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EFFECT OF LIQUID ORGANIC PREPARATIONS AND BIOCONTROL AGENTS ON FUSARIUM WILT MANAGEMENT IN COLOURED TOMATOES

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ABSTRACT

An experiment was conducted to evaluate the effect of liquid organic formulations and biocontrol agents on Fusarium wilt resistance in coloured tomato varieties. The study was carried out at the University Research Farm, Sri Konda Laxman Telangana Horticultural University (SKLTGHU), Mulugu, during the Rabi season of 2023–24 and 2024–25. The experiment was laid out in a Factorial Completely Randomized Design (FCRD) with two factors and two replications. Factor I consisted of three tomato varieties, namely MHTO100 (V_1), MHTO101 (V_2), and Arka Vikas (V_3), while Factor II comprised 13 plant protection treatments. The results indicated significant variation among the varieties and plant protection treatments with respect to disease incidence and disease control. Among the varieties, the highest PDI (40.42 % and 39.20 %) was recorded in V_3, whereas the lowest PDI (33.78 % and 33.42 %) was observed in V_2. Among the plant protection treatments, the untreated control P_{13} recorded the highest PDI (60.57 % and 56.26 %), followed by cow urine @ 5% applied at 7 day intervals P_3 with a PDI of (48.89 % and 48.69 %). The highest PEDC among the varieties was recorded in V_3 (40.94 % and 39.09 %). Among the plant protection treatments, P_{12} recorded the highest PEDC (76.48 % and 75.12%), followed by P_{10} (53.41 % and 47.65 %). The untreated control P_{13} exhibited the highest disease incidence and the lowest efficacy of disease control among all treatments.

***Key words*:** Coloured tomatoes, Fusarium wilt, Liquid organics, Biocontrol agents, Percent disease index (PDI) and Percent efficacy disease control (PEDC).

Introduction

Tomato (*Solanum lycopersicum* L.) a member of the family Solanaceae, is one of the most widely cultivated vegetable crops in the world and an important component of human nutrition. Originating in the Andean region of South America and later domesticated in Mexico, tomato is now grown extensively under diverse agroclimatic conditions, including India, one of the world's leading tomato producing countries. The crop is highly valued for its rich nutritional composition, including vitamins A and C, lycopene, β-carotene, minerals and other antioxidant compounds.

Among the major constraints affecting tomato production, Fusarium wilt caused by *Fusarium oxysporum* f. sp. *lycopersici* is one of the most destructive soil borne fungal diseases (Prihatna *et al.*, 2018). The pathogen persists in soil for many years through chlamydospores and infects plants through the root system, colonizing the vascular tissues and disrupting water and nutrient transport. Infected plants exhibit yellowing of lower leaves, vascular browning, wilting, stunted growth, poor fruit development and eventually plant death (Sally *et al.*, 2006; Asha *et al.*, 2011). Under favourable environmental conditions, Fusarium wilt can result in severe yield losses of 60–70% and in extreme cases, complete crop failure (Ravindra *et al.*, 2015).

Although chemical fungicides have been widely used to manage Fusarium wilt, their continuous use has raised concerns about environmental contamination, pathogen resistance, and adverse effects on beneficial soil microorganisms. Ecofriendly alternatives such as biocontrol agents (*Trichoderma viride*, *Trichoderma harzianum* and *Pseudomonas fluorescens*) and liquid organic formulations like Panchagavya and cow urine have shown potential in suppressing the pathogen while improving soil microbial activity and plant health (O'Brien, 2017). Therefore, the present investigation was undertaken to evaluate the effectiveness of liquid organics and biocontrol agents as sustainable management modules for controlling Fusarium wilt in tomato.

Materials and Methods

The experiment was conducted at the University Research Farm, Mulugu, using a Factorial Completely Randomized Design (FCRD) with two replications. Factor I comprised three coloured tomatoes, namely MHTO100 (V_1), MHTO101 (V_2) and Arka Vikas (V_3). Factor II consisted of 13 plant protection treatments: P_1 – Panchagavya @ 3 % applied at 7 day intervals; P_2 – Panchagavya @ 5 % applied at 7 day intervals; P_3 – Cow urine @ 5 % applied at 7 day intervals; P_4 – Cow urine @ 10 % applied at 7 day intervals; P_5 – *Trichoderma viride* seed treatment @ 10 g/kg seed + Cow urine @ 5 % applied at 7 day intervals; P_6 – *Trichoderma harzianum* seed treatment @ 10 g/kg seed + Cow urine @ 5 % applied at 7 day intervals; P_7 – *Pseudomonas fluorescens* seed treatment @ 10 g/kg seed + Cow urine @ 5 % applied at 7 day intervals; P_8 – Panchagavya @ 5 % + Cow urine @ 5 % applied at 10 day intervals; P_9 – *Trichoderma viride* seed treatment @ 10 g/kg seed + Panchagavya @ 5 % + Cow urine @ 5 % applied at 10 day intervals; P_{10} – *Trichoderma harzianum* seed treatment @ 10 g/kg seed + Panchagavya @ 5 % + Cow urine @ 5 % applied at 10 day intervals; P_{11} – *Pseudomonas fluorescens* seed treatment @ 10 g/kg seed + Panchagavya @ 5 % + Cow urine @ 5 % applied at 10 day intervals; P_{12} – Chemical control comprising seed treatment with Carbendazim 50 % WP @ 3 g kg^{-1} seed followed by soil drenching with Carbendazim @ 2 g L^{-1} after inoculation in the main field and P_{13} – Untreated control. The study was undertaken to identify Fusarium wilt resistant tomato varieties and to evaluate the effectiveness of different ecofriendly disease management practices against Fusarium wilt.

Isolation of the pathogen

The wilt causing fungus was isolated using the standard tissue isolation method under aseptic conditions during November 2023 in plant pathology laboratory at Forest College and Research Institute, Mulugu, Siddipet District, Telangana. Infected stems of tomato plants were longitudinally split open with a sterilized scalpel. Plant parts exhibiting brown discoloration of vascular tissues were then cut into small pieces and thoroughly washed in running tap water. These pieces were surface sterilized with a 0.1 per cent sodium hypochlorite solution for fifteen seconds and subsequently rinsed in sterile distilled water to remove any traces of the sterilizing agent. The sterilized pieces were then carefully transferred onto Petri dishes (100 mm × 15 mm) containing sterile Potato Dextrose Agar (PDA) media. The inoculated plates were incubated at 28 ± 1°C for 5-7 days in darkness.

Identification of the pathogen

The colonies of various fungi growing on Potato Dextrose Agar (PDA) medium were differentiated based on several characteristics, including colony colour, growth and colour of mycelium and the presence of sclerotia. Further identification was carried out using a compound microscope. Slides of fungi with dark coloured colonies were prepared in lactophenol. The pathogen was identified based on both morphological characteristics, such as the shape, size and colour of microconidia and macroconidia and cultural characteristics, such as the colony colour of the isolated cultures on PDA.

Mass Multiplication of Fusarium in Sorghum Grain Media

Pathogen inoculum was developed using an appropriate fungal substrate such as sorghum meal media. 50 g of sorghum grains were soaked in sterile distilled water in a 150 ml conical flask for 4h and then autoclave it at 121°C and 15 psi for 15 min. The autoclaved grains were inoculated with Fusarium fungus and incubated at 28°C for 7 days. The flasks were shook every alternate day for uniform growth and development of fungi on the grains.

Table 1: Effect of liquid organic formulations and biocontrol agents on Fusarium wilt resistance, percent disease index (PDI) in different coloured tomato varieties.

Varieties /Plant Protection measures	Percent Disease Index							
	2023-24				2024-25			
	V_1	V_2	V_3	Mean	V_1	V_2	V_4	Mean
P_1- Panchagavya @ 3% (7 days interval)	39.94	37.53	47.66	41.71	39.71	37.62	47.50	41.61
P_2- Panchagavya @ 5% (7 days interval)	36.44	34.24	44.12	38.27	36.62	35.17	43.82	38.54
P_3- Cow urine @ 5% (7 days interval)	48.50	45.05	53.12	48.89	47.66	45.38	53.04	48.69
P_4- Cow urine @ 10% (7 days interval)	43.49	41.00	50.32	44.94	42.92	39.65	48.62	43.74
P_5- *Trichoderma viride* @ 10g/kg seed @ 10% + Cow urine @ 5% (7 days interval)	32.00	30.72	34.53	32.42	31.75	29.76	33.80	31.77
P_6- *Trichoderma harzianum* @ 10g/kg seed + Cow urine @ 5% (7 days interval)	31.71	29.03	34.33	31.69	30.47	29.65	32.15	30.76
P_7-*Pseudomonas fluorescens* @ 10g/kg seed + Cow urine @ 5% (7 days interval)	35.68	32.92	38.23	35.61	33.46	30.80	34.98	33.08
P_8- Panchagavya @ 5% + Cow urine @ 5% (10 days interval)	39.21	36.21	42.54	39.32	39.11	37.02	42.14	39.44
P_9- *Trichoderma viride* @ 10g/kg seed + Panchagavya @ 5% + Cow urine @ 5% (10 days interval)	30.34	29.05	31.25	30.21	30.03	27.75	31.23	29.67
P_{10}- *Trichoderma harzianum* @ 10g/kg seed + Panchagavya @ 5% + Cow urine @ 5% (10 days interval)	28.12	25.90	30.20	28.07	29.15	27.68	30.77	29.20
P_{11}- *Pseudomonas fluorescens* @ 10g/kg seed + Panchagavya @ 5% + Cow urine @ 5% (10 days interval)	31.98	29.73	35.14	32.28	31.40	29.44	33.24	31.36
P_{12}- Chemical control (seed treatment Carbendazim 50% WP @ 3g/kg seed + Drenching in main field @ 2g/l after inoculation)	14.27	12.78	15.64	14.24	14.68	12.75	14.07	13.84
P_{13}- Control.	58.42	54.94	68.37	60.57	52.79	51.72	64.27	56.26
Mean	36.16	33.78	40.42		35.37	33.42	39.20	
	SEm ±		CD at 5 %		SEm ±		CD at 5 %	
Varieties (V)	0.81		2.31		0.75		2.15	
Nutrient Sources (N)	1.68		4.81		1.56		4.48	
V × T	2.91		NS		2.71		NS	
V_1- MHTO100; V_2- MHTO101; V_3- Arka Vikas								

Preparation of Panchagavya

Panchagavya was prepared by mixing 7 kg fresh cow dung and 1 kg ghee and incubated in a container for 2 days and it was mixed daily once. On the third day, 10 litres cow urine and 10 litres water were added, mixed thoroughly and incubated for fermentation for 13 days. Further, 3 litres of milk, 2 litres of curd, 3 litres of tender coconut water, 3 kg jaggery and 12 well ripened bananas were added and contents were incubated for 6 days. The mixture was stirred thoroughly thrice a day at morning, afternoon and evening. Plastic drum was kept in shade and it was covered with wet jute bag. After 21 days of fermentation mixture was filtered through a cotton cloth and used for spraying.

Seed material

The different coloured tomatoes used in the study are Red (Arka Vikas), Pink (MHTO100) and Golden Yellow (MHTO101). The seed material of Arka Vikas was procured from IIHR, Bangalore. MHTO100 and MHTO101 tomatoes are the advanced breeding lines developed at SKLTGHU and the seed material was collected from College of Horticulture, Mojerla. The seedlings for both the seasons were raised in Hi-Tech nursery at Centre of Excellence, Mulugu.

Sterilization of Media and Filling of Polybags

The experiment was carried out using polybags of size 143 × 163 . A mixture of soil, cocopeat and vermicompost was taken in 3:1:1 ratio and sterilized with 5 per cent hydrogen peroxide. This sterilized mixture was filled in poly bags of size and arranged as per experimental design with two replications, thirty nine treatments and three plants for each treatment.

Inoculation of Fusarium in polybags

The culture of Fusarium isolate was taken and mass multiplied on sorghum meal medium and each polybag

Table 2: Effect of liquid organic formulations and biocontrol agents on Fusarium wilt resistance and percent disease control efficacy in different coloured tomato varieties.

Varieties /Plant Protection measures	Percent Efficacy Disease Control							
	2023-24				2024-25			
	V_1	V_2	V_3	Mean	V_1	V_2	V_4	Mean
P_1- Panchagavya @ 3% (7 days interval)	31.41	31.35	35.53	31.05	24.76	27.14	26.46	26.12
P_2- Panchagavya @ 5% (7 days interval)	37.32	37.22	22.44	36.69	30.60	31.88	31.98	31.49
P_3- Cow urine @ 5% (7 days interval)	16.71	17.61	26.44	18.92	9.74	12.20	17.68	13.21
P_4- Cow urine @ 10% (7 days interval)	25.24	24.92	49.61	25.53	18.69	23.24	24.64	22.19
P_5- *Trichoderma viride* @ 10g/kg seed @ 10% + Cow urine @ 5% (7 days interval)	45.30	44.18	49.70	46.36	39.95	42.57	47.49	43.34
P_6- *Trichoderma harzianum* @ 10g/kg seed + Cow urine @ 5% (7 days interval)	45.69	47.09	44.26	47.49	42.32	42.74	50.01	45.02
P_7-*Pseudomonas fluorescens* @ 10g/kg seed + Cow urine @ 5% (7 days interval)	39.08	40.22	38.04	41.18	36.74	40.55	45.67	40.98
P_8- Panchagavya @ 5% + Cow urine @ 5% (10 days interval)	33.12	34.31	54.17	35.16	26.00	28.47	34.58	29.68
P_9- *Trichoderma viride* @ 10g/kg seed + Panchagavya @ 5% + Cow urine @ 5% (10 days interval)	48.02	47.06	30.38	49.75	43.16	46.34	51.36	46.95
P_{10}- *Trichoderma harzianum* @ 10g/kg seed + Panchagavya @ 5% + Cow urine @ 5% (10 days interval)	51.82	52.68	55.74	53.41	44.68	46.32	51.96	47.65
P_{11}- *Pseudomonas fluorescens* @ 10g/kg seed + Panchagavya @ 5% + Cow urine @ 5% (10 days interval)	45.43	45.99	48.82	46.75	40.59	43.10	48.37	44.02
P_{12}- Chemical control (seed treatment Carbendazim 50% WP @ 3g/kg seed + Drenching in main field @ 2g/l after inoculation)	75.52	76.77	77.13	76.48	72.20	75.26	77.92	75.12
P_{13}- Control.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mean	38.05	38.42	40.94		33.04	35.37	39.09	
	SEm ±		CD at 5 %		SEm ±		CD at 5 %	
Varieties (V)	0.94		NS		0.65		1.85	
Nutrient Sources (N)	1.96		5.62		1.35		3.86	
V × T	3.40		NS		2.34		NS	

V_1- MHTO100; V_2- MHTO101; V_3- Arka Vikas

was inoculated with sorghum meal medium (50g/kg of soil). Infested polybags were irrigated and set aside for seven days to guarantee pathogen dispersal in the soil before transplanting and kept under shade net. The seedlings of 45 days age were transplanted in the polybags and irrigated daily.

Results and Discussion

The results revealed that among the varieties, the highest percent disease index (40.42 % and 39.20 %) was recorded by V_3- Arka Vikas during 2023-24 and 2024-25 respectively. It was followed by (36.16 % and 35.37 %) in V_1- MHTO100, whereas the lowest percent disease index (33.78 % and 33.42 %) was recorded by V_2- MHTO101. Among different plant protection measures the highest percent disease index (60.57 % and 56.26 %) was recorded in P_{13}- Control, followed by P_3- Cow urine @ 5% (48.89 % and 48.69%), while the lowest (14.24 % and 13.84 %) was reported in P_{12}- Chemical control- Seed treatment with Carbendazim 50% WP @ 3 g kg^{-1} seed + drenching @ 2 g l^{-1} after inoculation.

The highest percent efficacy disease control (40.94 % and 39.09 %) was recorded by V_3- Arka Vikas during 2023-24 and 2024-25 respectively. It was followed by (38.42 % and 35.37%) in V_2- MHTO101 and (38.05 % and 33.04%) in V_1- MHTO100. Among the different plant protection measures the highest (76.48 % and 75.12 %) was recorded in P_{12}- Chemical control, followed by (53.41 % and 47.65 %) recorded in P_{10}- *Trichoderma harzianum* @ 10 g/kg seed + Panchagavya @ 5 % + Cow urine @ 5 %. The lowest (0.00 %) was recorded in P_{13}- Control.

The variation in PDI and PEDC observed among the plant protection treatments may be attributed to differences in their ability to suppress Fusarium infection and restrict subsequent disease development. The

untreated control recorded the highest PDI and consequently the lowest disease control efficacy, which may be due to the absence of any protective measure, allowing the pathogen to establish in the rhizosphere, infect the roots and subsequently colonize the vascular tissues. In contrast, P_{12}, recorded the lowest PDI and the highest PEDC, demonstrating its superior effectiveness against Fusarium wilt. The effectiveness of this treatment may be attributed to the combined protection provided by seed treatment and subsequent drenching, which could have reduced early infection and restricted further pathogen establishment in the root zone. The systemic fungicidal action of Carbendazim may have further contributed to suppression of fungal growth and disease progression. Similar effectiveness of fungicidal treatment in reducing Fusarium wilt severity was reported by Nandini *et al*., (2025).

The disease suppressing potential of biological treatments may be explained by the multiple mechanisms through which *Trichoderma* spp. act against soil borne pathogens. These include competition for nutrients and colonization sites, antibiosis, mycoparasitism and production of hydrolytic enzymes capable of degrading fungal cell walls Parmar *et al.*, (2025). Rapid establishment of *Trichoderma* in the rhizosphere can limit the availability of resources to the pathogen and restrict its growth and multiplication, thereby reducing disease severity and improving disease control efficacy. In particular, *Trichoderma harzianum* has been reported to be an effective antagonist against *Fusarium* spp. through its ability to colonize the root environment and interact directly with the pathogen. The present findings are in accordance with the observations of Singh *et al.*, (2018) and Nandini *et al*., (2025), who reported the effectiveness of biological approaches in reducing Fusarium wilt development.

Cow urine at 10% concentration also resulted in lower PDI and consequently greater disease control compared with the untreated control, indicating its potential as a natural disease management component. The suppressive effect may be related to the presence of soluble compounds and microbial metabolites in cow urine that can interfere with fungal growth and development Jandaik *et al.*, (2015). However, its disease control efficacy was comparatively lower than that of Carbendazim, suggesting that the level of pathogen suppression achieved with cow urine at the tested concentration was not sufficient to provide protection equivalent to the chemical treatment.

Conclusion

The results demonstrated that Variety V_2- MHTO101 possessed comparatively better tolerance against Fusarium wilt than V_1- MHTO100 and V_3- Arka Vikas. Although chemical control (Carbendazim) provided the highest disease suppression, integrated biological treatments comprising *Trichoderma harzianum* along with Panchagavya and cow urine effectively reduced disease incidence and offered an environmentally safer alternative for sustainable Fusarium wilt management.

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