phosphate buffer (pH 7.0) as extraction buffer and carborundum as an avrasive, on some host plants (25 plants of each tasted species) such as : *Chenopodium amaranticolor, Chenopodium murale, Datura alba, Nicotiana tabacum, Nicotiana glutinosa* and *Solanum melongina*.

(b) **Graft Transmission**: Grafting is an artificial type of transmission, in which part of one plant grows on the rooted part of another. Two methods i.e., cleft graft and natural graft of dodder graft was employed in the present study for the transmission of virus, following the methods[6].

(c)**Insect Transmission**: To study insect transmission the insect were collected from the fields of Tomato (*Lycopersicon esculentum*) of studied areas during different periods of the day (Morning, Noon, Evening and the night hours). The insects were identified and cultured in insect cages on healthy test plants. The insects were transferred directly from the source of virus i.e., diseased plants to healthy plants in one set and in another set a preliminary period of fasting was given to these insects before transferring them. During fasting period they were placed in clean patriplates and covered with cellophane. Insects used for transmission were of the same generation and age. Care was also taken so that insects of one species do not contaminate the other.

(d) **Seed Transmission**: Seeds were collected from virus infected plants and were stored in glass stopper bottles at 28 ^{o}C till the next season, when they were sown in 6" earthen pots (4 seeds/pot) having sterilized soil. Pots were observed in glass house for observation. Seedlings were observed for one month to detect the development of external symptoms and percentage of seed transmission was recorded. This study was repeated three times.

RESULTS AND DISCUSSION

Screening of Tomato Varieties against Tomato Mosaic Virus

Infectivity of the viruses under investigation declined with increase in the age of the plants. Young Tomato plants of 15 days old were observed most susceptible to virus infection with incubation periods of 11, 12 and 13 days respectively. 50 days old plans did not showed any infection.Screening of Virus-like Symptoms observed in the field were mosaic, mottling, and curl. Others were not easy to describe as they showed an overlap of different symptoms. Leaf curl virus disease-like symptoms were most prevalent with an especially in Agra, Aligarh and Firozabad .These results are in agreement with several workers[7,3]

Host range of tomato mosaic virus

The host range studies of mosaic causing virus of Tomato. 35 varieties along with 98 plant species belonging to the 26 different families were tested. However, all the varieties of the Tomato were found to be susceptible for the virus (Table 1), while the virus was found infected to 7 plant species viz., *Capsicum annuum*, *Datura alba*, *Nicotiana tabacum*, *N. glutinoda*, *Chenopodium amuranticolor* and *C. murale* (Table 1).Host range of a virus in general is considered a fixed and relatively stable character for a particular virus[8].

Table 1: Various plants tested for the host range of the Tomato Mosaic Viruses

S.No.	Family	Plant species tested	Results	Recovery of indicator host
1	Acanthaceae	1. *Ruellia petula* Jacq.	N	-
		2. *Justica adhatoda* L.	N	-
2	Amaranthaceae	3. *Achyranthus aspera* L.	N	-
		4. *Amaranthus spinosus* L.	N	-
		5. *Amaranthus caudatus* L.	N	-
		6. *A. paniculatus* L.	N	-
3	Apocynaceae	7. *Vinca rosea* L.	N	-
		8. *Nerium indicum*	N	-
4	Asclepiadaceae	9. *Calotropis procera* R.Br.	N	-
5	Boraginaceae	10. *Haliotropium indicum* L.	N	-
6	Capparidaceae	11. *Cliome viscera* L.	N	-
		12. *Cynandropsis pentaphylla* Dc.	N	-
7	Caryophyllaceae	13. *Dianthus caryophyllus* L.	N	-
		14. *Stellaria media* L.	N	-
8	Chenopodiaceae	15. *Chenopodium album* L.	N	-
		16. *C. Amaranticolor* Costte & Reyn	S	+
		17. *C. Murale* L.	S	+
		18. *C. Quinoa* wild	N	-
		19. *C. Hybridium* L.	N	-
		20. *Beta vulgaris* L.	N	-
		21. *Spinacea oleracia* L.	N	-
9	Compositae	22. *Agerantum conyzoides* L.	N	-
		23. *Calendula officinalis* L.	N	-

		24. *Eclipta erecta* L.	N	-
		25. *Helianthus annus* L.	N	-
		26. *Lactuca sativa* L.	N	-
		27. *Launea nudicaulis* B.K.F.	N	-
		28. *Pluchea Lanceolata* clark.	N	-
		29. *Tagetes erecta* L.	N	-
		30. *Xanthium strumarium* L.	N	-
		31. *Zinea elegans* jacq.	N	-
10	Convolvulaceae	32. *Convolvulus arvensis* L.	N	-
		33. *Ipomoea palmate* L.	N	-
		34. *Ipomoea pesteridis* L.	N	-
11	Cruciferae	35. *Bassica comprestris* L.	N	-
		36. *B. oleracea* L.	N	-
		37. *B. nigra* L.	N	-
		38. *B. rapa* L.	N	-
		39. *Raphanus sativum* L.	N	-
		40. *Nausturtium indicum* L.	N	-
12	Cucurbitaceae	41. *Cucurbita maxima* Duchesne.	N	-
		42. *C. pepo* L.	N	-
		43. *Cucumis sativus* L.	N	-
		44. *Citrulluss vulgaris* chard.	N	-
		45. *Luffa cylindrica*	N	-
		46. *Momordica charantia* L.	N	-
13	Euphorbiaceae	47. *Acalypha indica* L.	N	-
		48. *Euphorbia hirta* L.	N	-
		49. *Phyllanthus niruli* L.	N	-
		50. *Euphorbia pulcherrima* L.	N	-
		51. *Ricinus cummunis* L.	N	-
		52. *Croton oblongifolius* Roxb.	N	-
14	Graminae	53.*Andropogon sorghum*	N	-
		54. *Pennisetum typhoids* R.	N	-
		55. *Zea mays* L.	N	-
		56.*Triticum vulgure*	N	-
15	Labiatae	57. *Ocimum sanctum* L.	N	-
16	Leguminoceae	58. *Cajanus cajan* DC.	N	-
		59. *Crotalaria juncea* L.	N	-
		60. *Dolichos lablab* L.	N	-
		61. *Glycine* max.	N	-
		62. *Lathyrus sativus* L.	N	-
		63. *Phaseolus acontifolius* Jacq.	N	-
		64. *P. angularis* (W) Grey.	N	-
		65. *P. aureus* (L) Roxb.	N	-
		66. *P. mungo* L.	N	-
		67. *P. vulgaris* L.	N	-
		68. *P. trilobus*	N	-
		69. *Pisum sativum* L.	N	-
		70. *Sesbania aegypptiaca* Pers.	N	-
		71. *Vicia* faba	N	-

17	Liliaceae	72. *Allium cepa* L.	N	-
18	Malvaceae	73. *H. rosa-sinensis* L.	N	-
		74. *Abelmoschus esculentus* L.	N	-
19	Nyctaginaceae	75. *Boerhavia diffusa* L.	N	-
20	Oleaceae	76. *Jasmanium sambac* L.	N	-
21	Papaveraceae	77. *Argimone Mexicana* L.	N	-
		78. *Papaver somniferum* L.	N	-
22	Polygonaceae	79.*Polygonum plebejium* R.Br.	N	-
23	Solanaceae	80. *Capsicum annuum* L.	S	+
		81. *Datura alba* Nees.	S	+
		82. *D. stramonium* L.	S	+
		83. *Lycopersicon esculentum*	S	+
		84. *Nicotiana tabacum* L.	S	+
		85. *N. rustica*	N	-
		86. *N. glutinosa* L.	S	+
		87. *N. solanifera*	S	+
		88. *Physalis minima L.*	N	-
		89. *Solanum nigrum* L.	S	+
		90. *S. melongena* L.	N	-
		91. *S. melongena* L.	S	+
		92. *S. tuberosum* L.	N	-
		93. *S. xanthocarpum* L.	N	-
		94. *Withamia somnifera* DC.	N	-
24	Umbelliferae	95. *Coriandrum sativum* L.	N	-
		96. *Doccus carota* L.	N	-
25	Urticaceae	97. *Cannabis sativa* L.	N	-
26	Zygophyllaceae	98. *Tribulus terrestris* L.	N	-

S = Systematic Symptoms N= recovery attempt but it was unsuccessful

+ = virus recovered caused characteristic symptoms on tomato - = Symptoms did not appeared

Transmissionof Tomato Mosaic Virus

The present study conducted on the transmission, revealed that the viruses under study could easily be transmitted by Mechanical Transmission, Graft Transmission, Insect Transmission and Seed Transmission. The mode of mechanical inoculation, cleft graft and insect transmission has been done through crude sap alone gave successful results but the percentage of infection observed were very low (35-48%) (Table 2).

Table 2: Transmission of the virus on the test plant (*Lycopersicon esculantum*) through crude sap at 25 ^{o}C (± 2^{o}C).

S. No.	Number of plants		% Transmission	Incubation period (days)
	Inoculated	Infected		
1.	30	14	48	12-14
2.	30	12	40	13-16
3.	30	13	44	14-16
4.	30	14	46	11-13
5.	30	11	35	16-18

Transmission of viruses from plant to plant by insects is of considerable interest. Transmission by vectors is a complex phenomenon involving virus, the vector, the host plant and environmental conditions. *Bemisia tabaci* (Genn.)was found to be the vector of the virus causing mosaic of tomato (Table: 3). An increase in acquisition time followed by an increase in test feed time has increased the number of plants infected. An acquisition feed of 30 minutes even after a test feed of 20 minutes gave only 25% infection while an acquisition feed of 90 minutes gave 95% infection (Table 4).Attempts on seed transmission of the viruses were not successful in case of mottle virus of Carnation[9] .

Table 3: Preliminary screening of possible vector.

S. No.	Insect species tested	Acquisition feed	fasting	Test feed in hrs.			
				1	6	12	24
1.	*Aphis craccevora* (Koch.)	12 hrs	1 hrs	-	-	-	-
2.	*Aphis gossypii* (Glove)	12 hrs	1 hrs	-	-	-	-
3.	*Cicadula indica* (Pruthi)	12 hrs	1 hrs	-	-	-	-
4.	*Bemisia tabaci* (Genn.)	12 hrs	1 hrs	+	+	+	+
5.	*Myzus persicae* (Sulz)	12 hrs	1 hrs	-	-	-	-

Table 4: Effect of different acquisition and test feeds on the transmission of the virus by *Bemisia tabaci* (Genn).

S. No.	Acquisition	Test Feed							
		10 min	20 min	30 min	40 min	50 min	60 min	70 min	80 min
1.	10 min	-	-	-	-	-	-	-	-
2.	20 min	-	3	4	5	6	7	8	9
3.	30 min	1	5	7	12	17	17	18	18
4.	40 min	3	9	12	15	19	20	20	20
5.	50 min	4	12	17	18	19	20	20	20
6.	60 min	4	13	16	18	10	20	20	20
7.	70 min	3	14	17	18	19	20	20	20
8.	80 min	4	12	18	19	19	20	20	20
9.	90 min	8	19	20	18	20	20	20	20

The mechanical transmission of tomato Mosaic virus isolate were assayed by sap inoculation using 0.1 M phosphate buffer (pH 7.0).It is known fact that to improve the infectivity of the virus, use of phosphate buffer has been generally recommended[10.11]. Present study also showed that showed that addition of abrasive material like carborundom powder (600 Mesh) was greatly increased the efficiency of mechanical inoculation. It was observed that phosphate buffer when used with crude sap, led to significant increase in the infectivity of the virus. The similar observations also done[12].

In addition to sap transmission, thetomato mosaic viruses were readily transmitted by cleft graft, however it gave better results in terms of higher magnitude of transmission and lesser incubation period. Similar conclusions have been drawn by Singh (1970) with pea mosaic virus[9]. *Cuscuta* species used for natural graft could not transmit any of the three viruses understudy, however, the similar finding was also reported[13].

The transmission of viruses has the several ways but the best way but the most of insects travel plant to plants for searching food. Virus transmission by insects is a common way for viruses to travel between different host plants and this is possibly as a result of a protein that plant viruses attach to as they hitch an insect ride between plants.The present author also reported that several insects also transmitted this tomato viruse by *Aphis craccevora*(Koch.) *Aphis gossypii*(Glove) *Cicadula indica* (Pruthi)*Bemisia tabaci*(Genn.) and *Myzus persicae*(Sulz). Similar observations have also reported by several author time to time e,g; *Cauliflower mosaicvirus* (CaMV)aphidtransmission[14], *Maizechloroticdwarfvirus* (MCDV) and *Maizestreakvirus* (MSV) *Cicadulinambila* and *Cicadulina storeyi* transmission in maize[15].

The degree of susceptibility of the host is also an important factor in virus transmission. It depends upon metabolic activities going on the host during different hours of the day. Several workers have studies the effect of diurnal variations on the susceptibility of the host to viral infection [16].

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