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Evaluation of different farming systems for management of rhizome rot disease of zinger (*Zingiber officinale* Rose) incited by *Pythium aphanidermatum* (Edson) Fitz

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ABSTRACT

Ginger (*Zingiber officinale* Rosc.) is an herbaceous perennial crop mainly cultivated for underground rhizomes which is used as spice, flavoring, food and medicine. Rhizome rot disease is one among the major constraints of crop production incited by *Pythium aphanidermatum* resulting into significant yield loss and even it will lead to total failure of the crop. The disease is catastrophic in all the ginger growing countries across the world as well as India. In this context, we evaluated different farming systems like natural farming, organic farming, chemical framing and recommended package of practices (UHS, Bagalkot, Karnataka) against rhizome rot of ginger. Experiments were conducted for three consecutive years during 2019, 2020 and 2021. A randomized block design with five replications was used to set up the experiment. Among the evaluated management practices, chemical farming (Metalaxyl8% + Mancozeb 64% WP) was found to be effective with a least percent disease incidence (18.57% PDI) for three consecutive years and remaining treatments found similar trend during experimental period. Recommended package of practice (23.50% PDI) and organic farming (27.60% PDI) were found to be the next best treatments. Maximum disease severity was recorded in natural farming (32.20% PDI) which is least effective against management of disease. Chemical farming can effectively control the disease but results in the serious risk on human health and environmental hazards. Therefore, natural and organic farming are an alternative approach that are eco-friendly and economically viable effective management approaches against rhizome rot of zinger. These approaches include improved cultural practices and biological methods that effectively manage the soil and seed borne pathogens responsible forrhizome rot disease.

Key words: *Ginger, Pythium, Rhizome rot, Trichoderma, Pseudomonas, Sour curd, Naturopathy.*

Introduction

India is also known as a *'magical land of spices'* with diverse variety of spices. Ginger (*Zingiber officinale*) is aherbaceousperennial crop whose rhizomeis widely used as a spice and a folk medicine in natur-

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opathy belonging to family *Zingiberaceae*. (Aleem *et al*., 2020; Ore *et al*., 2021; Sharma *et al*., 2010). It is an herbaceous perennial which grows annual pseudo stems about a meter-tall bearing narrow leafblades (Sutarno *et al*., 1999). India is the largest producer of ginger accounting for about 1/3rd of total world output so it is basic need to develop high yielding varieties with better quality to increase the production and productivity of ginger in India. Ginger is grown in various states such as Kerala, Karnataka, Andhra Pradesh, Orissa, West Bengal, Arunachal Pradesh and Sikkim (Kumar *et al*., 2008; Sharma *et al*., 2010). According national horticulture board, it is cultivated in an area of 160 thousand hectare and production of 1118 thousand MT with productivity of 6.98 MT per hectare. Ginger is affected by a number of diseases among them, rhizome rot or soft rot disease of ginger caused by *Pythium aphanidermatum* is a major constraint for the production of healthy rhizome, this disease is prevalent throughout the growing period of the crop. Infected plants show symptoms of chlorosis which proceeds downward sultimately resulting in withering and death of the leaf. The collar region of the plant and the rhizomes turnpale. Watery and soft appearance becomes evident on just above the ground level. Therhizomes gradually decompose turning into adecoying mass of tissues enclosed by the comparatively tough rind, stems to collapse at this stage, stems are easily pulled from the rhizomes sometimes causing total failure of crop (Fagaria *et al*., 2006). Pythium is an oomycetes fungus also known as water mold and these can survive in the soil, rhizomes of ginger as well as weed host. under unfavorablecondition it produces thick-walled resting spores called 'oospores'. Spread of the water mold occurs when the 'zoospores's wim short distance in the water between soil particles and carried for longer distances in rainwater through the soil. Infected plants spread to nearby healthy ones, resulting in areas of yellowing plants throughout the field. Even it can spread over long distances by infected rhizomes used for planting. The disease caused by *Pythium* spp. can spread at the rate of up to 4.5m/day (Stirling *et al*., 2009). Hence this disease is catastrophic and causes serious yield reduction. Literatures indicate that the disease can be managed by adopting organic amendments, fungicides and antagonist (Ram, 1999; Pandey *et al*., 2010; Singh *et al*., 2011; Bandyopadhyay *et al*., 2012; Acharya *et al*., 2015). Kimutai *et al*., 2018 characterized the efficacy of *Lactobacillus* spp. which was isolated from sour curd against plant disease. Kannan *et al*. (2016) reviewed the antagonistic properties of sour butter milk against plant pathogenic fungi. Disease management strategy has been advocated for the management of the problem posed by this pathogen. Hence, the present investigation focused upon evaluation of different management practices against soft rot or rhizome rot disease of ginger.

Materials and Methods

The experiment was carried out at experimental field of natural farming project, College of Horticulture, Sirsi (UHS, Bagalkot) Karnataka India during three ginger growing seasons 2019–2022. The experiment was laid outin a randomized block design with five replications. Ginger seed rhizomes were planted in raised beds of 3 m × 1 m in an established sick plot. The popular dry ginger cultivar 'Himachal' was used for this study. The plant to plant and row to row spacing were 20 cm and 30 cm, respectively. The fertilizers were applied at the rate of N: P: K- 100:50:50 kgha^{-1} and FYM at the rate of 5 kg plot^{-1}. Other intercultural operations were practiced as recommended for commercial cultivation of ginger (UHS, Bagalkot). Treatment were imposed after appearance of symptoms and incidence recorded subsequently at 20 days of intervals. It included drenching of Copper oxy chloride 50% WP @ 3 g/l (RPP), *Tichoderma harzianum* + *Pseudomonos fluorescens* (talc-based formulation), drenching of sour butter milk (5 liters per 200 liters of water) in natural farming, drenching with Metalaxyl 4% + Mancozeb 64% WP (3g/l) in chemical farming.

Measurement of rhizome rot disease incidence of ginger

Observation on ginger rhizome rot disease development was taken at 30 days interval from the time of germination and continued till harvest of the crop. The percentage of disease development was calculated by the following formula (Kushalappa and Ludwig, 1982):

$$\text{Percent disease incidence (PDI)} = \frac{\text{Number of infected plants}}{\text{Total number of plants infected}} \times 100$$

Statistical analysis

To test the fitness of the results obtained the data were analysed statistically as per the method of de-

scribed by Panse and Sukhatme (1978) and Snedecor and Cochran (1967).

Results

The effects of the different management practices showed consistent trends in efficacy during the three years of evaluation. The perusal of data pertaining to Table 1 revealed among the four different management practices against rhizome rot disease in ginger crop chemical farming showed significant decrease in disease incidence (18.52% PDI) during 2019 which was followed by recommended package of practices (22.50% PDI) and organic farming (25.50% PDI). More incidence of disease was noticed in natural farming (30.50% PDI) at 40 days after second drench. During 2020 similar trend was observed least disease incidence was observed in chemical farming with a tone of 20.50% PDI followed by recommended package of practice (25.58% PDI) and organic farming (28.50% PDI). Maximum incidence of disease was noticed in natural farming (31.60% PDI) at 40 days after second drench. During 2021 least disease was noticed in chemical farming (16.70% PDI) followed by recommended package of practice (22.40% PDI) and organic farming (28.90% PDI). And maximum incidence was noticed in natural farming treatment with sour butter milk (35.50% PDI). Chemical farming showed effective management against rhizome rot of ginger with an irrespective time intervals after drenching. While natural farming found least effective when compare to other treatments.

The three years pooled result pertaining to Table 2 and figure 1 reveled that, natural farming recorded maximum disease incidence. At 20 DAFD and 40 DAFD showed 43.56% PDI and 39.10% PDI, respectively, as well as at 20 DASD and 40 DASD was recoded with 37.10% PDI and 32.20% PDI, respectively. Least disease incidence was noticed in chemical farming with 33.63% PDI and 29.88% PDI at 20 DAFD and 40 DAFD, respectively. Disease incidence at 20 DASD and 40 DASD showed 24.10% PDI and 18.57% PDI, respectively.

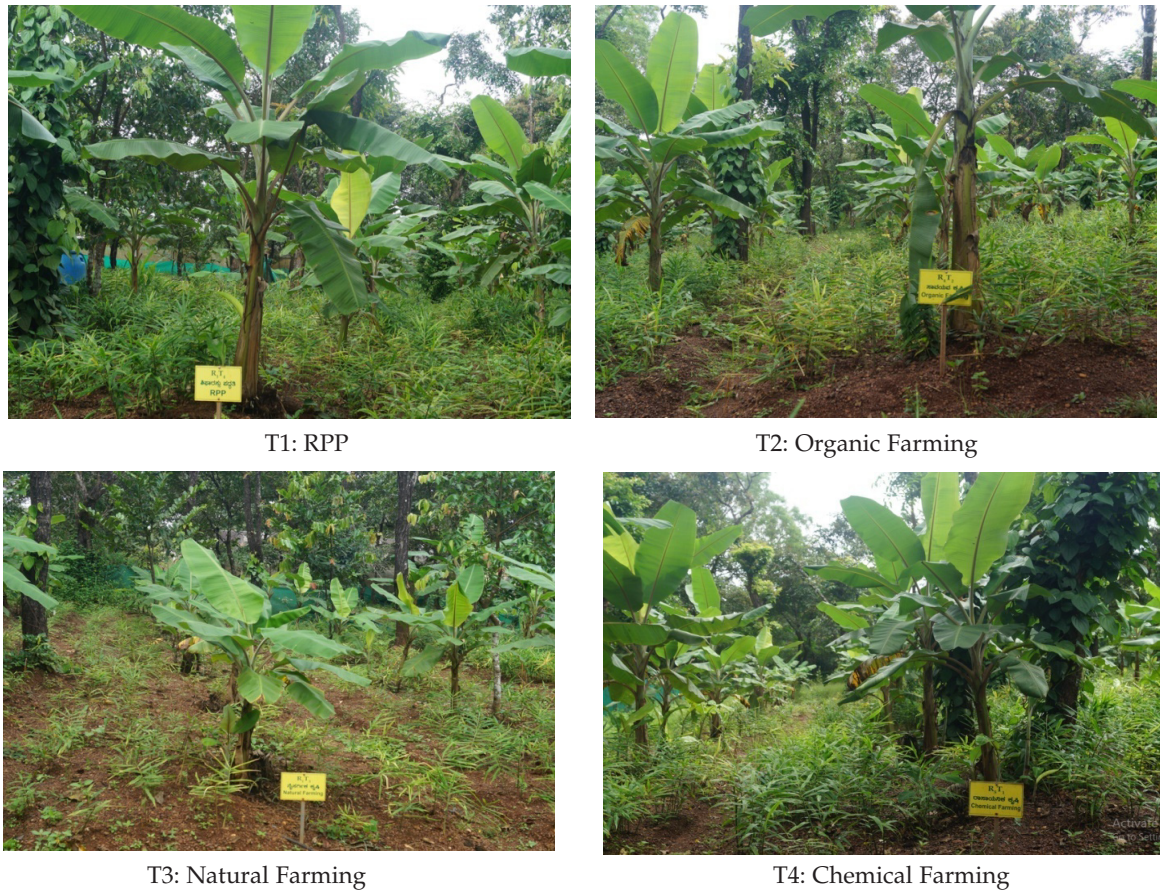
Discussion

Ginger is the most important spice crop grown in the diverse agroclimatic regions in Karnataka. It is affected by many fungal, bacterial, viral and Mycoplasma origins. Among them, rhizome rot is consid-

Table 1. Evaluation of different management practices against incidence of ginger rhizome rot disease caused by *Pythium aphanidermatum*.

Treatments		Per cent disease incidence (PDI)											
		2019-20				2020-21				2021-22			
		20 DAFD	40 DAFD	20 DASD	40 DASD	20 DAFD	40 DAFD	20 DASD	40 DASD	20 DAFD	40 DAFD	20 DASD	40 DASD
T_1	**RPP**	#35.50±0.50* (30.90)	30.50±0.48 (30.58)	28.50±0.25 (20.90)	22.50±0.05 (7.27)	38.20±1.10 (28.79)	35.50±2.47 (26.19)	32.00±0.55 (20.25)	25.58±0.41 (9.49)	39.20±1.57 (29.47)	38.60±0.85 (25.58)	30.60±1.19 (19.89)	22.40±0.23 (8.97)
T_2	**OF**	38.90±0.50 (31.92)	31.50±0.34 (30.89)	30.50±0.33 (22.10)	25.50±0.04 (8.21)	40.70±2.96 (29.64)	38.70±1.75 (27.25)	35.60±1.43 (22.41)	28.50±0.33 (8.95)	41.10±0.78 (30.65)	40.30±1.11 (28.87)	35.09±0.77 (24.39)	28.90±0.29 (7.98)
T_3	**NF**	42.20±0.73 (35.83)	35.50±0.49 (33.44)	34.60±0.37 (24.75)	30.50±0.03 (9.85)	43.10±4.57 (36.17)	40.30±2.83 (30.73)	38.90±1.42 (25.50)	31.60±0.68 (10.82)	45.40±1.33 (36.58)	41.50±0.95 (31.32)	39.10±1.54 (22.75)	35.50±0.32 (10.19)
T_4	**CF**	32.50±0.74 (23.48)	28.25±0.31 (24.07)	22.50±0.33 (17.28)	18.52±0.02 (6.86)	32.80±0.71 (20.89)	30.60±1.47 (19.76)	28.50±0.98 (16.47)	20.50±0.20 (7.34)	35.60±0.65 (23.26)	30.80±0.87 (20.06)	21.40±0.81 (16.78)	16.70±0.25 (7.11)
S.Em±		1.28	0.67	1.00	0.14	1.44	1.42	1.00	0.66	0.84	0.63	0.92	0.40
C.D @ 5%		3.95	2.07	3.07	0.43	4.32	4.29	3.03	2.00	2.62	1.94	2.83	1.17

Recommended Package of Practice(RPP): Copper oxy chloride 50% WP @ 3 g/l Organic farming (OF): Tichoderma + Pseudomonos + compost Natural Farming (NF): Sour butter milk (5 lit. per 200 lit. of water) Chemical farming: Metalaxyl 4% + Mancozeb 64% WP (3g/l) (# Mean of five replication DAP- Days after planting *Figures in parenthesis are arc sign transferred value).
DAFD- Days after first drenching, DASD- Days after second drenching



T1: RPP T2: Organic Farming

T3: Natural Farming T4: Chemical Farming

Plate 1. General view of different farming systems evaluated against management of rhizome rots diseasein ginger during 2019-20 to 2021-22.

ered one of the most prevalent and challenging diseases of ginger causing a significant yield loss and damage. An experiment was conducted regarding the effectiveness of different management practices. Among the evaluated management practice like chemical practice (metalaxyl 4% + mancozeb 64% WP@ 3g/l.), Recommended package of practice of UHS, Bagalkot (Copper oxy chloride 50% WP @ 3 g/

Table 2. Pooled data of different management practices against incidence of ginger rhizome rot disease caused by *Pythium aphanidermatum* during 2019 to 2022.

Treatments		Management practices	Per cent Disease Incidence (PDI)(Poled data of three years)			
			20 DAFD	40 DAFD	20 DASD	40 DASD
T_1	RPP	Copper oxy chloride 50% WP @ 3 g/l	39.20±1.32 (30.19)	34.86±0.68 (27.26)	30.33±0.51 (20.57)	23.50±0.19 (8.71)
T_2	Organic farming	*T. harzianum* + *P. fluorescens*	40.23±0.7 (30.45)	36.83±0.91 (28.92)	33.74±1.38 (22.57)	27.60±0.16 (8.42)
T_3	Natural farming	Sour butter milk (5 l per 200 l of water)	43.56±2.11 (36.21)	39.10±1.21 (31.63)	37.10±0.51 (25.09)	32.20±0.32 (10.36)
T_4	Chemical farming	Metalaxyl 4% + Mancozeb 64% WP (3g/l)	33.63±0.63 (23.00)	29.88±1.06 (21.30)	24.10±0.70 (17.15)	18.57±0.14 (7.09)
	S.Em±		0.76	0.67	0.66	0.30
	C.D @ 5%		2.29	2.03	2.03	0.92

DAFD- Days after first drenching, DASD- Days after second drenching
Figures in the parenthesis are arc sine transformed values

l), Organic practice (*Tichoderma harzianum* + *Pseudomonos fluorescens*) and natural farming (sour butter milk @ 5lit. per 200 lit. of water) against ginger rhizome rot/soft rot. The per cent disease incidence of rhizome rot of ginger was least in chemical farming compare to other management practices. This is mainly because of Copper ions have strong bonding affinity to amino acids and carboxyl groups, reacts with protein and acts as an enzyme inhibitor in target organisms. Copper ions also acts as antisporulant against fungal pathogen which inhibits sporulation by combining with sulfhydryl groups of certain enzymes copper oxychloride was also found effective against rhizome rot disease (Tripathi and Singh, 2021; Lalfakawma *et al*., 2014). Metalaxyl 4% + Mancozeb 64% WP@ 3g/l. was found second best treatment. These results are confirmatory with Ayub *et al*. (2009) who reveled metalaxyl 4% + mancozeb 64% WP and *Tichoderma harzianum+Pseudomonos fluorescens* were effective against managing rhizome rot of ginger. Sour butter milk found least effective and our results were parallel with findings of Sapre *et al*., 2006; Tutika *et al*., 2018; Kumhar *et al*., 2022.

Conclusion

Among the evaluated management practice, drenching of metalaxyl 4% + mancozeb 64% WP and copper oxy chloride 50% WP @ 3 g/lit. are found most effective than the organic practice (*Tichoderma harzianum* + *Pseudomonos fluorescens*) and natural farming practice (sour butter milk) against ginger rhizome rot/soft rot.

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