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Integrated management of foot rot disease of groundnut with seed and soil treatments

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ABSTRACT

Sclerotium rolfsii demonstrated major harmful effect on plant growth due to strict root colonization, whereas, presence of the microbial antagonists showed significant optimistic effect on plant growth by declining the colonization of roots by *S. rolfsii*. The efficacy of seed treatment, soil treated with *Tricho* compost and soil drenching with fungicide on foot rot of groundnut was studied in the research field and laboratory of Bangladesh Agricultural Research Institute, Bangladesh. The experiment was designed as a Randomized Completely Block Design (RCBD) containing eight treatments. All treatments (1. soil drenching by Contaf 5 EC 0.1 %, 2. seed treatment with Provex 2.5 gkg^{-1} seed, 3. soil treatment by *Tricho* compost 2.5 tha^{-1}, 4. combine application of soil treatment by Contaf 5 EC 0.1 % and seed treatment with Provex 2.5 gkg^{-1} seed, 5. soil drenching by Contaf 5 EC 0.1 % and soil treated by *Tricho* compost 2.5 tha^{-1}, 6. seed treatment with Provex 2.5 gkg^{-1} seed and soil treated by *Tricho* compost 2.5 tha^{-1}, and 7. soil drenching by Contaf 5 EC 0.1 %, seed treatment with Provex 2.5 gkg^{-1} seed and soil treated by *Tricho* compost 2.5 tha^{-1}) tested confirmed significantly lower percentages of foot rot infection by *Sclerotium rolfsii* and resulted in higher nut yield compared to untreated control. The highest nut yield was observed in case of seed treatment with Provex 2.5 gkg^{-1} seed and soil drenching with Contaf 5 EC 0.1 %, followed by another combination of seed treatment, soil drenching and soil treatment. Although, individual application of different treatments did not gave as better results as combine application of treatments. Our findings pointed out the effective management of foot rot and significant yield benefit from groundnut can be obtained through integrated use of seed treatment with Provex 2.5 gkg^{-1} seed and Contaf 5 EC 0.1 % for soil drenching.

Introduction

Groundnut (*Arachis hypogaea* L.) is a major legume and an important oil seed crop throughout the world as well as Bangladesh (Brown, 1999 and Bakr et al*.,* 2007). It is grown in over 100 countries with a total estimated area of 21.8 million ha and with production of 28.5 million tons. Numerous issues are accountable for low productivity among which diseases like leaf spot, collar rot, stem rot, bud necrosis, etc., are very important. Out of all, stem rot caused by *Sclerotium rolfsii* Sacc. is a major problem and is an economically important soilborne pathogen. Bakr et al*.,* (2007) recorded 28 diseases in Bangladesh so far, among them foot rot or stem rot incited by *S. rolfsii* Sacc is the most important disease for ground nut crops. An annual crop loss of $ 4.5-7.5 million has been reported due to foot rot alone (De waard, 1979). *S. rolfsii*, [teleomorph: *Athelia rolfsii* (Curzi) Tu & Kimbrough] is an economically important soil-borne pathogen that is very widespread in tropical, subtropical and other warm temperate regions of the world. The pathogen causes root rot, stem rot, wilt and foot rot diseases on more than 500 species of cultivated and wild plants including almost all the agricultural and horticultural crops (Ciancio & Mukerji, 2007). Mostly *S. rolfsii* infected diseases have been reported on dicotyledonous hosts, but several monocotyledonous species have also been infected (Ciancio & Mukerji, 2007). Humid weather is favorable to sclerotial germination and mycelial growth. Consequently the diseases caused by the fungus are more serious in tropical and subtropical regions than in temperate regions (Yorinori, 1994). The huge number of sclerotia produced by *S. rolfsii* and their ability to persist in the soil for several years, as well as the abundant growth rate of the fungus make it well matched facultative parasite and a pathogen of major importance throughout the world (Punja, 1988). Control of fungus is difficult due to lie dormant as sclerotia. It is suggested that the available source of host plant resistance and chemical control need to be strengthened for successful management of foot rot disease in groundnut (Podile and Kishore, 2002).

The modern agricultural era**,** the randomized use of chemical pesticides and has resulted in the expansion of several troubles such as pesticide resistance in pests, renaissance of target and non-target pests, destruction of beneficial organisms like honey bees, and chemical residues in food, feed and fodder. The massive use of chemical fertilizers and fungicides has also been necessary due to cultivation of high yielding varieties, resulted in deprivation of soil health (Cook, 1991). The substitute methods are being visualized in an eco-friendly approach intended at sustainable agriculture. Biological method propose an excellent replacement strategy for effective manage of various diseases and compost extracts have been found as bio-fertilizers to enhance plant growth and to suppress pathogens in soils (Gharib et al., 2008; Naidu el al., 2010).

Different methods for the control of foot rot of ground nut were suggested worldwide, including the use of resistant cultivars (Butzler et al*.,* 1998), cultural practices (El-Deeb and Ibrahim, 1998), biological and chemical control (Siddiqui et al*.,* 2002; Cilliers et al., 2003). All of these control measures is an important means in checking root rot of peanut (Helal et al., 1994). In addition, fungicides may eradicate pathogens in seeds and can also protect seeds and seedlings from soil from soil-borne pathogens (Maude, 1996). However, Integration of different bio-control agents with disease management options has improved disease protection and the activity spectrum of bio-control agent (Jetityanon and Kloewpper, 2002). In some cases the combined application of fungicide and fungicide tolerant biocontrol agents reduced, the severity of stem rot , damping off and post harvest rot of groundnut, tomato, and pea respectively (Kondoh et al., 2001, Manjula et al., 2004). Soil amendments are known to improved the nutrient status and increased the microbial activity and to suppress pathogens. Therefore, an attempt was made to access the effect of integrated diseases management modules with chemical treatments, organic amendments, and bio control agents on diseases incidence and yield of groundnut in comparison with untreated control.

Materials and methods

Pathogen isolation

The pathogen associated with the diseased plant parts of ground nut were cut into several pieces by scissors and placed on the moist filter paper (Whatman no.1). Three pieces of filter paper were moistened by dipping in sterile water were placed in each of the petri dish. The petri dishes with the diseased specimens were incubated at 22±2 °C under 12/12 alternating cycles of NUV and darkness in the incubation room of the Pathology Laboratory of Bangladesh Agricultural Research Institute (BARI) for 5-7 days. After incubation, the plates were examined under stereomicroscope for primary identification of the organisms (fungi). Further cultured on potato dextrose ager (PDA) plates and observed mustard seed like sclerotia.

Field experiment

A series of field experiments were conducted in Oil Seed Research Centre (ORC), Bangladesh Agricultural Research Institute (BARI) during the 2014 and 2015 growing seasons in fields naturally heavily infested with the root rot of groundnut. Three replicate plots (3 m × 2 m) with a spacing 40 cm × 15 cm for each treatment were prepared and arranged in a completely randomized block design. Groundnut variety BARI china badam-8 was used as planting material in this experiment. Each plot contained six rows, to comprise a total of 100 seeds per plot. Eight single treatments were, 1) soil drenching by Contaf 5 EC 0.1 %), 2) seed treatment with Provex 2.5 gkg^{-1} seed, 3) soil treated by *Tricho* compost 2.5 tha^{-1}, 4) combine application of seed treatment with Provex 2.5 tha^{-1} seed and soil drenching by Contaf 5 EC 0.1 %, 5) soil drenching by Contaf 5 EC 0.1 % and soil treated by *Tricho* compost 2.5 tha^{-1}, 6) seed treatment with Provex 2.5 gkg^{-1} seed, and soil treated by *Tricho* compost 2.5 tha^{-1}, 7) soil drenching by Contaf 5 EC 0.1 %, seed treatment by Provex 2.5 gkg^{-1} seed and soil treated (*Tricho* compost 2.5 tha^{-1}) and 8) control. Soil drenching were used furrow of the line and *Trocho*-compost were used within the two furrows before seed sowing. Intercultural operations were done and where needed. Nitrogen, phosphorus, and potassium fertilizers were applied at three rates recommended for peanut cultivation in different studies (El-Deeb and Ibrahim, 1998). Average pod yield of peanut was determined for each conducted treatment according to Morsy (1999), 120 days after planting. The plots were inspected regularly to observe the foot rot disease symptoms. Data were recorded on percentage of germination, percentage of seed rot**,** percentage of foot and root rot, number of mature nut $plant^{-1}$, number of immature nut $plant^{-1}$ and yield. Data were analyzed combine using SPSS program to compare the means for all phases of the two years experiments.

Results and discussion

Symptom of the foot rot disease of ground nut and isolation of the pathogen

In *Sclerotium rolfsii* induced foot rot, wet rot associated with wilting of vines is common. In the diseased plants fine young roots are infected first. The leaves and shoots turn yellow, wither and finally dry out to a pale brown color. The fungus attacks the roots and stem near the soil level (Fig. 1. A). Black lesion develops following necrosis of the plant cells. The mycelium invades the stem and rots the affected portions (Fig. 1. B). As a result, the plant become wilt and gradually dies. Abundant white mycelium and small light brown sclerotia form on the rotted plants. Gradually the rotting spreads through older roots and ultimately reaches the foot or collar region of the plant. In a diseased plant, the whole underground portion gets more or less completely rotten. When cultured in PDA plate *S. rolfsii* produced white cottony mycelia and further produced mastered seed like sclerotia (Fig. 1. C).

A **B** **C**

Fig. 1. A & B. Infected ground nut showing mycelium of *Sclerotium rolfsii*. C. Pure culture of *S. rolfsii*.

Effect of different management practices on the percentage of germination, seed rot and foot rot infection of groundnut seedling

Application of *Trichoderma harzianum* inoculum and soil drenching with 0.2 % carbendazim reduced the stem rot of groundnut caused by 44-60 % and increased the pod yields by 17-47 % (Asghari and Mayee, 1991). All Integrated Disease Management (IDM) modules were found to be superior over untreated control in reducing the diseases incidence and increasing nut yield during 2014 and 2015 presented in the figures. The experiment indicated the soil drenching of contaf 5EC (0.1%) along with seed treatment of Provex (2.5 gkg^{-1}) was found to be significantly effective by recording the minimum incidence of seed rot (7.0%) and foot rot (18.33%) during the two consecutive years. The trial indicated that seed treatment with Provex (2.5 gkg^{-1}) and soil drenching with contaf 5EC (0.1%) significantly gave highest nut yield (2.58 tha^{-1}), germination (92.5%) with lowest seed rot (7.0%) with minimum foot rot (18.33%) infection of ground nut production which was followed by the combine application of seed treatment with Provex (2.5 gkg^{-1}) and soil drenching with contaf 5EC (0.1%) and soil treated with *Tricho* compost (2.5tha^{-1}) treatments. However, combine application of seed treatment with Provex and soil drenching with contaf 5EC and soil treated with *Tricho*- compost @ (2.5 gkg^{-1}), (0.1%) and (2.5 tha^{-1}) respectively was subsequent best collection of nut yield (2.58tha^{-1}) and control of foot rot (22.16%) infection.

Germination percentage of the different treatments ranged 77.17 (%) to 91.15 (%). The maximum seed germination was recorded in combine application of Contaf 5 EC 0.1 and Provex 2.5 gkg^{-1} seed followed by another combine application of soil drenching of Contaf 5 EC 0.1, seed treatment of Provex 2.5 gkg^{-1} seed and soil treated with *Tricho* compost 2.5 tha^{-1} while the lowest number of germination (77.17%) we found from untreated Control. Besides 87.17 % and 83.24 % germination were counted from soil drenching with Contaf 5 EC (0.1 %), soil treated by *Tricho* compost 2.5 tha^{-1}, single application of soil drenching Contaf 5EC (Fig. 1). On the other hand, the minimum seed rot of 8.85 % was recorded the combine application of seed treated with Provex (2.5 gkg^{-1}) and soil drenching by Contaf 5EC (0.1%) treatment. The combine application of seed treated with Provex (2.5 gkg^{-1}) and soil drenching by Contaf 5EC (0.1%) ranked next to the three combine application (Provex 2.5 gkg^{-1}, Contaf 5EC (0.1%) and *Tricho* compost 2.5 tha^{-1}) in minimizing seed rot which was followed by other combine and single application.

The foot rot infection percentage due to different management and combination practices ranged from 18.24 to 42.65 %. We observed in our trail all the treatments significantly reduced foot rot infections of groundnut seedling over control. The highest foot rot infection (42.65) was recorded from untreated control while lowest infection was found from combine application of Contaf 5 EC 0.1 % and Provex 2.5 gkg^{-1} seed (18.24) (Fig. 2). Similar studies was observed by numerous researcher, Manu et.al (2012) reported that Hexaconazole, Tebuconazole and Propiconazole were found to be having strong inhibitory effect on the growth of *S. rolfsii* isolated from finger millet at lower concentration. Das et. al (2014) suggested that the fungicides i.e. Hexaconazole, Carboxin and Thiram (vitavex power), Tebuconazole and Propiconazole can be recommended to control *S. rolfsii* under field condition for the susceptible crop plants like Brinjal. Moreover, Bindu *et. al* (2011) reported that drenching of systemic fungicide such as Carbendazim and Dithane M-45 can be recommended as immediate control measure to protect against root rot. Finally adoption of integrated disease management was suggested for effective control of dry root rot disease. In addition, fungicide seed treatment shows to be economically feasible and relatively safer method for controlling both seed and soil-borne plant pathogens. It's may eliminate pathogens in seeds and can also protect seeds and seedlings from soil-borne pathogens (Geleta et al., 2007). Furthermore, the present findings are in conformity with the earlier reports, integration of disease management practices are more effective in controlling soil borne diseases *S. rolfsii* in ground nut (Appanna et al., 2011).

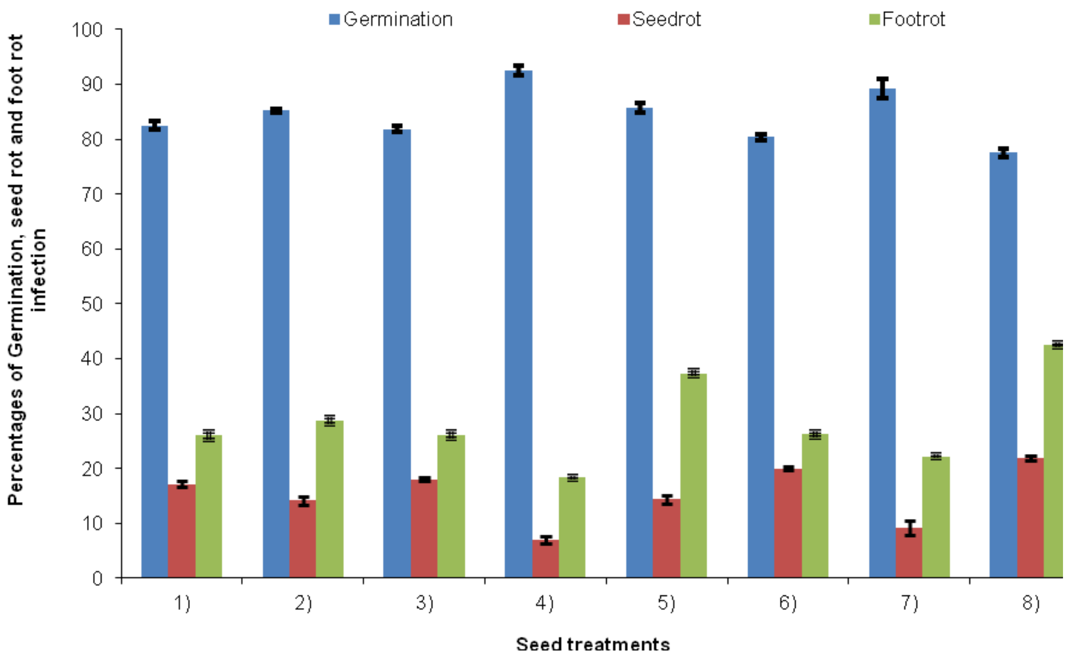

Fig. 2. Effect of different management practices on the percentage of germination, Seed rot and foot rot infection of groundnut seedling during 2014-2015. The treatments were, 1) soil drenching by Contaf 5 EC (0.1 %), 2) seed treatment with Provex 2.5 gkg^{-1} seed, 3) soil treated by *Tricho* compost 2.5 tha^{-1}, 4) combine application of seed treatment with Provex 2.5 tha^{-1} seed and soil drenching by Contaf 5 EC 0.1 %, 5) soil drenching by Contaf 5 EC 0.1 % and soil treated by *Tricho* compost 2.5 tha^{-1}, 6) seed treatment with Provex 2.5 gkg^{-1} seed, and soil treated by *Tricho* compost 2.5 tha^{-1}, 7) soil drenching by Contaf 5 EC 0.1 %, seed treatment by Provex 2.5 gkg^{-1} seed and soil treated *Tricho* compost 2.5 tha^{-1} and 8) control.

The effect of seed treatment with fungicide and bioagents on seed and seedling rots and effectively managed the diseases by seed treatment with carboxin and *T. harzianum* (Singh and Thapliyal, 1998). Likewise, seed treatment and soil drenching using Bavistin provided the highest disease control compared with individual methods (Kumar, 2011). A similar trend was also observed with Vitavax. These results are in agreement with the observations made by Vyas (1994) and Sharma et al. (2005). Studies conducted earlier have suggested using more than one type of bio agent for the management of *S. rolfsii* in addition to using both chemical and bio agent tools for its better management (Palaiah et al., 2007). However, some researcher found that the applications of *Tricho*-compost significantly reduced the pre- and post-emergence mortalities of cabbage seedlings caused by *S. rolfsii*; seedling mortalities were reduced by as much as 98% (Nahar et al., 2012). Bosah et.al (2010) reported that *Trichoderma* spp proved to be the most effective biocontrol agent against *S. rolfsii* and inhibited the growth of the pathogen by 80 % under *in vitro* conditions. On the other hand, in our study we did not find significant results through *Tricho*-compost.

Integrated management of foot rot (*Sclerotium rolfsii*) disease on the yield character of groundnut

By integrating different seed and soil treatments was taken up in susceptible variety of BARI china badam -8 to integrated management of foot rot diseases of ground nut. Data indicate that the combine application of seed treatment with Provex 2.5 gkg^{-1} and soil drenching by Contaf 5EC (0.1%) and soil treated with *Tricho*-compost @ 2.5 tha^{-1} were equally effective in controlling foot rot diseases. Yield and yield component of ground nut viz. number of mature nut $plant^{-1}$, number of immature nut $plant^{-1}$ and dry yield were also significantly affected by combine application of different treatments (Fig. 3). The combine application of seed treatment with Provex 2.5 gkg^{-1} and soil drenching by Contaf 5EC (0.1%) resulted in significantly increased mature nut and dry nut yield compared with untreated control. We observed effective management of foot rot and significant yield benefit from groundnut can be obtained through integrated use of seed treated with Provex 2.5 gkg^{-1} seed and Contaf 5 EC (0.1 %) for soil drenching. So, use of seed treated with Provex 2.5 gkg^{-1} seed and Contaf 5 EC (0.1 %) for soil drenching may be suggested to use by the farmer for controlling foot and root rot disease of eggplant.

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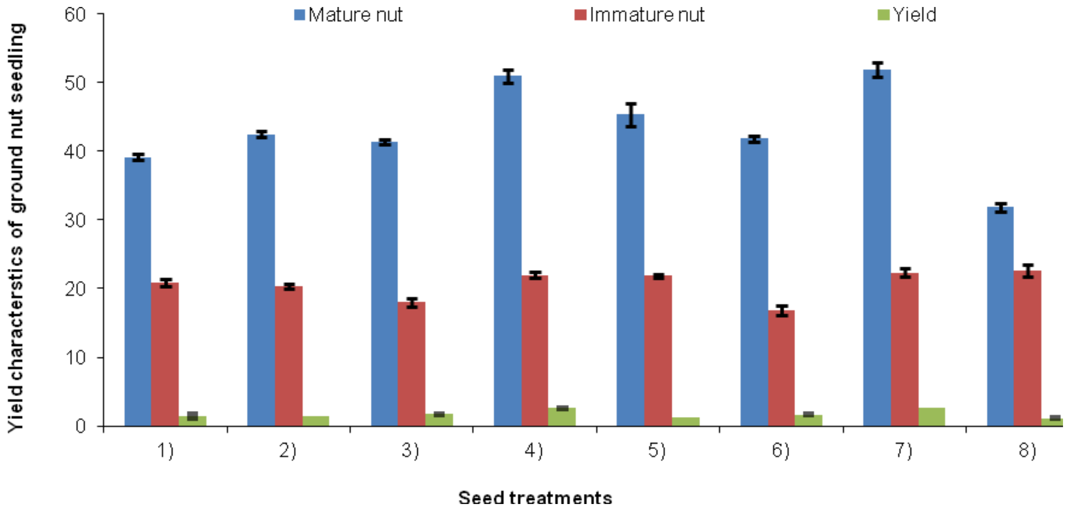

Fig. 3. Integrated management of foot rot (*S. rolfsii*) disease on the yield character of groundnut (2014-2015). Eight single treatments were, 1) soil drenching by Contaf 5 EC 0.1 %, 2) seed treatment with Provex 2.5 gkg^{-1} seed, 3) soil treated by *Tricho* compost 2.5 tha^{-1}, 4) combine application of seed treatment with Provex 2.5 tha^{-1} seed and soil drenching by Contaf 5 EC 0.1 %, 5) soil drenching by Contaf 5 EC 0.1 % and soil treated by *Tricho* compost 2.5 tha^{-1}, 6) seed treatment with Provex 2.5 gkg^{-1} seed, and soil treated by *Tricho* compost 2.5 tha^{-1}, 7) soil drenching by Contaf 5 EC 0.1 %, seed treatment by Provex 2.5 gkg^{-1} seed and soil treated (*Tricho* compost 2.5 tha^{-1}) and 8) control.

Relationship of yield with incidence of foot rot and seed rot infection

Correlation and regression analysis was performed to find out the relationship of yield with incidence of foot rot and seed rot of groundnut grown in field condition (Fig. 4 and 5). The yield increase over control was significant under all treatments with Contaf 5EC and Provex. The highest yield was obtained with seed treatment with Provex 2.5 gkg^{-1} seed and soil drenching by Contaf 5 EC (0.1 %), which was statistically similar to seed treatment with Provex 2.5 gkg^{-1} seed and soil drenching by Contaf 5 EC (0.1 %) and soil treated by *Tricho* compost 2.5 tha^{-1}. The lowest yield increase was found under untreated control followed by combine application of soil drenching with Contaf 5 EC (0.1 %) and soil treated by *Tricho* compost 2.5 tha^{-1}.

Pooled data on those parameters were used for this analysis and found that the relationship was linear and negative for fruit yield with foot rot and seed rot values with coefficient of correlations (r) 0.819 and 0.799, respectively (Fig. 4 and 5). The relationship was significant in case of fruit yield with incidence of foot rot and seed rot on those two parameters may be attributed to 81.90% (R^2=0.672) and 79.90% (R^2=0.639), successively (Fig. 4 and 5).

Conclusions

The beneficial effect of *Trichoderma* in crops has been a main focus in the recent past. The results of the present study would suggest that use of *Trichoderma* species can provide protection against *S. rolfsii* infection resulting in increased crop growth and productivity. The ability of these biocontrol agents to persist in soil can also provide protection in the next crop as well. However, individual applications did not give similar results as combine application. The soil and seed treatments improved groundnut yield. Among the treatments tested in the present study, the most effective one was seed treatment with Provex 2.5 gkg^{-1} seed and soil drenching by Contaf 5 EC (0.1 %), which was statistically similar to seed treatment with Provex 2.5 gkg^{-1} seed and soil drenching by Contaf 5 EC (0.1 %) and soil treated by *Tricho* compost 2.5 tha^{-1}. Based on research findings of the present investigation these two treatments may be recommended for controlling foot rot of groundnut.

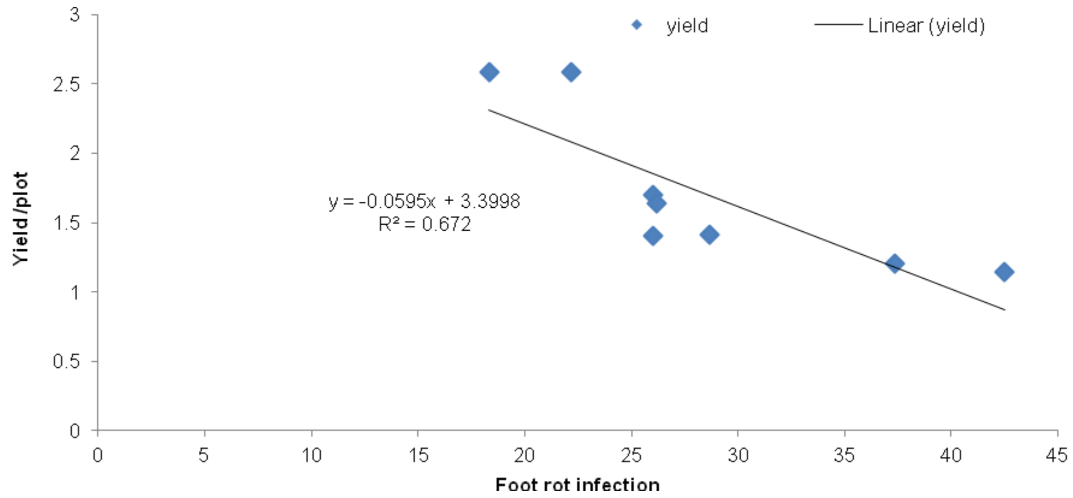

Fig. 4. Relationship of yield with foot rot of groundnut grown in infected field condition.

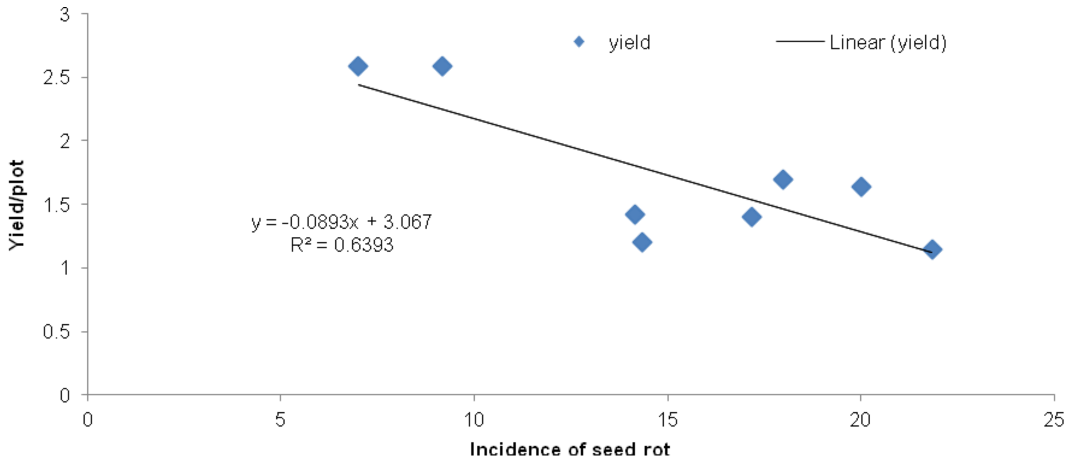

Fig. 5. Relationship of yield with seed rot of groundnut grown in infected field condition.

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