www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(5): 2495-2499

www.thepharmajournal.com
Received: 10-02-2022
Accepted: 31-04-2022

RK Mesta
Department of Plant Pathology, College of Horticulture Bagalkot, Karnataka, India

Madhushri Kerakalamatti
Department of Plant Pathology, College of Horticulture Bagalkot, Karnataka, India

Kiran Kumar KC
Department of Plant Pathology MHRAC, Arsikere, Karnataka, India

Corresponding Author:
RK Mesta
Department of Plant Pathology, College of Horticulture Bagalkot, Karnataka, India

Development of integrated disease management module for the wilt complex of pomegranate caused by *Ceratocystis fimbriata* Ell & Halst and association of *Meloidogyne incognita*

RK Mesta, Madhushri Kerakalamatti and Kiran Kumar KC

Abstract
Pomegranate (*Punica granatum* L.) is one of the popular horticultural fruit crops belonging to order, Myrtales and family Lythraceae. Among many diseases of pomegranate, wilt caused by *Ceratocystis fimbriata* and association of nematode *Meloidogyne incognita* has become a deadly disease in the cultivation of pomegranate. This was once deemed as a minor disease, but now wilt complex has become prime most threatening disease of pomegranate production resulting in severe yield losses. Most of the farmers highly worried to manage this disease. So, development of integrated disease management module for effective management of the disease was attained. Among 12 modules tested, module 5 (drenching with neem cake + fluensulfone 2% GR + tebuconazole 25% EC followed by soil drenching with *T. harzianum* after 15 days followed by propiconazole 25% EC at 30 days, fluensulfone 2% GR at 45 days and tricyclazole 75% WP at 60 days) showed less number of branches infected with highest net returns of Rs. 13,96,957 and with B:C of 4.63 which was compared to untreated plant (module M12), in which cent per cent of wilt incidence was observed. with least net returns and B: C.

Keywords: Pomegranate, Wilt, *Ceratocystis fimbriata*, *Meloidogyne incognita* and management

Introduction

Pomegranate (*Punica granatum* L.) is an attractive, highly prized, nutrient rich fruit. Arid and semiarid zones are popular for growing pomegranate trees. The alluring monetary return per unit area from this crop has resulted in steady increase in area, production and export of pomegranate, so called highly remunerative and lucrative agriculture business crop. It is grown in an estimated area of 276 thousand ha with a production of 3103 thousand MT and in fruit export market it occupies sixth place in India (Anon, 2021) [1]. 2/3rd of total area in the country is occupied by Maharashtra which is the largest producer followed by Karnataka, Andhra Pradesh, Gujarat and Rajasthan. The state Karnataka has an area of 29.92 thousand ha with a production of 330.30 thousand MT (Anon, 2021) [1] where this crop has extended over a wide area in different districts *viz.*, Chitradurga, Vijayapur, Bagalkote, Bellary, Koppal, Belagavi, Davangere, Tumkur, Kalaburgi and Bengaluru.

Among many diseases of pomegranate, wilt caused by *Ceratocystis fimbriata* Ell. & Halst and association of *Meloidogyne incognita* has become a deadly disease in the cultivation of pomegranate, which results in complete wilting of plant and is characterized by the initial symptoms as yellowing and wilting of leaves on one to several branches leading to death of affected plants in a few weeks. Cross sections of diseased plants revealed brown discoloration in the outer xylem from roots to the main trunk (Somasekhara and Wali, 1999) [11]. The diseased plants die due to wilt in patches, indicating the spread of the disease from an infected to an adjacent healthy orchard. Splitting of root or vertical sections of diseased plant parts showed dark greyish brown streaks or distinct starburst like black discoloration in vascular and adjoining cortex tissues. Crop losses have been reported ranging from 30 percent (Xu *et al.*, 2011) to 91.7 percent (Sharma *et al.*, 2012) [8]. Some farmers have been forced to uproot entire orchards due to delay in taking appropriate control measures to manage wilt disease. Most of the farmers highly worried to manage this disease. So, development of integrated disease management module for effective management of the disease was attained.

Material and Methods

The experiment was conducted in farmer's field during 2020-21 in rainy season. For the development of module, based on the *in vitro* and *in vivo* evaluation of fungicides, nematicides, organic amendments and bioagents against wilt complex disease caused by fungus, *C. fimbriata* and nematode, *Meloidogyne incognita* in pomegranate were selected (Kerakalamatti, 2018) [3].

Table 1: IDM modules evaluated for management of pomegranate wilt complex under field conditions.

Module	Treatment details				
	1st drenching	**2nd drenching**	**3rd drenching**	**4th drenching**	**5th drenching**
M1	Neem cake (100 g/plant) + Fluensulfone 2% GR (20 g/plant) + Propiconazole 25% EC (2ml/L)	*A. niger* AN-27 (5 g/plant)	Tebuconazole250 EC (2ml/L)	Fluensulfone 2% GR (20 g/plant)	Tricyclazole 75% WP (2g/L)
M2	Neem cake (100 g/plant) + Fluensulfone 2% GR (20 g/plant) + Propiconazole 25% EC (2ml/L)	*T. harzianum* (100 g/plant)	Tebuconazole250 EC (2ml/L)	Fluensulfone 2% GR (20 g/plant)	Tricyclazole 75% WP (2g/L)
M3	Neem cake (100 g/plant) + Fluensulfone 2% GR (20 g/plant) + Propiconazole 25% EC (2ml/L)	*P. lilacinus* (100 g/plant)	Tebuconazole250 EC (2ml/L)	Fluensulfone 2% GR (20 g/plant)	Tricyclazole 75% WP (2g/L)
M4	Neem cake (100 g/plant) + Fluensulfone 2% GR (20 g/plant) + Tebuconazole250 EC (2ml/L)	*A. niger* AN-27 (5 g/plant)	Propiconazole 25% EC (2ml/L)	Fluensulfone 2% GR (20 g/plant)	Tricyclazole 75% WP (2g/L)
M5	Neem cake (100 g/plant) + Fluensulfone 2% GR (20 g/plant) + Tebuconazole250 EC (2ml/L)	*T. harzianum* (100 g/plant)	Propiconazole 25% EC (2ml/L)	Fluensulfone 2% GR (20 g/plant)	Tricyclazole 75% WP (2g/L)
M6	Neem cake (100 g/plant) + Fluensulfone 2% GR (20 g/plant) + Tebuconazole250 EC (2ml/L)	*P. lilacinus* (100 g/plant)	Propiconazole 25% EC (2ml/L)	Fluensulfone 2% GR (20 g/plant)	Tricyclazole 75% WP (2g/L)
M7	Neem cake (100 g/plant) + Fluensulfone 2% GR (20 g/plant) + Propiconazole 25% EC (2ml/L)	*A. niger* AN-27 (5 g/plant)	Propiconazole 25% EC (2ml/L)	Fluensulfone 2% GR (20 g/plant)	Propiconazole 25% EC (2ml/L)
M8	Neem cake (100 g/plant) + Fluensulfone 2% GR (20 g/plant) + Tebuconazole250 EC (2ml/L)	*T. harzianum* (100 g/plant)	Tebuconazole250 EC (2ml/L)	Fluensulfone 2% GR (20 g/plant)	Tebuconazole250 EC (2ml/L)
M9	Neem cake (100 g/plant) + Fluensulfone 2% GR (20 g/plant) + Tricyclazole 75% WP (2g/L)	*P. lilacinus* (100 g/plant)	Tebuconazole250 EC (2ml/L)	Fluensulfone 2% GR (20 g/plant)	Tricyclazole 75% WP (2g/L)
*M10	Propiconazole25% EC (2ml/plant) + Chlorpyriphos 20 EC (2ml/ plant)	Neem oil (3 ml/plant)	*A. niger* AN-27 (5 g/plant)	*P. lilacinus* (100 g/plant)	Propiconazole25% EC (2ml/plant)
*M11	Chlorpyriphos 20 EC (4ml/ plant) + propiconazole 25% EC (1ml/plant)	Chlorpyriphos 20 EC (4ml/ plant) + propiconazole 25% EC (1ml/plant)	Chlorpyriphos 20 EC (4ml/ plant) + propiconazole 25% EC (1ml/plant)	Chlorpyriphos 20 EC (4ml/ plant) + propiconazole 25% EC (1ml/plant)	Chlorpyriphos 20 EC (4ml/ plant) + propiconazole 25% EC (1ml/plant)
M12	Untreated Control				

*M10- followed NRC pomegranate recommendation, *M11- followed UHS, Bagalkot recommendation for management of wilt

The most effective fungicides, *viz.*, tebuconazole 250 EC, propiconazole 25% EC and tricyclazole 75% WP, the nematicides, thimet 10 G and fluensulfone 2% GR, neem oil cake as organic amendment and *Trichoderma harzianum*, *Aspergilus niger* AN-27 and *Pacilomycis lilacinus* as bioagents were selected for the management of wilt complex of pomegranate, along with this National Research Center, pomegranate Solapur and University of Horticulture Science, Bagalkot recommendations were kept as check (Table 1). The disease management module includes 12 treatments and two replications. To nullify the infestation of shot hole borer the individual plants were pasted with mixture of Chloropyriphos 20 EC 20ml/L + burnt sienna powder. 15-25 per cent wilt infected plants along with nematode infested pomegranate field were selected for management. The fungicide solutions were prepared by dissolving known quantity of fungicide in water and ten liters of solution per tree was drenched at 15 days interval. Bioagents were applied by mixing known quantity of bioagents with one kilogram of farm yard manure. Before imposing pesticides total number of branches [Primary (I), secondary (II) and tertiary (III)] and per cent of branches infected were recorded. Data on percentage of branches infected (primary, secondary and tertiary) at 15, 30, 45 and 60 days were recorded.

Results and Discussion

Data on percentage of branches infected (primary, secondary and tertiary) at 15, 30, 45 and 60 days were recorded. Per cent disease incidence (Table 2) at 15 days, after first drench revealed that in untreated plant (M12) increase in per cent disease incidence was seen with 50.0% of primary, 50.0% of secondary and 54.5% of tertiary branches showing yellowing and wilting symptoms followed by M11, drenched with chlorpyriphos 20 EC + propiconazole 25% EC (33.3% of primary, 42.9% secondary and 28.1% tertiary branches infected) and M1 with neem cake + fluensulfone 2% GR + propiconazole 25% EC (50.0% primary, 24.3% secondary and 23.0% tertiary branches infected). In all other treatments *viz.*, M2, M3, M7 (Treatment with neem cake + fluensulfone 2% GR + propiconazole 25% EC), M4, M5, M6, M8 (Treatment with neem cake + fluensulfone 2% GR + tebuconazole 25% EC) and in M9 (Treatment with neem cake + fluensulfone 2% GR + tricyclazole 25% EC) increase in wilt incidence was not recorded.

Data obtained at 30 days after drenching, per cent of wilt incidence was not increased in first drenching with neem cake + fluensulfone 2% GR + tebuconazole 25% EC after 15 days followed by soil drenching with effective bioagents in M4 (*A. niger* AN-27), M5 (*T. harzianum*), M6 (*P. lilacinus*) and M8 (*T. harzianum*) treatments compared to other treatments.

Even at 60 days, increased in per cent of wilt incidence was not seen in M5 (drenching with neem cake + fluensulfone 2% GR + tebuconazole 25% EC followed by soil drenching with *T. harzianum* after 15 days followed by propiconazole 25% EC and fluensulfone 2% GR) recorded 16.7% primary 50.0% secondary and 37.8% tertiary branches infected which is on par with M6 (drenching with neem cake + fluensulfone 2% GR + tebuconazole 25% EC followed by soil drenching with *P. lilacinus* after 15 days followed by propiconazole 25% EC and fluensulfone 2% GR) recorded 33.33% secondary and

31.7% tertiary branches infected followed by M4 (drenching with neem cake + fluensulfone 2% GR + tebuconazole 25% EC followed by soil drenching with *A. niger* AN-27after 15 days followed by propiconazole 25% EC and fluensulfone 2% GR) showed 41.7% primary, 36.7% secondary and 42.2% tertiary branches infected compared to untreated plant T12, in which cent per cent of wilt incidence was observed.

The number of marketable fruits were recorded after harvest. The module M5 and found superior in yielding 35.27 t/ha. This was followed by module M6 (27.62 t/ha), M4 (26.39 t/ha). and M10 (22.22 t/ha) whereas, M2, M7, M9, M8, M3, M1 and M11 yielded 17.45 t/ha, 16.69 t/ha, 16.28 t/ha, 15.29 t/ha, 14.84 t/ha, 10.80 t/ha and 4.81 t/ha respectively. No fruits were recorded in the control due to complete wilting of plants.

The economic analysis of different modules tested under field condition during 2020-21 against wilt complex of pomegranate was depicted in Table 3. Among 12 modules tested under field conditions, module M5 found effective with highest net returns of Rs. 15,48,027 and with B:C of 8.18 which was followed by module M6 with net returns of Rs. 11,65,527 and B:C of 6.41, while in module M12 with Rs. –1,31,039 of least net returns.

Table 2: Evaluation of designed module for management of wilt complex of pomegranate caused by *Ceratocystis fimbriata* and *Meloidogyne incognita* under filed condition during 2020-21

Module *	Per cent of branches showing yellowing/wilting																		Yield /treat ment (Kg)	Yield (t/ha)
	Before drenching			15 days after drenching			30 days after drenching			45days after drenching			60 days after drenching			Overall increased incidence 60 days after drenching				
	I**	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III		
M1	50.0	17.1	20.9	50.0	24.3	23.0	50.0	29.3	29.4	66.7	36.4	42.1	66.7	48.6	62.8	16.7	31.4	41.9	14.60	10.80
M2	25.0	41.7	31.3	25.0	41.7	31.3	25.0	70.8	50.0	25.0	70.8	56.3	75.0	70.8	68.8	50.0	29.2	37.5	23.58	17.45
M3	41.7	37.5	37.4	41.7	37.5	37.4	41.7	37.5	44.9	41.7	37.5	50.0	41.7	37.5	50.0	0.0	0.0	12.6	20.05	14.84
M4	41.7	36.7	29.8	41.7	36.7	29.8	41.7	36.7	29.8	41.7	36.7	36.7	41.7	36.7	42.2	0.0	0.0	12.4	35.66	26.39
M5	16.7	50.0	37.8	16.7	50.0	37.8	16.7	50.0	37.8	16.7	50.0	37.8	16.7	50.0	37.8	0.0	0.0	0.0	47.66	35.27
M6	0.0	33.3	27.9	0.0	33.3	27.9	0.0	33.3	27.9	0.0	33.3	27.9	0.0	33.3	31.7	0.0	0.0	3.8	37.33	27.62
M7	37.5	26.3	14.7	37.5	26.3	20.0	37.5	42.5	32.0	37.5	42.5	40.7	37.5	58.8	58.7	0.0	32.5	44.0	22.55	16.69
M8	58.3	35.7	33.3	58.3	35.7	33.3	58.3	35.7	33.3	58.3	35.7	40.3	58.3	50.0	47.2	0.0	14.3	13.9	20.66	15.29
M9	50.0	27.8	20.7	50.0	27.8	20.7	50.0	41.7	31.4	50.0	41.7	39.6	50.0	47.2	47.9	0.0	19.4	27.2	22.00	16.28
M10	50.0	50.0	42.1	50.0	50.0	42.1	50.0	50.0	52.6	50.0	50.0	55.3	50.0	50.0	60.5	0.0	0.0	18.4	30.03	22.22
M11	33.3	28.6	18.7	33.3	42.9	28.1	50.0	42.9	30.9	66.7	50.0	39.6	66.7	57.1	56.9	33.3	28.6	38.2	6.50	4.81
M12	50.0	25.0	27.3	50.0	50.0	54.5	50.0	50.0	72.7	50.0	75.0	81.8	100.0	100.0	100.0	50.0	75.0	72.7	0.00	0.00

**I- Primary branches, II- Secondary branches, III- branches

Module	*Treatment details				
	1st drenching	15 days after drenching	30 days after drenching	45days after drenching	60 days after drenching
M1	Neem+ Fluensulfone + Propiconazole	*A. niger*	Tebuconazole	Fluensulfone	Tricyclazole
M2	Neem+ Fluensulfone + Propiconazole	*T. harzianum*	Tebuconazole	Fluensulfone	Tricyclazole
M3	Neem+ Fluensulfone + Propiconazole	*P. lilacinus*	Tebuconazole	Fluensulfone	Tricyclazole
M4	Neem+ Fluensulfone + Tebuconazole	*A. niger*	propiconazole	Fluensulfone	Tricyclazole
M5	Neem+ Fluensulfone + Tebuconazole	*T. harzianum*	propiconazole	Fluensulfone	Tricyclazole
M6	Neem+ Fluensulfone + Tebuconazole	*P. lilacinus*	propiconazole	Fluensulfone	Tricyclazole
M7	Neem+ Fluensulfone + Propiconazole	*A. niger*	propiconazole	Fluensulfone	Propiconazole
M8	Neem+ Fluensulfone + tebuconazole	*T. harzianum*	Tebuconazole	Fluensulfone	Tebuconazole
M9	Neem+ Fluensulfone + tricyclazole	*P. lilacinus*	Tebuconazole	Fluensulfone	Tricyclazole
M10	Propiconazole+ chlorpyriphos	Neem oil	*A. niger*	*Paecilomyces lilacinus*	Propiconazole
M11	Chlorpyriphos+ propiconazole	Chlorpyriphos+ propiconazole	Chlorpyriphos+ propiconazole	Chlorpyriphos+ propiconazole	Chlorpyriphos+ propiconazole
M12	Untreated				

Table 3: Economics of the experiment on evaluation of designed modules for the management of *C. fimbriata* and *M. incognita* during 2020-21

Module	Yield/ treatment	Yield (t/ha)	Cost of cultivation/ha	Cost of treatments/ha	Total cost	Returns	B:C	Net returns	ICBR
M1	14.60	10.80	131039	106634	237673	540000	2.27	302327	4.12
M2	23.58	17.45	131039	84434	215473	872500	4.05	657027	6.66
M3	20.05	14.84	131039	84434	215473	742000	3.44	526527	5.66
M4	35.66	26.39	131039	106634	237673	1319500	5.55	1081827	10.07
M5	47.66	35.27	131039	84434	215473	1763500	8.18	1548027	13.46
M6	37.33	27.62	131039	84434	215473	1381000	6.41	1165527	10.54
M7	22.55	16.69	131039	87394	218433	834500	3.82	616067	6.37
M8	20.66	15.29	131039	96274	227313	764500	3.36	537187	5.83
M9	22.00	16.28	131039	93314	224353	814000	3.63	589647	6.21
M10	30.03	22.22	131039	94350	225389	1111000	4.93	885611	8.48
M11	6.50	4.81	131039	102120	233159	240500	1.03	7341	1.84
M12	0.00	0	131039	0	131039	0	0.00	-131039	0.00

*I- Primary branches, II- Secondary branches, III- branches

Module	Treatment details				
	1st drenching	15 days after drenching	30 days after drenching	45days after drenching	60 days after drenching
M1	Neem+ Fluensulfone + Propiconazole	*A. niger*	Tebuconazole	Fluensulfone	Tricyclazole
M2	Neem+ Fluensulfone + Propiconazole	*T. harzianum*	Tebuconazole	Fluensulfone	Tricyclazole
M3	Neem+ Fluensulfone + Propiconazole	*P. lilacinus*	Tebuconazole	Fluensulfone	Tricyclazole
M4	Neem+ Fluensulfone + Tebuconazole	*A. niger*	propiconazole	Fluensulfone	Tricyclazole
M5	Neem+ Fluensulfone + Tebuconazole	*T. harzianum*	propiconazole	Fluensulfone	Tricyclazole
M6	Neem+ Fluensulfone + Tebuconazole	*P. lilacinus*	propiconazole	Fluensulfone	Tricyclazole
M7	Neem+ Fluensulfone + Propiconazole	*A. niger*	propiconazole	Fluensulfone	propiconazole
M8	Neem+ Fluensulfone + tebuconazole	*T. harzianum*	Tebuconazole	Fluensulfone	Tebuconazole
M9	Neem+ Fluensulfone + tricyclazole	*P. lilacinus*	Tebuconazole	Fluensulfone	Tricyclazole
M10	Propiconazole+ chlorpyriphos	Neem oil	*A. niger*	*Paecilomyces lilacinus*	Propiconazole
M11	Chlorpyriphos+ propiconazole	Chlorpyriphos+ propiconazole	Chlorpyriphos+ propiconazole	Chlorpyriphos+ propiconazole	Chlorpyriphos+ propiconazole
M12	Untreated				

The fungus *C. fimbriata* survives in unfavourable conditions inside the host plant or in the soil that acts as the principal source of inoculum. Occurrence of nematode infestation in pomegranate solely making some difference in recent years. But involving in interaction with soil borne pathogens creating a huge difference from incidence to severity level. Association of *M. incognita* which predisposes the wilt diseases by damaging the host tissue with a stylet which intern helps easy penetration of the mycelia and it produces root knots and galls throughout the root system of infected plants. The extent of damage caused by root nematode increased with the age of the plant. Serious infection results in the death of the entire tree, causing serious yield losses leading to the death of affected plants within a few weeks.

Amendments of soil with decomposable organic matter is recognized as the most efficient method of changing soil and rhizosphere environment, thereby adversely affecting the life cycle of pathogens and enabling the plant to resist the attack of pathogens through better vigour or altered physiology. It was also reported that chemicals like ammonia (Khan *et al.*, 1974) [4] and fatty acids (Sitaramaiah and Singh, 1978) [10] liberated during the decomposition of neem cake could be one of the factors involved in nematode control. Phorate is an organophosphate group chemical, which mainly effect on nervous system of nematodes by inhibiting acetylcholinesterase (AChE) enzyme a chemical messenger that function as neurotransmitter. The chemical which effects on cholinergic (*i.e.*, it mimics the action of neurotransmitter) system can have very dangerous effects which may lead to paralysis of the nematode. A new synthetic nematicide is fluensulfone reported that it affects nematode reproduction, development, feeding, and motility and ultimately has shown nematicidal action. Fluensulfone was tested by Giannakou and Panopoulou (2019) [2] against field populations of root-knot nematodes *Meloidogyne sp*. in commercial cucumber and tomato greenhouses. Propiconazole interfere with the synthesis of ergosterol in plant, which is essential to the formation of fungus. The systemic translocation contributes to good distribution of the active ingredient within the plant tissue. Propiconazole acts on the fungal pathogen inside the plant at the stage of first haustoria formation. In tebuconazole demethylase inhibitors interfere in the process of building the structure of fungal cell wall. Finally inhibit the reproduction and further growth of fungus and blocks elongation of primary hyphae after spore germination but does not prevent spore germination. Tricyclazole, is a broad-spectrum systemic action fungicide which inhibits the melanisation of fungal wall, resulting in the cessation of fungal spore production. Somu (2017) [12] reported that in the field experiment propiconazole @ 0.2%, propiconazole + difenoconazole @ 0.2%, tricyclazole @ 0.2% and tebuconazole @ 0.2%, four times at 15 days intervals showed the maximum disease control with higher fruit yield and net returns.

Trichoderma harzianum inhibits enzymes necessary for pathogens to penetrate plant surfaces. Whips (1992) [13] reported that *T. harzianum* showed antagonistic behaviour towards *C. paradoxa*. Another possibility for reduction in mycelial growth may be competition between *C. fimbriata* and *T. harzianum* for nutrition and other growth factors. It was due to the penetration of the antagonistic hyphae into hyphae of the pathogen at the place of contact as confirmed by Mukherji *et al.*, (2000) [6]. *Paecilomyces lilacinus* is an endoparasitic cosmopolitan fungus. It is mainly known for its nematophagous capacity and an important natural enemy of some plant-parasitic nematodes. It can parasitize eggs and infect larvae and females. The principle antifungal compound has been isolated from strain *A. niger* AN-27 and identified as *trans* and *cis*- 4(3acetoxy-6-methoxy-2-hydroxyphenyl)-2-methoxy-butanolide, which controlling the disease and also promotes growth and yield of the cauliflower crop (Mondal *et al.*, 1999).

As per the present recommendation, on observing the first symptoms of wilt in the orchard farmers need to drench roots of infected plants and healthy plants surrounding the infected plants with effective chemicals or bio-agents; in case of root-knot nematode infection along with chemicals nematicides or oil cakes have to be applied. In the present study Module M5 (Drenching with neem cake + fluensulfone 2% GR + tebuconazole 25% EC followed by soil drenching with *T. harzianum* after 15 days followed by propiconazole 25% EC) and Module M6 (Drenching with neem cake + fluensulfone 2% GR + tebuconazole 25% EC followed by soil drenching with *P. lilacinus* after 15 days followed by propiconazole 25% EC gave best results in managing wilt complex disease. Followed by M4 (Drenching with neem cake + fluensulfone 2% GR + tebuconazole 25% EC followed by soil drenching with *A. niger* AN-27after 15 days followed by propiconazole 25% EC) gave good results in managing wilt complex disease. The findings of the present study are somewhat similar to study conducted Raja (2017) [7] conducted a field experiment on wilt of pomegranate caused by *Ceratocystis fimbriata* for two years. The result indicated that three drenching of propiconazole (0.2%), *T. virens* (diamond) (0.7 g/l) and *T. harzianum* (Th-R) (5 g/l) at an interval of 15 days showed the maximum disease control with higher mean fruit yield and cost benefit ratio. Somu (2017) [12] reported that in the field experiment propiconazole @ 0.2%, propiconazole + difenoconazole @ 0.2%, tricyclazole @ 0.2% and tebuconazole @ 0.2%, four times at 15 days intervals showed the maximum disease control with higher fruit yield and net returns. *C. fimbriata* and *M. incognita* are soil borne pathogens which survives long time in the soil. Sharma *et al.* (2010) [9] reported that soil drenching of affected and adjacent healthy plants with carbendazim or propiconazole (0.2%) + chlorpyriphos (0.2%) has resulted in effective wilt management. Khosla (2013) [5] reported that triazoles such as tebuconazole, cyproconazole, propiconazole, difenoconazole and diniconazole provide excellent control of some soil borne diseases including wilt.

Moreover, infected plants are removed timely from field. The dead trees need to be removed and fresh planting is to be done after treating the soil with formalin. The prophylactic management practices have to followed by farmers to manage the wilt complex disease of pomegranate.

Conclusion
Pomegranate wilt complex caused by *Ceratocystis fimbriata* and association of nematode *Meloidogyne incognita* has become serious disease in cultivation of pomegranate. Protection of crop plants from disease causing agents is the major agenda. So, in depth analysis and realization about, the startling features of microbial virulence and replacing them with good management practices to fill the starve of cultivating farmers was the need of the hour. Being a complex disease its management through single chemical is not effective. So, development of integrated disease management module for effective management of the disease was attained. Being soil born disease, drenching the infected plants and surrounding plants with effective chemicals, bio-agents, organic amendments, nematicides helps to manage the disease. The prophylactic management practices have to followed by farmers to manage the wilt complex disease of pomegranate.

Acknowledgement
I am thankful for giving me opportunity to work in this area to the Department of Plant Pathology, College of Horticulture, University of Horticultural Sciences, Bagalkot, 587104, Karnataka, India and Tulasigeri (Bagalkot district) farmers for providing their land for the experimental purpose.

Reference
1. Anonymous. Horticulture statistics division, Department of Agriculture, Cooperation & Farmers' Welfare, Government of India. 2021, 1-18.
2. Giannakou IO, Panopoulou S. The use of fluensulfone for the control of root-knot nematodes in greenhouse cultivated crops: Efficacy and phytotoxicity effects. Cogent Food Agric. 2019;5:1643819.
3. Kerakalamatti. Investigation on association of *Ceratocystis fimbriata* Ell. and Halst. and *Meloidogyne incognita* (Kofoid and White) Chitwood in causing wilt of pomegranate and it's management. M.Sc. (Hort.) Thesis, Univ. Hort. Sci., Bagalkot (India). 2018.
4. Khan A, Alam MM, Ahmed R. Mechanism of the control of plant parasitic nematodes as a result of the applications of oil cakes to the soil. Indian J Nematol. 1974;4:93-96.
5. Khosla K. Evaluation of fungicides and plant extracts against *Ceratocystis fimbriata* causing wilt of pomegranate. J Mycol. Pl. Pathol. 2013;43(2):193-197.
6. Mukherji S, Tripathi HS, Rathi YPS. Integrated management of wilt of french bean (*Phaseolus vulgaries* L.). J. Mycol. Pl. Path. 2000;31:213-215.
7. Raja. Investigations on wilt of pomegranate caused by *Ceratocystis fimbriata* Ell. and Halst. in Karnataka. *Ph.D. (Agri.) Thesis*, Univ. Agric. Sci., Raichur, 2017, 85-105.
8. Sharma J, Sharma KK, Jadhav VT, Misra AK, Chowdappa P, Sharma P. Diseases of pomegranate in diseases of fruit crops. Indian Phytopathol., New Delhi, 2012, pp. 181-224.
9. Sharma KK, Sharma J, Jadahv VT. Etiology of pomegranate wilt and its management. Fruit Veg. Cer. Sci. Biotech. 2010;4(2):125-130.
10. Sitaramaiah K, Singh RS. Effect of oil cakes on phenolic content of soil and plant and response of *Meloidogyne incognita* and its host related compound. Pl. Soil. 1978;50:671-679.
11. Somasekhara YM, Wali SY. New record of *Ceratocystis fimbriata* causing wilt of pomegranate. Plant Dis. 1999;83(4):400.
12. Somu R. Etiology, epidemiology and management of wilt of pomegranate caused by *Ceratocystis fimbriata* Ellis and Halst. *Ph.D. (Hort.) Thesis*, Univ. Hort. Sci., Bagalkot (India). 2017.
13. Whips JM. Status of biological disease control in horticulture. Bio. Sci. Tech. 1992;2:3-24.
14. Xu B, Zheng XH, Guo WX, Zhou XP. First report of pomegranate wilt caused by *Ceratocystis fimbriata* in Sichuan province. Pl. Dis, 2011, 95 (6).