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RESEARCH ARTICLE

INTEGRATED MANAGEMENT OF LATE LEAF SPOT AND RUST DISEASES OF PEANUT (*ARACHIS HYPOGAEA* L.)

B. Meena*

Coconut Research Station, Tamil Nadu Agricultural University, Aliyarnagar– 642 101, Tamil Nadu, India
Email: meepath@gmail.com

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Abstract: Groundnut or Peanut (*Arachis hypogaea* L.) is an important oilseed crop widely grown in major tropical and sub-tropical regions of the world. Late leaf spot (LLS, *Phaeoisariopsis personata*) and rust (*Puccinia arachidis*) are the two major biotic constraints in groundnut of global importance. Six isolates of *Bacillus subtilis* were isolated from the rhizosphere of groundnut using Nutrient Agar Medium. The effect of *Bacillus subtilis* isolates against foliar diseases of groundnut was studied under pot culture condition. From the results, it was found that *Bacillus subtilis* isolate *Bs1* was effective in managing the late leaf spot and rust diseases of groundnut. Hence, field experiment was conducted during 2021 and 2022 using the talc formulation of the effective isolate *Bacillus subtilis Bs1* for the management of foliar diseases of groundnut. The pooled mean results of the field experiments conducted during 2021 and 2022 revealed that seed treatment with *Bacillus subtilis* Bbv57 talc formulation @ 10 g/kg seed followed by foliar spray of Tebuconazole 50% + Trifloxystrobin 25% @ 1 g/l at 40 and 60 DAS was effective in managing the foliar diseases of groundnut with the late leaf spot (18.8 PDI) and rust (11.5 PDI) diseases. The maximum late leaf spot of 62.6 PDI and rust of 43.7 PDI respectively were recorded in the untreated control. In addition to disease reduction, the pod yield (2472 kg/ha) and haulm yield (2889 kg/ha) were found to be maximum in this treatment. In the untreated control, minimum pod yield of 1871 kg/ha and haulm yield of 2026 kg/ha were observed.

Keywords: Groundnut, Late leaf spot, Rust, *Bacillus*, Fungicides

INTRODUCTION

Groundnut (*Arachis hypogaea* L.) is an important oilseed, food and feed crop of India contributing about 24% and 29% to total area and production of oilseeds respectively. Peanut is also called as "Wonder nut" or poor man's almond. It is an important oilseed crop with high levels of proteins, carbohydrates, vitamins and minerals contained within seeds. Groundnut is cultivated as *kharif* (rainfed or monsoon season) and *rabi-summer* (irrigated) crop and well drained, sandy soils are best suited for groundnut production.

The groundnut crop in general experiences several serious biotic and abiotic challenges that limit pod yields. Diseases of groundnut reduce the yield and quality and increase the production cost wherever the crop is grown. Late leaf spot caused by *Phaeoisariopsis personata* and rust caused by *Puccinia arachidis* are the foremost serious fungal diseases of groundnut on a world-wide scale and account for more than 50% yield loss (Nataraja *et al*.,2014). The late leaf spot usually appears at 55 to 60 days after sowing and causes more than 50% loss in pod and haulm yield (Hegde*et al*., 2016). The combined infection of rust and leaf spots cause pod losses of more than 70%, if not managed (Savary and Zadoks, 1992). *Alternaria* leaf blight is another fungal disease causing blighting of groundnut leaves. Reduction in pod and haulm yield was reported as 25.3% and 53.0% respectively (Eswara Reddy and Venkateswara Rao, 1999).

The deployment of host plant resistance for LLS and rust management is limited by the absence of desirable levels of disease resistance coupled with agronomic traits such as seed shape, testa colour and pod filling, in cultivated groundnut. Application of chemical fungicides is considered as the preferred disease management strategy among the farmers and their indiscriminate application has serious adverse effect on beneficial insects, human health and surrounding environment. Biological control had attained importance in modern agriculture for disease control. Since the efficacy of bio-control agents in disease abatement has been inconsistent due to their inability to maintain a critical threshold population necessary for sustained bio-control activity, bio-control with antagonistic microorganism alone could not be an entire replacement for management strategies currently employed. The increasing

*Corresponding Author

problems by continued usage of pesticides and failure of individual IPM components to reduce the pest population necessitate the event of IPM modules that involves the synergistic integration of IPM components. Hence, the present research was undertaken to evaluate the fungicides and bioagent, *Bacillus subtilis* talc formulation for the management of late leaf spot and rust diseases of groundnut.

MATERIALS AND METHODS

Isolation of *Bacillus subtilis* from rhizosphere of groundnut

The isolation of *Bacillus subtilis* isolates was done using Nutrient Agar Medium. The rhizosphere soil was collected from groundnut crop and isolation of bacterial antagonists was made by serial dilution technique with 10^{-6} dilution. The plates were incubated at 28°C for 48 hours. The bacterial cultures were further purified by streaking on to the Nutrient Agar plates. Totally six isolates were isolated. Single pure culture colonies of these isolates were sub cultured and maintained on Nutrient Agar slants.

Preparation of bacterial inoculum

The potential *Bacillus subtilis* isolates (containing $1x10^8$cfu/g) were grown in 100 ml Nutrient broth in 250 ml conical flasks and incubated on a rotary shaker (150 rpm min^{-1}) for 48 hrs at room temperature (28±2°C). The fresh culture broth after 48 hrs was used as bacterial inoculum for foliar application.

Pot culture studies to test the efficacy of *Bacillus subtilis*isolates against late leaf spot and rust diseases of groundnut

The effect of *Bacillus subtilis*isolates against foliar diseases of groundnut was studied under pot culture condition. The susceptible groundnut cultivar Co 2 was used for the pot culture experiment. The groundnut plants (45 days old) were sprayed with cell suspension of *Bacillus subtilis* isolates (10^6 cells/ml). The plants were challenge inoculated with spore suspension of late leaf spot and rust pathogen (10^5spores/ml). The plants sprayed with water served as the control. The foliar diseases *viz*., late leaf spot and rust were scoredusing Modified 1-9 disease scale as proposed by Subramanyam*et al*., 2008.

Field experiment on the effect of integration of bioagent, *Bacillus subtilis*and fungicidesin managing foliar diseases of groundnut

Management trials on foliar diseases of groundnut using bioagent, *Bacillus subtilis* Bbv57 talc formulationand fungicides wereconducted during 2021 and 2022 at Coconut Research Station, Aliyarnagar, and Tamil Nadu Agricultural University (identified as hot spot area for leaf spot and rust diseases of groundnut). The field experiments were laid out in Randomized Block Design with seven treatments and three replications. The susceptible groundnut variety Co2 was used for the field experiments. The plot size was 5.0 m x 4.0 m and spacing of 30 cm x 10 cm was adopted. The treatments were imposed as per the schedule. Seeds were treated with bioagent *Bacillus subtilis* Bbv57 talc formulation @ 10 g/kg or fungicide Tebuconazole 2DS @ 1.5 g/kg. Foliar application was done with fungicides Tebuconazole 50% + Trifloxystrobin 25% @ 1 g/l or Azoxystrobin 22.9% @ 1 g/l or Tebuconazole 25.9%EC @ 1 ml/l or Difenoconazole 11.4%EC @ 1 ml/l or*B. subtilis* @ 1 g/l. Two rounds of spraying were made at 40 DAS and 60 DAS.

The plots not treated with fungicides or bioagent served as the control. The disease intensity of foliar diseases *viz*., late leaf spot (LLS) and rust were recorded at the time of physiological maturity by random selection of 25 plants per plot for each treatment. Modified 1-9 disease scale was used for scoring late leaf spot and rust diseasesof groundnut as proposed by Subramanyam *et al*., 2008.

Per cent disease index (PDI) was calculated using the formula

$$PDI = \frac{\text{Sum of numerical ratings}}{\text{Number of plants observed} \times \text{Maximum disease grade}} \times 100$$

The pod yield and haulm yield were also recorded for each treatment. The data were statistically analyzed by Duncan's Multiple Range Test.

Table 1. Scoring for foliar diseases of groundnut using Modified 1-9 scale (Subrahmanyam *et al*., 1985)

Disease score	Infection percentage
1	0% infection on leaves
2	1-5% infection on leaves
3	6-10% infection on leaves
4	11-20% infection on leaves
5	21-30% infection on leaves
6	31-40% infection on leaves
7	41-60% infection on leaves
8	61-80% infection on leaves
9	81-100% infection on leaves

RESULTS AND DISCUSSION

About six isolates of *Bacillus subtilis* were isolated from the rhizosphere soil of groundnut plant using Nutrient Agar Medium. The isolates were purified, identified and maintained at 4°C.The results of the pot culture experiment conducted on the efficacy of *Bacillus subtilis* isolates against foliar diseases of groundnut revealed that the isolate *Bacillus subtilis Bs1*recorded the minimum late leaf spot and rust disease grade of 1 respectively (Table 2). The isolates *Bacillus subtilis Bs2* and *Bs4* recorded the late leaf spot and rust disease grade of 2 respectively. The isolate *Bacillus subtilis Bs3* recorded the late leaf spot disease grade of 4 and rust disease grade of 3 respectively. The late leaf spot disease grade of 3 and rust disease grade of 2 respectively was recorded by the isolates *Bacillus subtilis Bs5 and Bs*6. The maximum late leaf spot and rust disease grade of 6 respectively was observed in the untreated control (Table 2).

Every effort should be made to utilize all available and compatible disease control measures. The pooled mean results of the field experiments conducted for the management of foliar diseases of groundnut during 2021 and 2022 revealed that seed treatment with *Bacillussubtilis*Bbv57 talc formulation @ 10 g/kg seed followed by foliar spray of Tebuconazole 50% + Trifloxystrobin 25% @ 1 g/l at 40 and 60 DAS was effective in managing the foliar diseases of groundnut with the late leaf spotof 18.8 PDI and rust of 11.5 PDI respectively. Seed treatment with *B. subtilis* @ 10 g/kg seed followed by foliar spray of Tebuconazole 25.9%EC @1 ml/l at 40 and 60 DAS ranked next with late leaf spot of 21.6 PDI and rust of 12.7 PDI respectively (Table 3).

Seed treatment with Tebuconazole 2 DS @ 1.5 g/kg seed followed by foliar application of *B. subtilis* @ 1 g/l at 40 and 60 DAS recorded late leaf spot of 28.1 PDI and rust of 23.6 PDI respectively. The fungicides *viz.*, azoxystrobin, chlorothalonil and tebuconazole were found to be effective for the management of leaf spot and stem rot in groundnut (Hagan *et al*., 2010). In the control, maximum late leaf spot of 62.6 PDI and rust of 43.7 PDI were observed (Table 3). The effectiveness of fungicide tebuconazolein managing leaf spot disease of groundnut was reported by Grichar *et al*., 2010.The effect of seed treatment in peanut against seedling diseases was highlighted by Dudi and Lodha (2003). Dutta and Das (2002) reported that the significant disease reduction of collar rot in tomato was obtained by integration of fungicides and biocontrol agent, Trichoderma sp. Jadon *et al*., 2017 documented the integrated disease management of foliar and soil borne diseases with fungicides, castor cake and *Trichoderma* in groundnut. De *et al*., 2003; Ramkishore and Singh, 2008 reported that the reduction of foliar disease severity in linseed was observed by treating seeds with Carbendazim + Thiram. Wann *et al*. (2011) reported that leaf spot disease in groundnut could be managed using fungicides.

Integrated management of diseases by combining chemical and biological method would be an effective method for the management of diseases compared to adopting single method.The maximum pod yield of 2472 kg/ha and haulm yield of 2889 kg/ha were observed in the effective treatment of seed treatment with *Bacillussubtilis* talc formulation @ 10 g/kg seed followed by foliar spray of Tebuconazole 50% + Trifloxystrobin 25% @ 1 g/l at 40 and 60 DAS.The enhanced pod yield in groundnut obtained by seed treatment with hexaconazole was reported by Dandnaik*et al*., 2009. Seed treatment with *B. subtilis* @ 10 g/kg seed followed by foliar spray of Tebuconazole 25.9%EC @ 1 ml/l at 40 and 60 DAS ranked next with pod yield and haulm yield of 2356 and 2813 kg/ha respectively (Table 3). In the untreated control, minimum pod yield of 1871 kg/ha and haulm yield of 2026 kg/ha were recorded (Table 3). The effect of seed treatment in increasing the pod yield was reported by several workers (Dutta and Das, 2002; De *et al*., 2003; Balode, 2010; Jadon, 2017).

Table 2. Efficacy of *Bacillus subtilis* isolates against late leaf spot and rust (Pot culture experiment)

B. subtilis isolates	Late leaf spot Disease grade	Rust Disease grade
*Bs*1	1	1
*Bs*2	2	2
*Bs*3	4	3
*Bs*4	2	2
Bs5	3	2
*Bs*6	3	2
Control	6	6

Table 3. Management of foliar diseases of groundnut (Pooled mean of 2021 & 2022)

S.No.	Treatments	Late leaf spot (PDI)	Rust (PDI)	Pod yield (kg/ha)	Haulm yield (kg/ha)
T_1	Seed treatment with *Bacillussubtilis* Bbv57 @ 10 g/kg + FS of Tebuconazole 50% + Trifloxystrobin 25% @ 1 g/l at 40 & 60 DAS	18.8 (21.6)	11.5 (13.9)	2472	2889
T_2	Seed treatment with *B. subtilis* @ 10 g/kg + FS of Azoxystrobin 22.9% @ 1 g/l at 40 & 60 DAS	24.5 (27.3)	20.4 (22.6)	2248	2739
T_3	Seed treatment with *B. subtilis* @ 10 g/kg + FS of Tebuconazole 25.9%EC @ 1 ml/l at 40 & 60 DAS	21.6 (24.4)	12.7 (14.3)	2356	2813
T_4	Seed treatment with *B. subtilis* @ 10 g/kg + FS of Difenoconazole 11.4%EC @ 1 ml/l at 40 & 60 DAS	22.3 (25.7)	18.2 (20.7)	2272	2783
T_5	Seed treatment with Tebuconazole 2 DS @ 1.5 g/kg + FS of *B. subtilis* @ 1 g/l at 40 & 60 DAS	28.1 (31.7)	23.6 (25.4)	1928	2134
T_6	Seed treatment with Tebuconazole 2 DS @ 1.5 g/kg + FS of Tebuconazole 25.9%EC @ 1 ml/l at 40 & 60 DAS	26.3 (29.6)	21.8 (23.1)	1993	2364
T_7	Untreated control	62.6 (65.1)	43.7 (45.2)	1871	2026
	CD(P=0.05)	2.41	1.86	43.71	32.69
	SE(d)	1.63	0.87	21.83	17.39

*Mean of three replications Var : Co2

CONCLUSION

Seed treatment with *Bacillus subtilis* Bbv57 talc formulation @ 10 g/kg of seed followed by foliar spray of Tebuconazole 50% + Trifloxystrobin 25% @ 1 g/l at 40 and 60 DAS was found to be effective in managing the late leaf spot and rust diseases of groundnut with increased pod yield and haulm yield.

REFERENCES

Dandnaik, B.P., Patil, D.T., Chavanand, M.H. and Dandnaik, A.B. (2009). Chemical control of stem rots of groundnut caused by *Sclerotium rolfsii*. *Journal of Mycology and Plant Pathology*,**39**:185.

Google Scholar

De, R.K., Dwivedi, R.P. and Udit Narain (2003).Biological control of lentil wilt caused by *Fusariumoxysporum*fsp.lentis. *Annals of Plant Protection Sciences*, **11**: 46-52.

Google Scholar

Dudi, J. and Lodha, P.C. (2003).Compatibility of seed dressing fungicides with rhizobium in groundnut. National seminar : Stress management in oil seeds, 28-30. p. 24-25.

Google Scholar

Dutta, P. and Das, B.C. (2002). Management of collar rot of tomato by Trichoderma spp. and chemicals. *Indian Phytopathology*, **55**: 235-237.

Google Scholar

Eswara Reddy, N.P. and Venkateswara Rao, K. (1999).Chemical control of Phaeospariopsis leaf spot of groundnut. *J. Plant dis. and prot*.**106**: 507-511.

Google Scholar

Grichar, W.J., Jaks, A.J. and Woodward, J. (2010).Using prothioconazole plus tebuconazole for foliar and soil borne diseases control in Texas peanut.Crop management.CM--0405-02-RS.

Google Scholar

Hagan, A.K., Campbell, H.L., Bowen, K.L., Wells, L. and Goodman, R. (2010). Managing early leaf spot and stem rot with reduced fungicide inputs on disease resistant peanut cultivars. *Peanut Science*,**37**: 129-136.

Google Scholar

Hegde, Y.R., Ravichandran, S. and Keshgond, R. (2016). Bioefficacy of new molecules against fungal foliar diseases of groundnut. Journal of Pure and Applied Microbiology, **10**: 635.

Google Scholar

Jadon, K.S., Thirumalaiswamy, P.P., Vinod Kumar, Koradia, V.G. and Padavi, R.D. (2017). Integrated management of major foliar and soil borne diseases of pea nut (*Arachis hypogeae* L.) with fungicides, Trichoderma and Castor cake. *Int. J. Curr. Microbiol. App. Sci.*, **6**(12): 1884-1899.

Google Scholar

Nataraja, M.V., Jadon, K.S., Holajjer, P., Thirumalaisamy, P.P., Jasrotia, P. and Ram Dutta.(2014). Integrated Pest and Disease Management in Groundnut. Directorate of Groundnut Research, Technical bulletin, p. 19.

Google Scholar

Ramkishore, R. and Singh, J. (2008).Evaluation of fungicides against *Fusarium oxysporum* f.sp.*lentis* of

linseed. *Anals of Plant Protection Sciences,* **16**: 165-167.

Google Scholar

Savary, S. and Zadoks, J.C. (1992).Analysis of crop loss in the multiple pathosystem groundnut-rust-late leaf spot. II. Study of the interactions between diseases and crop intensification in factorial experiments. *Crop Protection*, **11**: 110–120.

Google Scholar

Subrahmanyam, P., McDonald, D., Waliyar,, E., Reddy L.J., Nigam, S.N., Gibbons, R.W. and Thind, T.S. (2008). Screening methods and sources of resistance to rust and late leaf spot of groundnut (In En.Summaries in En, Fr, Sp, and Pt.).Information Bulletin no. 47.Patancheru 502 324, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics, p. 24.

Google Scholar

Wann, D.Q., Tubbs, R.S. and Culbreath, A.K. (2011). Genotype and approved fungicides evaluation for reducing leaf spot diseases in organically-managed peanut. Plant Health Progress. (October): PHP-2010-1027-01-RS, 2011.

Google Scholar