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Management of Collar Rot Disease in Groundnut (*Arachis hypogaea* L.) Caused by *Aspergillus niger* in Rajasthan Through Bio-control Agents

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ABSTRACT

Background: Groundnut is an economically important edible oilseed crop. Groundnut suffers from seed, soil and foliar diseases. Among the groundnut diseases, collar rot is one of the economically important diseases. Collar rot is damaged regularly due to its seed and soil-borne nature. This disease is prevalent in almost all groundnut-growing states. Collar rot disease of groundnut is one of the most serious, destructive diseases and yield losses range from 13 to 52% and can be as high as 93.6% in some areas. Being mainly a soil-inhabiting pathogen, many environmental and soil factors are responsible for disease development.

Methods: Field experiment was conducted for four years to find out effective control of collar rot of groundnut. Eight treatments including fungicides/bio agents along with control were laid in randomized block design with three replications. Efficacy of deep summer ploughing with mould board plough+Seed treatment with Tebuconazole followed by PGPR+Soil application of *Trichoderma* enriched in 250 kg FYM/ha at 35 and 80 DAS along with farmer practices as well as control was tested at ARS, Bikaner in RBD design during *kharif* season from 2017 to 2020 for management of collar rot diseases of groundnut.

Result: The result of experiment revealed that deep summer ploughing with mould board plough+Soil application of *Trichoderma* @ 4 kg/ha enriched in 250 kg FYM/ha+Seed treatment with Tebuconazole 2 DS @ 1.5 g/kg of seed followed by seed treatment with PGPR @ 625 g/ha of seed+Soil application of *Trichoderma* @ 4 kg/ha enriched in 250 kg FYM/ha at 35 and 80 DAS (T_4) gave maximum germination (93.00%), minimum collar rot incidence (6.17%) and highest pod yield (4066.3 kg/ha) followed by deep summer ploughing with mould board plough+Seed treatment with Tebuconazole 2DS 1.5 g/kg seed followed by PGPR @ 625 g/ha of seed+Soil application of *Trichoderma* @ 4 kg/ha enriched in 250 kg FYM/ha at 35 and 80 DAS (T_1) where germination (89.30%), collar rot (7.04%) and with pod yield (3661.9 kg/ha). All the treatment significantly were superior as compared to control, where minimum germination (82.00), maximum collar rot incidence (15.59%) and minimum pod yield (2125.1 kg/ha) were recorded. As regard to ICBR, in different treatments, maximum ICBR ratio (1:20.68) was recorded in treatment consisting (T_4): Deep summer ploughing with mould board plough+Seed treatment with Tebuconazole 1.5 g/kg seeds+Soil application of *Trichoderma* @ 4 kg/ha enriched in 250 kg FYM/ha at 35 and 80 DAS followed by treatment (T_1).

Key words: *Aspergillus niger*, Carboxin+mancozeb, Groundnut, PGPR, Tebuconazole 2DS, *Trichoderma*.

INTRODUCTION

Groundnut (*Arachis hypogaea* L.) is a member of sub-family, *Papilionaceae* of the family *Leguminacaeae*. Groundnut (*Arachis hypogea* L.) is commonly also called peanut, goober pea, pindad jack nut, manila nut, pygmy nut, pignut and monkey nut (Rathnakumar *et al*., 2013). It is known as 'king of oil seeds' (Aycock, 1966).

India has second position in production after China. In India area, production and productivity are 6.09 million hectare, 10.21 million ton and 1676 ka/ha, respectively (Annonymous, 2020-21) In India groundnut rank first (36%), soybean (28%) and rapeseed mustard (23%). It is known as king of oilseed due to 35.99% production of total oilseed. In Rajasthan area, production and productivity are 7.95 Lac hectare, 19.24 lac ton and 2300 ka/ha, (Anonymous, 2021-22). In Bikaner has maximum area, production and productivity 2.43 lac ha, 7.29 lac ton and 3000 kg/ha, respectively (Anonymous, 2021-22).

More than 70 diseases due to fungi, bacteria, viruses, nematodes *etc.* have been reported and estimated yield loss to be up to 70% (McDonald *et al*., 1985; Lukose *et al.,* 2008). Among diseases, stem rot, collar rot, aflaroot, leaf

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spots (early and late), rust and bud necrosis affects the groundnut crop. However, the incidence and severity of these diseases may vary from season to season. Diseases reduce the pod yield of groundnut and also fodder quality of haulm. Collar rot/seedling blight (*Aspergillus niger* van Tieghem), stem rot /Sclerotium wilt (*Sclerotium rolfsii* Sacc) dry wilt or dry root rot (*Macrophomina phaseolina* (Tassi) Goid-*Rhizoctonia bataticola* (Taub.,Butler) have been recognized as economically important diseases. Among these diseases, collar rot diseases is the most predominant, devastating as well as yield reducing factor of groundnut in north western plain zone of Rajasthan. Collar rot of groundnut is a serious problem in arid and semi-arid region of Rajasthan and causes considerable yield losses to be 28–50% in northern part of India (Bakhetia 1983). The conventional method to control the diseases in groundnut crop is fungicide application (Gangopadhyay *et al.,* 1996; Nutsugah *et al.,* 2007; Rakholiya *et al.,* 2012).

Collar rot of groundnut was first reported from India by Jain and Nenra (1952). This disease is prevalent in almost all groundnut growing states of India *viz*, Punjab andhra Pradesh, Tamil Nadu, Uttar Pradesh, Gujarat, Maharashtra, Rajasthan, Karnataka and Orissa. Collar rot is causing more damage in sandy loam and medium black soil. The most of the groundnut cultivars are susceptible to this disease. The disease is expressing their symptoms in pre and post emergence phases. Infected seeds become black. Many seed dressing fungicides are reported to be effective against collar rot of groundnut (Gangopadhyay *et al*.; 1996, Karthikeyan, 1996). The loss due to this disease was reported 28 to 50% (Bakhetia, 1983). In Rajasthan due to warm climates grains are easily infected with Aspergillus niger. Annual world yield losses by the disease are more than 10% and fungus is prevalent in soils with the low moisture and approximately 30°C temperature. *Aspergillus niger* was the most toxic fungus and causing yellowing of the leaves, blighting effect on the shoot part and at last finally leading to death of crown portion of the plants. (Suzui and Makino, 1980). The objective of this study was "Management of collar rot disease in groundnut caused by *Aspergillus niger* through bio-control agents.

MATERIALS AND METHODS

The field experiment was conducted during *kharif* season from 2017 to 2020 at Agriculture Research Station, Swami Keshwanand Rajasthan Agriculture University, Bikaner (Rajasthan). The region falls under Hyper arid and partially irrigated plain regions (Agro Climatic Zone-Ic) of Rajasthan. Sowing was done in the last week of June using HNG-10 cultivar of groundnut. The experiment was laid out in randomized block design (RBD) with three replications and eight treatments with control using 30×15 cm and with plot size of (5 m×3 m) for each treatment to find out effective seed treatment fungicides and bioagents for control of collar rot of groundnut. Observations of germination percentage, disease incidence and pod yield were recorded. The recommended package of practices was followed for the experiment.

Per cent collar rot incidence was calculated by following formula:

$$\text{Per cent disease incidence} = \frac{\text{Number of infected plant}}{\text{Total number of plant}} \times 100$$

The yields were recorded after harvesting the crop at maturity and the weight of pods at every plot was separately to calculate the yield per hectare.

Experiment details

I. Treatments.

T_1: Deep summer ploughing with mould board plough+Seed treatment with Tebuconazole 2DS 1.5 g/kg seeds followed by PGPR @ 625 g for per ha of seeds+Soil application of *Trichoderma* @ 4 kg/ha enriched in 250 kg FYM/ha at 35 and 80 DAS.

T_2: Deep summer ploughing with mould board plough+Seed treatment with *T. viride* 10/kg seeds followed by PGPR @ 625 g for per ha of seeds+Soil application of *Trichoderma* @ 4 kg/ha enriched in 250 kg FYM/ha at 35 and 80 DAS.

T_3: Deep summer ploughing with mould board plough+Seed treatment with Tebuconazole 2DS 1.5 g/kg seeds +Soil application of *Trichoderma* @ 4 kg/ha enriched in 250 kg FYM/ha at 35 and 80 DAS.

T_4: Deep summer ploughing with mould board plough+Soil application of *Trichoderma* @ 4 kg/ha enriched in 250 kg FYM/ha+Seed treatment with Tebuconazole 2DS @ 1.5 g/kg of seeds followed by seed treatment with PGPR @625 g for per ha of seeds+Soil application of *Trichoderma* @ 4 kg/ha enriched in 250 kg FYM/ha at 35 and 80 DAS.

T_5: Sowing at a depth of 2.5 cm+seed treatment with Carboxin+Mancozeb @ 2 g/kg seed+ Tebuconazole 25.9EC @ 1.5 mL/L @ 10 DAG.

T_6: Intercropping with bajra (10:2 rows) + Sowing at a depth of 2.5 cm+seed treatment with Carboxin+Mancozeb @ 2 g/kg seed+Tebuconazole 25.9EC @ 1.5 mL/L @ 10 DAG.

T_7: Farmers' Practice (respective centre).

T_8: Control (without any treatments).

II. Replications: Three

III. Design: R.B.D.

IV. Plot size: 5.0 m × 3.0 m (10 rows)

V. Spacing: 30 cm × 10 cm

VI. Seed rate: 90 kg/ha

VII. Crop and Variety: Groundnut, HNG-10

RESULTS AND DISCUSSION

The data presented in Table 1 revealed that first year of study all treatments were significantly superior over the control. maximum germination (96.00%), minimum collar rot incidence (5.94%) and highest pod yield (2553.3 kg/ha)

Table 1: Evaluation of different bioagents/fungicides for management of collar rot (*Aspergillus niger*) disease in groundnut (*Kharif*-2017 to 2020).

Treatment	Germination (%)				Collar rot disease incidence (%)				Pod Yield (kg/ha)			
	2017	2018	2019	2020	Mean	2017	2018	2019	2020	Mean	2017	2018	2019	2020	Mean
T_1	94.0	93.0	87.0	83.0	89.3	7.38 (15.76)	6.76(15.07)	6.33(14.57)	7.67(16.07)	7.04(15.39)	2246.6	2944.4	4836.6	4620	3661.9
T_2	93.0	92.0	88.0	84.0	89.3	8.65 (17.10)	9.51(17.96)	8.67(17.12)	9.00(17.46)	8.96(17.42)	1871.0	2493.3	4366.6	3855	3146.5
T_3	92.0	92.0	87.0	86.0	89.3	10.15 (18.57)	9.75(18.19)	7.00(15.34)	8.33(16.78)	8.81(17.27)	1644.4	1933.3	4516.6	4320	3103.6
T_4	96.0	97.0	90.0	89.0	93.0	5.94(14.10)	5.74(13.86)	5.67(13.78)	7.33(15.71)	6.17(14.38)	2533.3	3475.5	5453.3	4803	4066.3
T_5	93.0	94.0	85.0	82.0	88.5	8.06 (16.49)	7.81(16.22)	8.33(16.78)	9.33(17.79)	8.38(16.83)	2044.4	2824.4	4183.3	4030	3270.5
T_6	91.0	90.0	86.0	80.6	86.9	11.17 (19.52)	10.15(18.57)	10.33(18.75)	12.00(20.27)	10.91(19.29)	1546.6	1744.4	3600.0	3827	2679.5
T_7	90.0	88.0	81.0	76.0	83.8	12.79 (20.95)	10.64(19.03)	11.67(19.98)	13.67(21.70)	12.19(20.43)	1426.6	1404.4	3073.3	3200	2276.1
T_8	88.0	87.0	79.0	74.0	82.0	19.63 (26.29)	14.80(22.62)	13.00(21.13)	15.33(23.05)	15.69(23.33)	1313.3	1346.6	2813.3	3027	2125.1
SEm±						2.43	0.97	0.41	0.57	0.58	208.50	238.8	305.5	308	265.2
CD at 5%						4.65	2.96	1.24	1.71	1.70	635.80	724.4	926.6	934	805.2
CV%						16.08	11.00	7.97	9.51	11.82	12.11	14.87	12.89	13.47	13.3

were observed in the treatment of deep summer ploughing with mould board plough+Soil application of *Trichoderma* @ 4 kg/ha enriched in 250 kg FYM/ha+Seed treatment with Tebuconazole 2DS @ 1.5 g/kg of seeds followed by seed treatment with PGPR @ 625 g for per ha of seeds+Soil application of *Trichoderma* @ 4 kg/ha enriched in 250 kg FYM/ha at 35 and 80 DAS (T_4) followed by deep summer ploughing with mould board plough+Seed treatment with Tebuconazole 2DS 1.5 g/kg seeds followed by PGPR @ 625 g for per ha of seeds+Soil application of *Trichoderma* @ 4 kg/ha enriched in 250 kg FYM/ha at 35 and 80 DAS(T_1) maximum collar rot was recorded in the control (19.63%). In first year of the study, (Fig 1). All the treatments significantly were superior as compared to the control, where minimum germination (88.00), maximum collar rot incidence (19.63%) and minimum pod yield (1313.3 kg/ha) and almost the same trends were observed in the second-year, third year and forth year study.

Looking at the pooled analysis maximum germination (93.00%), minimum collar rot incidence (6.17%) and highest pod yield (4066.3 kg/ha) were recorded in the treatment of deep summer ploughing with mould board plough+Soil application of *Trichoderma* @ 4 kg/ha enriched in 250 kg FYM/ha+Seed treatment with Tebuconazole 2DS @ 1.5 g/kg of seeds followed by seed treatment with PGPR @625 g for per ha of seeds+Soil application of *Trichoderma* @ 4 kg/ha enriched in 250 kg FYM/ha at 35 and 80 DAS (T_4) followed by deep summer ploughing with mould board plough+Seed treatment with Tebuconazole 2DS 1.5 g/kg seeds followed by PGPR @ 625 g for per ha of seeds+Soil application of *Trichoderma* @ 4 kg/ha enriched in 250 kg FYM/ha at 35 and 80 DAS (T_1). All the treatments significantly were superior as compared to the control, where minimum germination (82.00), maximum collar rot incidence (15.69%) and minimum pod yield (2125.1 kg/ha). As regards ICBR (Incremental Cost: Benefit Ratio) in Table 2 different treatments, the maximum ICBR ratio (1:20.68) was recorded in treatment consisting (T_4): Deep summer ploughing with mould board plough+Seed treatment with Tebuconazole 1.5 g/kg seeds+Soil application of *Trichoderma* @ 4 kg/ha enriched in 250 kg FYM/ha at 35 and 80 DAS followed by treatment (T_1). This finding collaborates with the finding of earlier workers Kumhar *et al.* (2018) reported that treatment module consisting of seed treatment with Tebuconazole 2 DS @ 1.5 g kg/seed+furrow application of *T. viride* @ 4.0 kg enriched with 50 kg FYM ha^{-1} + broadcasting of *T. viride* @ 4.0 kg enriched with 50 kg FYM ha^{-1} at 40 DAS+two foliar sprays of Tebuconazole 25.9% EC @ 1.0 ml starting from initiation of diseases and second spray at 15 days intervals was found most effective and economically beneficial treatment module in controlling of collar rot disease of groundnut and Smith *et al.* (2000) reported that increased groundnut pod yield and higher net return was also recorded after seed treatment and fungicidal spray in groundnut as compared to the untreated control. Similarly higher economic returns and benefit-cost



Fig 1: Experiment trial for management of collar rot disease (*Aspergillus niger)*.

Table 2: Economics of management of collar rot diseases (Based on four years *kharif*-2017 to 2020).

Treatment	Yield increase over control (Kg/ha)	Additional income obtained (Rs) (A)	Additional expenditure incurred (Rs) (B)				ICBR (A/B)
			Pesticides including application charges	Enriched *Trichoderma* in FYM /PGPR	Miscellaneous	Total	
T_1	1536.00	75264.00	400	3500	500	4400.00	1:17.11
T_2	1021.00	50029.00	-	3600	400	4000.00	1:12.51
T_3	978.00	47922.00	400	2600	400	4400.00	1:10.89
T_4	1941.00	95109.00	400	3800	400	4600.00	1:20.68
T_5	1145.00	56105.00	2800	-	600	2600.00	1:16.50
T_6	554.00	27146.00	2800	-	700	2800.00	1:7.76
T_7	151.00	7399.00	1000	-	800	1600.00	1:4.11
T_8	0.00	0.00	0	0	0	0.00	0

ICBR- Incremental cost: Benefit ratio.

ratio at farmer's fields was reported in groundnut crop due to the use of *T. Harzianum* (Sharma *et al.,* 2012) and Bhushan *et al.* (2022) reported that seed treatment with mancozeb at half recommended dose *i.e.,* 1.25 g kg^{-1} seed+potential isolate of *Trichoderma* spp. *i.e.,* GT2 in Talc formulation@ 4 g kg^{-1} seed showed least per cent disease incidence and maximum germination per cent (92.17%) and Meena *et al.* (2019) conducted FLDs on management of collar rot with *Trichoderma viride* used as seed dresser @ 10 g/kg kernel during 2009 and 2013 at farmers' fields in three sample villages (Khatwa, Ramjipura and Didwana). The average yield in demonstration (14.47 q/ha), while on farmers' practice field it was (13.23 q/ha) and percent increase in yield was 9.37. Therefore, the use of *Trichoderma* as seed treatment is found effective for collar rot management in groundnut. Similar results were also obtained by Harsukh *et al.* (2011) reported that seed treatment with *Trichoderma* reduced the disease incidence in susceptible and tolerant varieties at 15 DAS, under *A. niger* infection. Seed treatment with biocontrol agents like *Trichoderma viride*, *T. harzianum* has shown some benefits in managing the collar rot of (Gangwar *et al.,* 2014; Rawal *et al*., 2013; Sharma *et al*., 2017).

CONCLUSION

Collar rot of groundnut caused by *Aspergillus niger* (Van Teighem) is one of the economic important seed borne disease. Four years pooled analysis of data concluded that maximum germination (93.00%), minimum collar rot incidence (6.17%) and highest pod yield (4066.3 kg/ha) were recorded treatment of deep summer ploughing with mould board plough+Soil application of *Trichoderma* @ 4 kg/ha enriched in 250 kg FYM/ha+Seed treatment with Tebuconazole 2DS @ 1.5 g/kg of seeds followed by seed treatment with PGPR @ 625 g for per ha of seeds+Soil application of *Trichoderma* @ 4 kg/ha enriched in 250 kg FYM/ha at 35 and 80 DAS followed by deep summer ploughing with mould board plough+Seed treatment with Tebuconazole 2DS 1.5 g/kg seeds followed by PGPR @

625 g for per ha of seeds+Soil application of Trichoderma @ 4 kg/ha enriched in 250 kg FYM/ha at 35 and 80 DAS.

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Conflict of interest

All author declar that they have no conflict of interest.

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