Proceedings of the 13th ISTRC Symposium, 2007
pp. 165 - 169

Correlation study on population dynamics of ginger soft rot inciting pathogens under different organic amendments, disease incidence and its survival in Darjeeling hill soils

Tarafdar J.[1] and Saha N.[2]
Regional Research Station (Hill Zone), Bidhan Chandra Krishi Viswavidyalaya (BCKV), Kalimpong, District Drajeeling, PIN: 734301, West Bengal, India
Present address for communication: [1]All India Coordinated Research Project on Tuber crops, Bidhan Chandra Krishi Viswavidyalaya (B.C.K.V), Directorate of Research, Kalyani, PIN: 741235, Nadia, West Bengal, India
Present address [2]Department of Soil Sciences and Agricultural Chemistry, Bidhan Chandra Krishi Viswavidyalaya (B.C.K.V.), Mohanpur 741252, Nadia, West Bengal, India

Abstract. Ginger soft rot complex disease incited by *Pythium spp.*, *Fusarium spp.* and *Ralstonia solanacearam* survived extended periods in naturally infested ginger rhizosphere soil. In pieces of organic matter or dead roots application of Farm Yard Manure (FYM) along with different locally available organics like neem cake, FYM, leaves extract of *Scima walllichi*, garlic extract and mustard oil cake were investigated the effect on the population dynamics of the pathogens. The inoculum densities were decreased markedly due to amendments of the different organics in the plots in comparison to the check plots. Analysis of variance implicated that propagule density of two fungal pathogens viz. *Fusarium spp*. and *Pythium spp.*, in the ginger rhizosphere soil steadily declined with the application of the organic extracts. The correlation matrix study on the propagule density of the pathogens at the different growth stages revealed that decreasing inoculum density of two fungal pathogens was highly significant with decreasing disease. The application of FYM with mustard cake and neem cake showed significant reduction of *Fusarium spp*. and *Pythium spp*. and population of *Ralstonia solanacearam*, respectively and increased the fresh rhizome yield.The microscopic observation also revealed that the survival of fungal pathogens in the plant debris presented several epidemiological considerations**.**

Introduction

Ginger is an important commercial crop, which earns a sizeable amount of foreign exchange for the country. But presently, the outbursts of soft rot disease of ginger throw a challenge to the ginger growers, scientists and planners. Various chemicals are adopted to control the disease. The chemicals are costly and also hazardous to the environment as well as the quality of the ginger. So it is imperative to control the disease in a sustainable manner through other agencies- easily available, eco-friendly and remunerative. In this context, many organic amendments show very effectiveness to control the soil borne diseases (Dohroo *et al.*, 1994, Lazarovits, 2001). Hence, it would be very interesting and useful to study the efficacy of locally available conventional and non-conventional soil amendments to control the soft rot of ginger under degraded agro ecosystem of terrace cultivation in hilly area of Darjeeling hills for sustenance of the ginger cultivation.

Materials and Methods

Soil application of FYM (5 kg/2 sq m), alone or in combination with mustard oilcake (1kg/ 2sq m) and neem (*Azadirachta indica*) cake (1kg/sq m) as well as leaf extract of Chillaune plant (*Scima wallichi*) (2 kg/10 l of water) and garlic extract (250 g/ 1 l of water) for foliar spray as well as soil application was tested against the abundance of ginger soft rot disease inciting agents *Fusarium* sp., *Pythium* sp. and *Pseudomonas* sp. The natural rhizosphere population of cited microorganisms are enumerated in standard specific medium meant for. The quantitative assay of the population density of the amended rhizosphere soil is performed at sprouting, active tillering stage and at harvest of ginger. The incidence of ginger soft rot was recorded at active tillering stage by adopting 0 – 9 scale to cover all the broad symptoms. The percent disease (PDI) was calculated using the following formula:

$$\text{PDI} = \frac{\text{Ótotal scores x 100}}{\text{Total number of plantsassessed x 9}}$$

The correlation matrix of the population dynamics of pathogens at different crop growth stages is compared with disease severity and yield. Roots and rhizomes of ginger from the field are assayed for Pythium spp. by thoroughly washing seedlings in tap water. After washing the plant parts were surface sterilized with 0.1% mercuric chloride followed by washing with sterile water and cut into 2-3mm pieces. The cut pieces were rinsed in 10% KOH at 4° C overnight and after washing with 0.1N HCl the tissues were observed under microscope. The microscopic observations of the infected tissues from ginger rhizome were made to assure the presence of the fungal structure in side the tissues.

Results and Discussion

Analysis of variance showed soil amended with FYM alone or in combination with cited organics exerted significant drastic effect on the population density of *Fusarium* sp. *Pythium* sp. and *Pseudomonas* sp. and percent disease incidence of soft rot of ginger at different growth stages as compared to that of control (Table 1). In this context, FYM and mustard oil cake together induced the most inimical influence on the population dynamics of cited pathogenic organisms as well as diseases incidence. This substantiates the earlier report of Rajan and Singh (1971), Sadanandan and Iyer (1986), Toyata and Kimura (1992), Dohroo *et al.* (1997) that FYM amended soils were more fungistatic than non-amended soils. The active ingredient of organics in combination of FYM used, which may produce such amelioration effects on soil borne pathogens as reducing numbers by lysis, temporarily or permanently inactivating fungal propagules, serving food bases for antibiotic and toxic production or as the origin of inhibitory volatile substances. Moreover, the organic amendments may cause the proliferation of certain beneficial organisms resulting in detrimental influence on the growth of pathogenic organisms in ginger rhizosphere. The relative reduction of PDI was due to relative effectiveness of the organics to suppress the pathogens concerned. The results showed superiority of mustard oil cake to other organics, its intrinsic quality being more inhibitory to the pathogens (Table 1).

With the age of the crops, the population density of the pathogens increases from sprouting of mother rhizomes to active tillering of pseudo stem and then declines at the harvesting of daughter rhizome. This suggests that initial decomposed products of organics are beneficial to the pathogenic organisms while the advanced products are inhibitory. Moreover, the advanced decomposed products encourage more natural antagonist to control the cited

Table 1: Relative abundance of ginger soft rot inciting pathogens, disease incidence and rhizome yield under different treatments.

Treatment	Fusarium (CFU X10^3)			Pythium (CFU X10^3)			Pseudomonas (CFU X10^3)			%Disease Infection	Yieldt/ha
	S1*	S2	S3	S1	S2	S3	S1	S2	S3	(PDI)	
Control	63.16à	109.78à	102.93à	60.48à	85.02à	70.85à	135.75à	149.11à	128.33à	79.62	6.0
FYM	33.41ü	98.02ü	63.81ü	24.24c	79.60ab	56.57b	88.46c	90.12bc	80.25cd	54.48	8.3
FYM+ Garlic Extract	28.91üà	95.79ü	61.20ü	19.92e	70.86b	53.47bc	110.53b	104.32b	88.91c	54.16	9.3
FYM+ NeemCake	22.03ñd	52.39c	32.82c	41.59b	56.81c	50.50bc	66.08e	56.18d	69.44d	49.07	10.0
FYM+ChillauneLeave Extract	18.24d	47.97ñ	23.86ñ	25.59c	54.28c	45.22cd	14.85b	146.46a	113.69b	43.51	10.75
FYM+Oil cake(Mustard)	16.23d	38.45d	4.61c	23.89c	43.58d	39.76d	75.46d	75.64c	82.06e	37.96	13.25

S1, S2 and S3 denote sprouting, active tillering and harvesting stage of gingers.
Figures represented by same letter are not significant by DMRT.

pathogens. Additionally, rhizosphere effects as discussed by Ketznelson (1965), affect the soil borne plant pathogens differently under different growth stages. At the later stage of growth, root may exudates more oleresin inhibitory to the growth of pathogenic organisms. It is also evident that high nitrogen product mixture may increase the free ammonia and nitric acid in soil, which are toxic to some of the pathogens (Lazarovits, 2001).

Neem cake in combination with FYM suppresses more *Pseudomonas* cells than that of mustard oil cake as in case *Fusarium* and *Pythium*. Neem cake may elaborate some anti-bacterial volatile substances, which destroy the viable bacterial cells. Lazarovits (2001) explains that organic amendments reduce the plant pathogens and some of the beneficial organisms are found to increase which are potential bio-control agents.

The highest rhizome yield was recorded under the influence of FYM and oil cake followed by those of chillaune leaves extract, neem cake and garlic extract, respectively. The sequential influence of treatments of yield of ginger is in accordance with the relative influence of respective treatments on the soft rot disease incidence. Moreover, FYM improves the overall soil conditions to support the better establishment of ginger which inturn, impart better resistance toward the soft rot disease, resulting good yield. Results thus establish that mustard oil cake and chillaune leaves in combination with FYM can effectively be used in ginger soft rot management programme in hilly areas of Darjeeling Himalayan region.

In the correlation studies on the population counts of three pathogenic organisms the results reveal that there is a positive interaction on the population of *Fusarium* sp. and *Pythium* sp. at the different growth stage of the plants and the inoculum density of these two fungal pathogens would be accelerated to significantly very high level with a strong relationship between these two pathogens at the active tillering stage of the crop. The severity of soft rot disease positively correlates with the propagule

Table 2: Analysis of correlation coefficient with population density of the soft inciting pathogens, disease incidence and yield of ginger.

Fu-S1	Fu-S2	Fu-S3	Py-S1	Py-S2	Py-S3	Ps-S1	Ps-S2	Ps-S3	PDI	Yield	(t/ha)
Fu-S1	1.000										
Fu-S2	0.829	1.000									
Fu-S3	0.968	0.935	1.000								
Py-S1	0.770	0.341	0.613	1.000							
Py-S2	0.857	0.976	0.928	0.440	1.000						
Py-S3	0.967	0.887	0.963	0.730	0.930	1.000					
Ps-S1	0.687	0.603	0.661	0.372	0.592	0.633	1.000				
Ps-S2	0.526	0.383	0.454	0.302	0.411	0.455	0.948	1.000			
Ps-S3	0.629	0.355	0.516	0.504	0.389	0.521	0.927	0.963	1.000		
PDI	0.987	0.845	0.963	0.779	0.877	0.988	0.687	0.511	0.602	1.000	
Yield(ton/ha)	-0.904	-0.895	-0.914	-0.644	-0.956	-0.978	-0.633	-0.476	-0.494	-0.942	1.000

r>0.811 are significant at 5% level of significance and r>0.917 are significant at 1% level of significance.

pressure of *Fusarium* sp. and *Pythium* sp., whereas, the population counts of *Pseudomonas* sp. does not show the relationship with PDI. However, with the yield of rhizome, it was significantly negative (Table 2). Thus, the active increase in population of two fungal pathogens result high intensity of soft rot disease of ginger in the field

Propagules of *Pythium sp.* are recovered from the roots and rhizomes at harvest. Oospore and chlamydospores are the most frequent form of over wintering propagule of *Pythium* isolated from the root tissues. Direct microscopic examination shows that both oospore and chlamydospore are found in association with root tissues, which are left in the field and may survive as dormant phase in the soil organic matter. It is reported that oospore of *Pythium aphanidermatum* are the sole survival structures in naturally infested soil (Burr and Stranhellini, 1973). The formation zoosporiums are also very coomon n the tissues of the infected rhizome. Soil samples taken in the rhizosphere of ginger plant, tissues from roots and rhizome of infected plants may contain mycelial fragments and conidia, which could give rise to colonies on a dilution plate. The occurrence of *Fusarium* sp. and *Pseudomonas* sp. are very wide spread in the infested soil. The bacteria do not produce survival structures that can be readily isolated from the soil and plant sample, which incite the infection.

Implications. Results thus establish that mustard oil cake and chillaune leaves in combination with FYM can effectively be used in ginger soft rot management programme in hilly areas of Darjeeling Himalayan region and lead to reduce the soil popuation of the pathogens.

References

Burr, T.J. and M.F. Stranghellini. 1973. Propagule nature and density of *Pythium aphanidermatum* in field soil. Phytopathol. 63:1499-1501.

Dohroo, N.P, Sharma, O, Sharma and R.S. M and Sarlach. 1994. Effect of organic amendments of soil on rhizome rot, nematodes and rhizosphere mycoflora of ginger (*Zingiber officinale* Roscoe). Annals of Biol. 10:2:208-210.

Dohroo, N.P, Sharma, Sanjeev and S. Sharma. 1997. Effect of organic amendments and intercropping of spore density of VAM fungi and yellows of ginger. Plant Disease Res. 12(1): 46-48.

Katznelson H. 1965. Nature and importance of rhizosphere. In: Ecology of soil borne plant pathogens. Prelude to biological control (Ed. K.F. Baker and W.C. Synder)

Lazarovits G. 2001. Management of soil-borne plant pathogens with organic soil amendments: a disease control strategy salvaged from the past. Canadian J of Plant Pathol. 23: 1-7

Rajan, K.M. and R.N. Singh. 1971. Effect of organic amendments of soil on plant growth, yield and incidence of soft rot of ginger. Journal of Plantation Crops. No. 1 119-123.

Sadanandan, A.K. and R. Iyer. 1986. Effect of organic amendments on rhizome rot of ginger. Indian Cocoa, Arecanut and Spices Journal. 94 –95.

Toyata, K. and M. Kimura. 1992. Population dynamics of *Fusarium oxysporum* f.sp. *raphani* in soils of different fungistatic capacity. FEMS Microbial Letter. 102: 15-20