Bangladesh J. Bot. **50**(1): 45-49, 2021 (March)

EFFECTS OF *TRICHODERMA VIRIDE* AND COPPER HYDROXIDE ON RHIZOME ROT OF GINGER

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Keywords: Trichoderma viride, Ginger, Rhizome rot, Copper hydroxide

Abstract

To assess the impact of rhizome rot disease management on growth and yield of ginger a study was carried out. Rhizome treatment with copper hydroxide resulted 86% ginger germination followed by *Trichoderma viride* which was 81% over local check. The results further revealed that rhizome treatment by copper hydroxide and its soil drenching effectively controlled rhizome rot disease (67%) with reduced disease incidence (4.6%) followed by *Trichoderma viride* which controlled the disease by 53.5% and reduced the disease incidence to 6.8% over local check. Extension and technology gap was recorded 2.5 and 3.8 t/ha. Raised bed planting, use of *Trichoderma viride*, disease free seed and rhizome treatment were adopted by 53.3, 26.6, 29.3 and 24% respondents.

Introduction

Ginger (*Zingiber officinale* Roscoe) is an herbaceous perennial, cultivated in India, China, Japan, Indonesia, Australia, Nigeria and the West Indies. India contributes about 36% of the world's total ginger production. Out of the total production of ginger in India, about 30% is converted into dry ginger, 50% consumed as green ginger as a vegetable and the rest is used for propagation. Ginger oil is primarily used as a flavoring agent in confectionary and for soft drinks (Yadav *et al.* 2004). Ginger is being grown in 4400 ha area with very low productivity (1.27 tonnes per ha) in Madhya Pradesh (Anon. 2017). Its productivity is reasonably low perhaps due to use of local cultivars susceptible to several serious diseases such as rhizome rot, inadequate and imbalanced use of fertilizers. Rhizome rot disease caused by fungi (*Pythium* spp., and *Fusarium oxyporium* f. sp. *zingiberi*) and bacteria [*Pseudomonas* (*Ralstonia*) *solaniserum*] is the major problem of the region as well as in country (Dohroo 2005). Keeping in view the above, present study was carried out to assess the effect of *Trichoderma viride* and copper hydroxide on rhizome rot disease of ginger during Kharif 2011 to 2017 in Bundelkhand and Vindhyan plateau region of Madhya Pradesh.

Materials and Methods

The study was carried out in Chhatarpur and Sagar districts of Bundelkhand and Vindhyan Plateau agro-climatic region at 75 locations in Kharif *season* during 2011 to 2017 in participatory mode on mixed red to medium black soil. Based on priority of the problems, trials were conducted in participatory mode. The technology package and technical information was provided to respondents through training at Agriculture Science Center (ASC). Each trial was conducted on an area of 0.20 ha and the same area adjacent to the trial plot was kept as local check (farmer's practice). Disease management was assessed by rhizome treatment with copper hydroxide 0.3%

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followed by soil drenching @ 0.2% (T_1), soil amendment with *Trichoderma viride* @ 2.5 kg/ha with FYM and rhizome treatment by *T. viride* @ 10 g/l of water (T_2) and no rhizome treatment in local check (T_3).

Rhizome sown in the first week of July every year with the seed rate of one tone/ha and the spacing was kept 30 and 20 cm between rows and plants. NPK @ 75 : 50 : 50 kg/ha was applied through urea, single super phosphate and muriate of potash (potassium chloride) at sowing time. Nitrogen was applied in two splits (half at sowing time and rest half during earthing). One hand weeding was done at 30 - 35 DAS for effective control of weeds after one month of mulching with leaves of 'Palas' and maintained proper drainage in the trial plots. Copper hydroxide and *Trichoderma viride* drenching was done at 45 DAS. In the adjacent plot, ginger was sown using basal dose of di-ammonium phosphate @ 100 kg and muriate of potash @ 20 kg per ha which maintained as local check (farmers' practice). After rainy season 6 - 8 irrigations were given in the period of four months. Crop was harvested at the end of January to first week of February every year. The data on germination, incidence of rhizome rot disease, rhizome weight and yield of ginger from trial as well as local check plot was recorded. An extensive survey was also conducted in ginger growing areas in Chhatarpur and Sagar districts of Madhya Pradesh. The rhizome rot samples were collected for study. To identify the rhizome rot pathogen, sample plates prepared and after grew up of the fungus spores; slide was prepared from the PDA and identified under microscope using the method given by Kevimeo and Tiameren (2013). Other parameters were i.e. gap analysis, costs and returns calculated using the formulae suggested by Yadav *et al.* (2004) and Dayanand *et al.* (2012). Technology gap, extension gap and technology index were calculated using the formulae given by Kadian *et al.* (1997).

Results and Discussion

It was observed that rhizome treatment with copper hydroxide higher the ginger germination which recorded 86% followed by *Trichoderma viride* and local check (Table 1). It was inferred that application of copper hydroxide as rhizome treatment and soil drenching (T_1) controlled the rhizome rot by 67 per cent with reduction in disease incidence from 14.4 to 4.6% and yielded 10.4 t/ha rhizomes which was 35% higher over T_3 (7.7 t/ha). These results are in conformity with results reported by Rajan *et al.* (2002) who proved the role of copper oxychloride (Phytolon) in management of rhizome rot. Rhizome treatment and soil amendment with *Trichoderma viride* controlled rhizome rot by 53.5% with reduction in disease incidence from 14.4 to 6.8% and gave 10.1 t/ha yield which was 31.1% higher over local check. The ginger yield in *T. viride* treated plot was however slightly lower than copper hydroxide but being a bio-agent *T. viride* was environment friendly and improved the antagonistic activities of the soil microorganisms. These findings are in agreement with those of Dohroo *et al.* (1994), Ram *et al.* (1999), Balakrishnan *et al.* (2000), Ram *et al.* (2000), Anandaraj and Sharma (2003), Ambia (2006), Ahmmed and Hossain (2006), Sagar (2006), Usman (2006), Bhuyan (2010).

The economic and socio-economic impact of the rhizome rot disease management reflected that an additional yield of 2.7 and 2.4 t/ha and net return of Rs. 61500 and Rs. 56000 per ha noticed in T_1 and in T_2 treatments, respectively over local check (Table 2). B : C ratio was recorded to be high in T_2 due to less cultivation cost over T_1. An average extension gap of 2.5 t/ha was noticed between trials and local check. An average technology gap of 3.8 t/ha was observed during the study period. Similar results were reported by Singh *et al.* (2015).

In the survey it was noticed that farmer-to-farmer information transfer was the major source of advice; the farmer may have received the information from the dealers, possibility of this trend was agreed by several farmers. All respondents watched agricultural programmes in television and

heard the radio programmes; 80% of them were reading newspaper/agricultural magazine for better crop production. More than 50% of the farmers contacted to scientists or other extension workers for plant protection practices in ginger. Out of 75 respondents, 26.6% participated in training programmes and they also attended the group meetings being member in farmers groups.

Table 1. Efficacy of different treatments in rhizome rot disease management.

Treatments	Germination (%)	Incidence of rhizome rot disease (%)	Yield (t/ha)
T_1	86	4.6	10.4
T_2	81	6.8	10.1
T_3	72	14.4	7.7

T_1 = Rhizome treatment with copper hydroxide (0.3%) followed by soil drenching of the same (@ 0.2%), T_2 = Soil amendment with *Trichoderma viride* (2.5 kg/ha) with FYM and rhizome treatment with *T. viride* (@10 g/litre of water), T_3 = Local check (No treatment).

Table 2. Economics of ginger cultivation in demonstration and local check plots.

Treatments	Additional yield over local check (t/ha)	Cost of cultivation (Rs/ha)	Gross return (Rs/ha)	Net return (Rs/ha)	B : C ratio	Additional cost of cultivation (Rs./ha)	Incremental net returns (Rs./ha)
T_1	2.7	72000	260000	188000	3.61	6000	61500
T_2	2.4	69500	252000	182500	3.62	3500	56000
T_3	-	66000	192500	126500	2.91	-	-

Table 3. Adoption status of various integrated disease management (IDM) components (respondents - 75).

IDM component	Per cent of adoption	Frequency
Disease free seed	29.3	22
Rhizome treatment	24.0	18
Raised bed planting	53.3	40
Use of *Trichoderma viride*	26.6	20
Synthetic fungicide spray	100	75

Adoption of raised bed planting in ginger for proper drainage and disease management was carried out by 53.3 per cent respondents (Table 3). *Trichoderma viride* was used as soil application and rhizome treatment for rhizome rot disease management by 26.6% respondents. Use of disease free seed and rhizome treatment was carried out by 29.3 and 24% respondents, respectively while all the respondents used chemical (synthetic fungicide) spray for disease

management. Respondents told that all of them were spraying synthetic fungicides, but the number of sprays reduced with adoption of the integrated disease management (IDM) technique. Similar findings were observed by Rathore *et al.* (1992) in ginger and Ramulamma *et al.* (2017) in case of chilli.

In most of the surveyed plots, *Fusarium oxysporum*/*F. solani* and *Pythium aphanidermatum* were associated with infected plants. During the crop season, foliage yellowing and wilting was more prominent and at the time of harvest dry rot and rotten rhizome noticed. Similar findings were reported by Haware and Joshi (1973).

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(Manuscript received on 8 June, 2019; revised on 5 April, 2020)