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H Parashurama
Department of Seed Science and Technology, SRTC, Rajendranagar, Hyderabad, Telangana, India

K Parimala
Seed Research and Technology Centre, PJTSAU, Rajendranagar, Hyderabad, Telangana, India

B Pushpavathi
Seed Research and Technology Centre, PJTSAU, Rajendranagar, Hyderabad, Telangana, India

Corresponding Author:
H Parashurama
Department of Seed Science and Technology, SRTC, Rajendranagar, Hyderabad, Telangana, India

Influence of fungicide and biocontrol agent based polymer coating on seed yield and its attributes in groundnut (*Arachis hypogaea* L.)

H Parashurama, K Parimala and B Pushpavathi

Abstract
An experiment was taken up to assess the effect of seed coating polymers in combination with fungicide and biocontrol agent on field performance of groundnut variety Kadiri-6. The trial was laid out in randomized block design with three replications at Seed Research and Technology Centre, Hyderabad during *kharif*, 2019. Analysis of variance revealed the presence of significant differences among the treatments studied. The results showed that seed treatment with polymer-1 + tebuconazole + *Trichoderma harzianum* was found to be significantly superior for plant height, number of branches per plant, number of pods per plant, pod yield per plant, kernel weight per plant and pod yield per ha compared to control. The treatments such as polymer-2 + tebuconazole + *Trichoderma harzianum* and polymer-1 + tebuconazole were showed superiority for some of the yield components. Low disease incidence of collar rot and low disease severity of tikka leaf spot and rust disease were observed in polymer-1 + tebuconazole + *Trichoderma harzianum* followed by polymer-2 + tebuconazole + *Trichoderma harzianum* and polymer-1+tebuconazole. Use of quality seed is one of the best ways to exploit the potential of the varieties. Based on the study, it is suggested that seed treatment with polymer, fungicide and biocontrol agent could be used to realize higher yields in groundnut.

Keywords: groundnut, yield, polymer coating, fungicide, bioagent

Introduction
Groundnut (*Arachis hypogea* L.) is one of the important oilseed crops. The groundnut seeds are valued for oil (40-48%) and protein (22-26%) also contain carbohydrate (26%), fat (3%), calcium, thiamine, niacin, fibre, vitamin E and antioxidants which make a substantial contribution of protein for human and animal nutrition (Maiti *et al.*, 1991) [5]. In India, it is grown to an extent of 5.3 m ha with a production of 9.1 mt and productivity of 1731 kg per ha (FAOSTAT, 2017-18) [2]. One of the major constraints in groundnut production is the non-availability of quality seeds at the time of planting. Seed viability is a major factor in crop stand establishment and subsequent productivity in many parts of the world. Losses in seed quality occur during field weathering, harvesting and storage if they are exposed to high temperature and humidity. Seed coating materials were reported to improve the germination and increase the seedling emergence at changing soil moisture especially in the suboptimal range. Polymer coating improves plant stand and emergence of seeds, accurate application of the chemical and reducing chemical wastage. The polymer coating is simple to apply, diffuses rapidly and non- toxic to the seed during germination. The polymer film may act as physical barrier, which has been reported to reduce the leaching of inhibitors from the seed coverings and may restrict oxygen diffusion to the embryo (Vanangamudi *et al.*, 2003) [12]. Seed treatment with fungicide would protect the seeds and young seedlings from seed borne and soil borne pathogens. The bioagents like *Trichoderma harzianum* and *Trichoderma viride* are most effective suppressants of soil borne pathogens. By encasing the seed with thin film of biodegradable polymer, the adherence of seed treatment to the seed is improves, ensures dust free handling, making treated seed both useful and environment friendly. In view of the above the present investigation was undertaken to assess the influence of fungicide and biocontrol agent based polymer seed coating on yield of groundnut.

Material and Methods
The present experiment was conducted at Seed Research and Technology Centre, PJTSAU, Rajendranagar, Hyderabad during *Kharif*, 2019. The seed was treated with cellulose based

polymers (polymer-1 and polymer-2) @10 ml per kg of seed, tebuconazole @ 1 g per kg of seed and *Trichoderma harzianum* @ 0.1 g pure conidial powder ($1x10^8$ CFUs/g) per kg of seed. Seeds treated with polymers, tebuconazole and *Trichoderma harzianum* were kept under the shade for 24 hours. The experiment comprising of nine treatments along with control (untreated seeds). The different seed treatment combinations used in the experiment *viz*., *Trichoderma harzianum* (T_1), tebuconazole (T_2), polymer-1+*Trichoderma harzianum* (T_3), polymer-2 + *Trichoderma harzianum* (T_4), polymer-1 + tebuconazole (T_5), polymer-2 + tebuconazole (T_6), polymer-1 + tebuconazole + *Trichoderma harzianum* (T_7), polymer-2 + tebuconazole + *Trichoderma harzianum* (T_8) and control (T_9). The trial was laid out in Randomized Block Design with three replications. Recommended package of practices was followed to raise the crop. Data was collected for plant height (cm) at 30 DAS, 60 DAS and at maturity, number of branches per plant, number of pods per plant, pod yield per plant (g), kernel weight per plant (g), test weight (g) and pod yield per ha (kg). Ten plants in each treatment and replication were randomly selected for recording of the data. Pod yield obtained per plot was computed and extrapolated to get pod yield per hectare. Effect of seed treatments on collar rot, tikka leaf spot and rust diseases were evaluated. The incidence of collar rot disease was recorded from five randomly selected locations (1 m^2 area) in each treatment and replication up to three weeks' age of the crop at weekly intervals. The cumulative data on number of plants affected out of total number of plants was recorded used for calculating per cent disease incidence (PDI) by adopting the following formula

$$\text{Disease Incidence (\%)} = \frac{\text{Number of diseased plants}}{\text{Total number of plants observed}} \times 100$$

Disease severity of tikka leaf spot and rust was recorded based on visual observations at 90 days after sowing when the disease was at its peak and was expressed in percentage. The data was collected from five randomly selected locations (1 m^2 area) in each treatment and replication for calculating the disease severity.

The mean data were subjected to statistical analysis following the procedure given by Panse and Sukhatme (1985) [8].

Results And Discussion

The analysis of variance revealed the existence of significant differences among the treatments for all the parameters studied (Table 1). Among the nine treatments evaluated, seed coating with polymer-1 + tebuconazole + *Trichoderma harzianum* showed significant superiority over other treatments for most of the yield components (Table 2). The trait plant height at 60 DAS (43.25 cm) and plant height at maturity (63.63cm) was found to be high in seed coating with polymer-1 +tebuconazole + *Trichoderma harzianum* which was found to be on par with polymer-2 +tebuconazole + *Trichoderma harzianum*. This may be due to the protection of plants from soil and seed borne pathogens which results in maintaining of healthy plant growth. Shakuntala *et al*. (2010) [11] who studied the influence of polymer based fungicide seed treatment on sunflower showed the increased plant height compared to control. More number of branches per plant was noticed in seeds treated with polymer-1 + tebuconazole + *Trichoderma harzianum* (6.36) and polymer-1 + tebuconazole (6.20).

Seed coating with polymer-1 + tebuconazole + *Trichoderma harzianum* exhibited more number of pods per plant (31.73), pod yield per plant (30.29 g), kernel weight per plant (21.37 g). The next best treatment for these traits was polymer-2 + tebuconazole + *Trichoderma harzianum*. This might be due to symbiosis of plant and bioagent and also protecting the foliar diseases by fungicide which results in accumulation of more dry matter and production of more pods. Similar finding was reported by Vasundara *et al*. (2015) [13] who observed more number of pods per plant and higher pod weight due to film coating with fungicide and bioagent in groundnut. Effect of polymer coating in groundnut studied by Chikkanna *et al.* (2000) [1] who reported increased number of pods per plant. The test weight was found to be high in seed treatment with polymer-1 + *Trichoderma harzianum* and polymer-1 + tebuconazole + *Trichoderma harzianum*. The significant improvement of pod yield per ha was recorded in seed coating with polymer-1 + tebuconazole + *Trichoderma harzianum* (2830 kg/ha) which was on par with polymer-1 + tebuconazole (2566 kg/ha) and polymer-2 + tebuconazole + *Trichoderma harzianum* (2533 kg/ha).

The increased pod yield was attributed to more number of branches per plant, number of pods per plant, higher pod yield per plant and test weight. Higher pod yield was recorded in seed treated with combination of fungicide and bioagent based polymer coating. This may be due to the beneficial effect of *Trichoderma harzianum* which acted as potential biocontrol agent and growth promoter. Kapadiya and Mordiya (2017) [6] evaluated the effect of tebuconazole in combination with biocontrol agents such as *Trichoderma viride* and *Trichoderma harzianum* on disease incidence and seed yield of groundnut who reported the significant superiority in pod yield (3833 kg/ha) over control (2230 kg/ha). Similar results were observed by Kanti *et al.* (2013) [5] in soybean and Chikkanna *et al.* (2000) [1] in groundnut.

Influence of fungicide and biocontrol agent based seed polymer coating was evaluated against the major diseases in groundnut **(**Table-3). Among the treatments studied, polymer-1 + tebuconazole + *Trichoderma harzianum* (4.33), tebuconazole (4.33), polymer-1+ tebuconazole (4.67), polymer-2 + tebuconazole + *Trichoderma harzianum* (5.33) and polymer-2 + tebuconazole (5.33) recorded minimum number of collar rot affected plants compared to *Trichoderma harzianum*, polymer-1 + *Trichoderma harzianum*, polymer-2 + *Trichoderma harzianum* and control. It indicated that, polymer coating with fungicide and biocontrol agent plays an important role in management of collar rot. This may be due to the sustained release of fungicide entrapped in the polymer carriers. The treatments *viz*., polymer-1 + *Trichoderma harzianum* (8.67) and polymer-2 + *Trichoderma harzianum* (8.67%) were found to be on par with each other. Johnson and Subramanyam (2010) [3] studied the effect of seed treatment of tebuconazole and observed less incidence of collar rot in groundnut.

It was found that, the mean disease severity of tikka leaf spot was observed to be 18.12%. The treatments showed a range of disease severity varied from 14.20 to 23.73%. Seeds treated with polymer -2 + tebuconazole + *Trichoderma harzianum* recorded less severity of tikka leaf spot (14.20%) followed by polymer-1 + tebuconazole (15.67%), polymer-1 + tebuconazole + *Trichoderma harzianum* (15.00%), polymer-2 + tebuconazole (16.00%) compared to other treatments. The combination of tebuconazole and *Trichoderma* treatments

recorded minimum occurrence of tikka leaf spot. Rojo *et al*. (2007) [9] reported that, groundnut seeds treated with carboxymethyl cellulose + *Trichoderma harzianum* showed decreased mean disease severity, increased frequency of healthy plants and boosting yield. Senapati *et al*. (2017) [10] who studied the influence of seed treatment of tebuconazole on tikka leaf spot followed by two foliar sprays with tebuconazole, proved to be most effective which recorded the less per cent disease incidence of 26.4 compared to control (42.5%).

The seeds treated with polymer-1 + tebuconazole + *Trichoderma harzianum* (7.67%), polymer-2 + tebuconazole + *Trichoderma harzianum* (8.20%) and polymer-2 + tebuconazole (8.20%) exhibited low rust disease severity compared to other treatments. Comparatively high disease severity was observed in treatments *viz*., polymer-1 + *Trichoderma harzianum* (12.53%), *Trichoderma harzianum* (13.07%) and untreated seeds (13.33%). Seed treatment with tebuconazole and bioagent based polymer coating prevents occurrence of seed borne diseases as well as foliar disease. Kalaskar *et al*. (2012) [4] studied the influence of fungicides and bioagents on rust disease and reported the lowest disease incidence compared to control. Senapati *et al*. (2017) [10] also observed the less disease incidence in seed treated with tebuconazole followed by two foliar sprays with tebuconazole.

From the study, it is suggested that seed treatment in combination with fungicide and biocontrol agent based polymer coating was found to be good for realizing higher yield in groundnut.

Table 1: Analysis of variance for seed yield and its attributes of groundnut

Source of variance	d.f	Mean sum of squares								
		Plant height (cm) at 30 DAS	Plant height (cm) at 60 DAS	Plant height (cm) at maturity	Number of branches/ plant	Number of pods / plant	Pod yield plant/ (g)	Kernel weight / plan (g)	Test weight (g)	Pod yield (kg/ ha)
Replications	2	0.54	5.50	4.29	0.34	2.40	2.14	0.71	0.03	110818.60
Treatments	8	1.65**	7.99*	27.24**	0.44*	23.97*	29.67*	13.57*	7.84*	81676.59*
Error	16	0.19	2.25	5.09	0.14	11.56	8.85	4.21	2.70	31048.04
Total	26	0.66	4.26	11.84	0.24	14.67	14.73	6.82	4.07	52761.23

*Significant at 5% level, ** Significant at 1% level

Table 2: Effect of seed treatment on seed yield and its attributes of groundnut

Treatments	Plant height (cm) at 30 DAS	Plant height (cm) at 60 DAS	Plant height (cm) at maturity	Number of branches/ plant	Number of pods / plant	Pod yield plant/ (g)	Kernel weight / plant (g)	Test weight (g)	Pod yield (kg/ ha)
Trichoderma harzianum	12.60	39.13	55.52	5.63	22.60	20.11	15.41	39.59	2319
Tebuconazole	13.17	40.30	58.98	6.03	25.00	22.85	17.48	41.20	2488
Polymer-1 + *Trichoderma harzianum*	14.58	41.77	57.20	5.43	22.73	20.82	16.73	43.24	2436
Polymer-2 + *Trichoderma harzianum*	13.55	40.13	57.79	5.46	23.73	23.37	17.71	42.34	2442
Polymer-1 + tebuconazole	13.51	39.80	60.60	6.20	25.40	23.89	17.80	40.56	2566
Polymer-2 + tebuconazole	13.27	39.20	57.69	5.53	24.72	23.84	17.70	42.24	2443
Polymer-1 + tebuconazole + *Trichoderma harzianum*	14.21	43.25	63.63	6.36	31.73	30.29	21.37	43.11	2830
Polymer-2 + tebuconazole + *Trichoderma harzianum*	14.10	42.83	62.54	6.06	26.02	24.98	17.83	42.79	2533
Control (untreated seed)	12.28	38.90	54.73	5.33	21.40	20.09	14.70	38.72	2247
Grand Mean	13.48	40.59	58.74	5.78	24.75	23.36	17.07	41.53	2478
S.Em. ±	0.25	0.86	1.30	0.21	1.96	1.71	1.18	0.95	101.68
C.D. (0.05)	0.75	2.59	3.94	0.65	5.88	5.14	3.55	2.87	307.47

Table 3: Effect of seed treatment on diseases of groundnut

Treatment		Per cent disease incidence / severity		
		Collar rot	Tikka leaf spot	Rust
T_1	*Trichoderma harzianum*	7.00	19.93	13.07
T_2	Tebuconazole	4.33	18.67	11.80
T_3	Polymer-1 + *Trichoderma harzianum*	8.67	19.67	12.53
T_4	Polymer-2 + *Trichoderma harzianum*	8.67	20.27	11.00
T_5	Polymer-1 + Tebuconazole	4.67	15.67	8.33
T_6	Polymer-2 + Tebuconazole	5.33	16.00	8.20
T_7	Polymer-1 + Tebuconazole + *Trichoderma harzianum*	4.33	15.00	7.67
T_8	Polymer-2 + Tebuconazole + *Trichoderma harzianum*	5.33	14.20	8.20
T_9	Control	11.67	23.73	13.33
	Grand Mean	6.67	18.12	10.46
	S.Em.±	1.62	1.29	1.18
	C.D.(0.05)	0.54	3.89	0.39

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