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Original article

Host range and transmission of Tobacco streak virus (TSV) causing cotton mosaic disease

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ABSTRACT

Tobacco streak virus (TSV) causing cotton mosaic disease was found to be transmissible by mechanical means specially when extracts were made in neutral phosphate buffer 0.02M containing reducing agent like 2-Mercaptoethanol.The disease was found to be transmitted by Thrips palmi (cotton thrips) and Thrips tobacci (onion thrips). TSV was detected in sample showing mosaic symptoms. TSV was readily grafted transmissible but not transmissible by mechanical means, no evidence of its transmission through seed or by thrips was obtained. About 19 plant species belonging to five different families viz.malvaceae, chenopodiaceae, compositeae, leguminoceae and solanaceae were tested for host range and virus isolate causing cotton mosaic disease.

1. Introduction

Cotton is one of the most important fibre crops playing a key role in economic and social status of the world. Cotton locally known as “white gold” is also a king of cash crops. Cotton belongs to genus Gossypium of the family Malvaceae and has several different species but Cotton varieties grown in India belongs to four distinct species viz. G. arborium, G. herbaceum, G. hirsutum and G. barbadence. It is said to have two centers of origin viz.old world

India Indo-China or tropical Africa and new world Mexico or Central America. G. arborium and G. herbacium belongs to old world are known as deshi cotton, where as G. hirsutum and G. barbadense are new world cotton. G. arborium is indigenous to India while G. herbacium seems to have been introduced from Central Asia, and G. hirsutum constitutes the American uplands or Compodia cottons.

In India cotton is grown in almost all the states of the India but Maharashtra, Gujarat, Andra-pradesh, Madya-pradesh, Punjab, Rajasthan, Tamilnadu and Karnataka accounts for more than ninety per cent of the area and out put. In India cotton occupies on area of nearly 9.5 million hector with production of 31 million bales, which is 16 per cent of global production. India contributes about 29.9 per cent of total Indian agricultural gross domestic product ranking third in the world after USA and China. The lint productivity of cotton is 599kg lint/ha which is lowest and is below that of the world average of 627kg/ha (Anonymous, 2008).

While over twenty virus diseases of cotton have been described in the American phytopathological society is "cotton disease compendium" only a few have actually been shown to be of virus etiology. The main ones so proven, include several Gemini viruses (Brown and Nelson 1984 Mansor et al.; 1993 and Nadeem et al.; 1997) and Tobacco streak virus (Cauquil and Folin ,1983.;Ahmed and Nelson, 1997) viral diseases of cotton have historically been of only sporadic importance to global cotton production. Recent devastating epidemics in Pakistan and other areas of India like Andhra Pradesh. It has brought new awareness in to the potential disaster of pathogen once considered to be of minor importance. Under changing condition Tobacco streak virus has emerged as serious problem in Pakistan (Ahmed and Nelson, 1997).

2. Materials and methods

In this experiment, transmission tests with thrips, typical venial necrosis symptoms were observed on cowpea plants 3 days after the release of Frankliniella schultzei, Scirthothrips dorsalis and Megalurothrips usitatus on to leaves dusted with pollen from infected sunflower, marigold and parthenium plants. F Schultzei was more efficient than other 2 species in disease transmission. The thrips on infected leaves alone did not transmit the virus. The disease transmission under natural conditions seems to occur through wounding of leaf tissue as well as infected pollen and their proximity during thrips feeding, rather than a specific virus-vector interaction (Stoodee and Teakle 1987).

2.1. Mechanical transmission

For mechanical transmission inoculum was prepared by grinding young infected leaves of maintenance host showing symptoms in a chilled 0.05M potassium phosphate buffer, pH 7.0 containing 0.02M 2- mercaptoethanol by grinding the young unfolded leaves of cotton with a chilled mortar and pestle. The plants were inoculated by conventional leaf rub method using a cotton swab. Carborundum powder (800 mesh) was used as an abrasive. Immediately after inoculation leaves of the test plants were washed with the water sprays. Test plants used for mechanical inoculation were raised from healthy seeds in earthen pots containing steam sterilized soil and compost and maintained in an insect proof glass house for recording observations of symptom development, inoculation period and transmission rate.

2.2. Thrips transmission

Thrips species viz., Thrips palmi (cotton thrips) and Thrips tobacci (onion thrips) were used for transmission. Thrips from field infected cotton plants having cotton mosaic were collected early in the morning. Thrips were separated in the laboratory. Fifteen to twenty thrips of the species were released on cotton seedling at three to four quadrifoliate leaf stages. After completion of 12 days of inoculation feeding all the thrips were killed by spraying 0.025 per cent metasystox. Plants were observed for development of symptoms upto two months.

2.3. Seed transmission

Seed transmission studies were conducted with seeds (viz.MRC-6301Bt) collected from naturally infected cotton plants exhibiting cotton mosaic disease. For this test 400 seeds were sown in two lots in earthen pots containing steam sterilized soil, compost and sand (2:1:1) mixture. The pots were then maintained in an insect free glasshouse. Seedling emergence and infectivity were recorded.

Host range

For host range studies, the plant species belonging to different families comprised of cultivated crops, weeds and ornamentals were used. Healthy seeds of these hosts in earthen pots containing the mixture of steam sterilized soil, sand and compost in 2:2:1 ratio (v/v) were sown and maintained in an insect proof glass house. Five plants of each species were inoculated at three to four quadrifoliate stage with sap extracted from young cotton leaves infected with cotton mosaic disease by conventional rub method. The inoculated plants were observed upto 8 weeks for production of symptoms.

The plants that did not show any symptom even after 8 weeks were back indexed on assay host cowpea cv. Pusa Komal for recovery of virus or detection of latent infection if any. The following plant species were used as test hosts for the viruses causing cotton mosaic disease in cotton.

3. Results and discussion

3.1. Mechanical transmission

The results (Table 1) of sap inoculation indicated that the virus causing cotton mosaic disease of cotton is readily transmissible mechanically using chilled buffer, pH 7.0, containing 0.02 M 2-mercaptoethanol as reducing agent from cotton cultivar to cotton. The results decpicted in Table 1 indicate that the virus causing cotton mosaic disease was readily sap transmissible. Success in transmission was obtained if chilled condition was maintained and leaves of mosaic or chlorotic symptoms were used for inoculation. Results (Table 2) showed that virus showed higher percentage of transmission, if chilled condition was maintained and young mosaic and chlorosis symptoms leaves were used for inoculation. The virus showed high rate of transmission on host plants belonging to leguminaceae and solanaceae families.

3.2. Thrips transmission

Data (Table 3) showed that Thrips spp. Viz. Thrips palmi and Thrips tobacci could transmit the virus of this disease from cotton to cotton to the extent of 2-5 per cent.

3.3. Seed transmission

Results on seed transmission indicated that the virus is not transmissible through seed. The virus causing cotton mosaic disease was found to be transmissible by mechanical means specially when extracts were made in neutral phosphate buffer 0.02M containing reducing agent like 2-Mercaptoethanol.The disease was found to be transmitted by Thrips palmi (cotton thrips) and Thrips tobacci (onion thrips). TSV was detected in sample showing mosaic symptoms.TSV was readily grafted transmissible but not transmissible by mechanical means, no evidence of its transmission through seed or by thrips was obtained (Ahmed and Butt, 2003). Seed transmission is not at all reported in present investigation. In the present investigation physical properties of the virus causing cotton mosaic disease are found to be mostly identical to the physical properties of the virus TSV causing stem necrosis in ground nut and sunflower necrosis disease (Ghanekar et al.; 1979 and Reddy et al.; 2002). About 19 plant species belonging to five different families viz.malvaceae, chenopodiaceae, compositeae, leguminoceae and solanaceae were tested for host range and virus isolate causing cotton mosaic disease. The symptoms produced by TSV in various crops are similar to various scientists on their respective crops on which they have worked.

3.4. Experimental host range of TSV causing cotton mosaic disease

About 19 plants species belonging to 5 families viz. malvaceae, chenopodiaceae , compositae ,leguminaceae and solanaceae were tested for host range for virus isolate causing cotton mosaic disease. Virus isolate infected mostly all the plant species with few exception. The host range data is in agreement with several reports for TSV (Costa and Carvalho, 1961.; Salazar et al., 1982.; Kaiser et al., 1982). The detailed results of the host range reaction of cotton mosaic disease virus are described below.

4. Conclusion

The role of the flower inhabiting thrips in the transmission of TSV has been established. Seed transmission of TSV in Cotton and other crop plants as well as in weed hosts requires further investigation.Variuos proposed disease management practices could not be validated on-farm due to lack of natural disease pressure in

subsequent years. However, based on field observations and laboratory tests the development of tolerant or resistant varieties is having wide scope in the future. Seed treatments may be good controlling measure in case of seed transmitted crops. The naturally infected plants from field showing good symptoms were also difficult to identify in latere stages. Because they disappear with time. The virus was very easily sap transmissible. The virus was found to be transmitted by Thrips palmi and Thrips tobacci in persistent manner. No seed transmission was observed.

Table 1

Sap transmission of the virus causing cotton mosaic disease from cotton to cotton.

Sr. No.	Hosts	Transmission percent
1.	Ankur	20
2.	Brahma	16
3.	MRC-6301	22
4.	Tulsi	20

Table 2

Sap transmission of the virus causing cotton mosaic disease to different hosts.

Sr. No.	Hosts	Transmission percent
1.	*Chenopodiaceae*	
a.	*Chenopodium album*	60
b.	*Chenopodium amaranticolor*	55
2.	*Leguminaceae*	
a.	*Vigna unguilata*	75
b.	*Glycine max*	70
c.	*Archis hypogea*	65
d.	*Vigna radiate*	70
e.	*Pisum sativum*	75
f.	*Cajanus cajan*	70
g.	*Vigna mungo*	65
3.	*Solanaceae*	
a.	*Capsicum annum*	70
b.	*Lycoprsicon esculantum*	70
c.	*Nicotiana glutinosa*	65
d.	*Solanum melongenaL*	70
4.	*Compositeae*	
a.	*Helianthus annuus*	60
b.	*Carthamus tinctorius*	50

Table 3

Thrips transmission of virus causing cotton mosaic disease.

Sr. No.	Cotton cultivars	Transmission percent	
		T. palmi	T. tobacci
1.	MRC-6301	5.00	3.00
2.	Ankur	3.00	3.00
3.	Tulsi	3.00	2.00

Table 4

Reactions of virus causing Cotton mosaic on cowpea varieties

Sr. No.	Hosts	Symptoms		Incubation period(days)		Remarks
		Local	Systemic	Local	Systemic	
1	*Chenopodiaceae*					
	Chenopodium	CL	TN of stem and leaves	5-6	16-17	LH,SH
	amaranticolor	CL	TN of leaves	5-7	18-20	LH,SH
	Chenopodium album					
2	*Compositae*					
	Helianthus annuus	CL	TN of stem and leaves	5-7	18-20	LH,SH
	Carthamus tinctorious	NL	TN of leaves	4-6	17-20	LH,SH
3	*Leguminaceae*					
	Cajanus cajan	NL	TN of stem and leaves	4-5	17-19	LH,SH
	Arachis hypogea	NL	TN of leaves	4-6	14-16	LH,SH
	Glycine max	CL	TN of stem and leaves	4-7	18-19	LH,SH
	Vigna mungo	NL	TN of stem and leaves	4-8	13-15	LH,SH
	Vigna unguiculata	CL,NL	EL,Stn,TN of stem TN of stem	5-6	15-17	LH,SH
	Phaseolus vulgaris	NL,VN	and leaves	5-8	16-19	LH,SH
	Vigna radiata	NL	TN of stem and leaves	6-7	14-16	LH,SH
	Cicer arietinum	NL	TN of leaves	5-8	12-15	LH,SH
4	*Solanaceae*					
	Lycopersicon	NL	MO			LH,SH
	esculentum	VN	TN of leaves	4-6	15-17	LH,SH
	Capsicum annuum	CL	NL			LH,SH
	Solanum melangona	CL		4-7	17-19	LH,SH
	Nicotiana rustica		VN			
				7-8	17-19	
				8-10	14-16	

CLL -Chloritic local lesions NS -Necrotic spots on leaves VC -Veinal chlorosis
Del -Defoliation of leaves NLL-Necrotic local lesions FP -Flaccidity of petioles
DL -Drying of leaves

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