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Effect of seed coating with polymer, fungicide and biocontrol agent on seed quality parameters of groundnut (*Arachis hypogea* L.)

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Abstract

The experiment was conducted to assess the effect of seed treatment with polymers, fungicide and biocontrol agents on seed quality parameters of groundnut during storage. The analysis of variance revealed that treatments differed significantly for the parameters studied at different storage periods. At the end of four months of storage higher germination was observed in seeds treated with polymer-1 + tebuconazole + *Trichoderma harzianum* (65.00%) followed by polymer-2 + tebuconazole + *Trichoderma harzianum* (61.67%) and least germination percentage was noticed in untreated seed (53.00%). Seedling traits declined with a mean reduction of 47.47% and 42.01% for root and shoot length respectively at four months of storage. The treatments polymer-1 + tebuconazole + *Trichoderma harzianum* and polymer-2 + tebuconazole + *Trichoderma harzianum* were found to be superior for seedling vigour index-I, seedling dry weight, seedling vigour index-II, speed of germination and field emergence across the storage periods tested compared to other treatments. The study also indicated that these treatments showed minimum per cent seed rot (15.33%) and per cent seed infection (14.0%) compared to other treatments. The study indicated that, the polymer based chemical and biocontrol seed treatments were found to be promising for enhancing the seed quality traits.

Keywords: Groundnut, polymer coating, seed quality

Introduction

Groundnut is one of the important oil, food and feed legume crop grown in many countries. It is the world's fourth most important source of edible oil and the third important source of vegetable protein. Quality seed plays an important role for the production of healthy crop. Healthy and pathogen free seeds are the basic requirements for disease free crop. In general, seeds are stored for a considerable period of time in order to catch the correct season. Loss of viability and vigour under high temperature and humid conditions is a common phenomenon in many crop seeds. Seed treatment with fungicide would protect the seeds and young seedlings from many seed borne and soil borne pathogens.

Groundnut being an oilseed crop, seed has short life and loses viability quickly under ambient conditions. Ageing in groundnut seed leads to increased lipid peroxidation, decreased activities of several free radical and peroxide scavenging enzymes (Rao *et al*., 2006) [10]. Groundnut seeds are more sensitive to storage conditions like high temperature; high seed moisture content and light exposure. Seed treatment with fungicide is simple, cheap and effective method for control of seed borne diseases and also, it is a known fact that the choice of chemicals for seed treatment also exerts a positive effect on seed viability and vigour during storage. Currently seed coating polymers are being used along with active ingredients such as insecticides and fungicides. Recently, the biocontrol approaches have been opened an era of new technology by using antagonistic microorganisms to combat the seed borne diseases. Among bioagents, beneficial fungi like *Trichoderma harzianum* and *Trichoderma viride*, are most effective and efficient suppressants of soil borne pathogens including fungal diseases such as collar rot, stem rot, root rot, dry root rot, seedling blight and their application may lead to satisfactory control of all these diseases and subsequent promotion of growth and yield of groundnut. The present experiment was undertaken to assess the effect of seed coating polymers, fungicides and bioagents on seed quality parameters of groundnut.

Materials and Methods

Storage studies were conducted to assess the effect of different seed treatments on seed quality parameters of groundnut. The groundnut seeds of Kadiri-6 were treated with polymer @10 ml kg^{-1} seed, tebuconazole @ 1g kg^{-1} seed and *Trichoderma harzianum* @ 0.1 g kg^{-1} seed. The pure conidial powder of *Trichoderma harzianum* with $1x10^8$ CFUs (Colony Forming Units) was used for seed treatment purpose. The experiment was conducted at Seed Research and Technology Centre, Rajendranagar, Hyderabad during 2019-20 by imposing nine treatments along with control (untreated seeds) in completely randomized block design with three replications. The treatments *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) were imposed. Immediately after seed treatment, seeds were stored in cloth bag under ambient conditions to study the effect of seed treatment on seed quality parameters of groundnut during storage. The data was recorded at monthly intervals upto four months of storage for seed quality parameters *viz*., germination (%), root length (cm), shoot length (cm), seedling dry weight (mg), seedling vigour index-I, seedling vigour index-II, per cent seed rot, per cent seed infection, speed of germination and field emergence (%). The data recorded at monthly intervals on various seed quality parameters was subjected to statistical analysis as per the method suggested by Panse and Sukhatme (1985) [8].

Results and Discussion

The analysis of variance revealed that treatments differed significantly for the parameters studied at different storage periods except for root length at 4 MAS and seedling dry weight at 4 MAS (Table-1). Significant differences in germination percentage due to different seed treatment were recorded at all the storage periods studied. The mean germination percentage observed to be gradually decreased from 81.56% to 59.19% (Table-2). At initial month of storage, significantly higher germination was noticed in the treatment polymer-1 + tebuconazole (84.67%) while the lowest germination was recorded in untreated seeds (79%). The treatment, polymer-1 + tebuconazole + *Trichoderma harzianum* and polymer-2 + tebuconazole + *Trichoderma harzianum* exhibited significant superiority over other treatments at two and three months after storage. The decline in seed germination (%) over the storage period may be due to ageing effect leading to depletion of food reserves, fluctuating temperature, relative humidity and seed moisture content. Coating of seeds with polymer, bioagent and fungicide might have protected the seed from influence of above factors resulting in maintenance of seed viability for a comparatively longer period. These results were in agreement with the findings of Shahid *et al.* (2011) [11] who reported that chickpea seed treated with *T. viride* + vitavax and vitavax @ 2 g kg^{-1} of seed was found to be superior in germination.

Regardless of seed treatments the root length declined progressively as the storage period extends. At one to three months after storage, the treatments polymer-1 + tebuconazole + *Trichoderma harzianum* and polymer-1 + *Trichoderma harzianum* and polymer-2 + tebuconazole + *Trichoderma harzianum* recorded higher root length compare to other treatments. At four months after storage the treatments exhibited non-significant differences for this trait. Rakesh *et al.* (2017) [9] reported that seed treatment with chitosan + carbendazim + *T. harzianum* (Th4d) recorded significantly higher root length (19.12 cm) as compared to control (12.56 cm) in groundnut. At the end of storage period, higher shoot length was recorded in polymer-1 + tebuconazole + *Trichoderma harzianum* (12.18 cm) which was significantly superior over polymer-2 + tebuconazole + *Trichoderma harzianum* (11.00 cm), *Trichoderma harzianum* (10.47 cm) and control (10.09 cm). These findings were in accordance with Kunkur *et al.* (2007) [4] who studied the effect of polymers on seed quality parameters of cotton.

The seeds treated with polymer-1 + tebuconazole + *Trichoderma harzianum* was found to had higher seedling dry weight (640.29 mg) and it was on par with polymer based chemical and bioagent seed treatments at initial month of storage (Table-3). Whereas, *Trichoderma harzianum* (610.13 mg), tebuconazole (603.31 mg) and untreated seed (590.25 mg) recorded significantly low seedling dry weight compared to seeds treated with polymer-1 + tebuconazole + *Trichoderma harzianum*. Goswami *et al.* (2017) [2] reported that soybean seed treated with polymer + vitavax 200 exhibited superior seedling dry weight. The mean seedling vigour index-1 decreased gradually with increase in storage period from 2536 to 1030 with a significant reduction of 59.38 per cent from initial month of storage to four months of storage. Manonmani (2000) [6] in groundnut and Kandil *et al*. (2013) [3] in soybean reported progressive decline in seedling vigour as storage period extends. With regard to the effect of treatments and period of storage, seed coating with polymer-1 + tebuconazole + *Trichoderma harzianum* and polymer 2 + tebuconazole + *Trichoderma harzianum* showed higher seedling dry weight, seedling vigour index-I and seedling vigour index-II. These treatments also found to exhibit superiority for field emergence (%) and speed of germination (Table-4). This indicated that, the polymer based chemical and biocontrol seed treatments were found to be promising for enhancing the seed quality traits. It might be due to the fact that these treatments control the storage fungi and also minimise the leakage of electrolyte. Sunil Kumar (2004) observed higher seedling vigour index in soybean seeds treated with chemicals and biocontrol agents. Mukhtar *et al.* (2012) also reported that seeds treated with *Trichoderma viride and T. harzianum* showed higher seedling vigour in soybean. Moeinzadeh *et al*. (2010) [7] reported that sunflower seeds treated with *Pseudomonas fluorescencs* showed high speed of germination. Vijay Kumar *et al*. (2017) [14] observed that sunflower seeds treated with polymer + vitavax power@200 recorded higher field emergence (85.33%) as compared to control seed (78.66%). Seed coating in cotton with thiram @ 1.5g + polymer @ 5g kg^{-1} seed exhibited higher speed of germination (Vijaykumar, 2007) [13].

Table 1: Analysis of variance for the effect of seed treatments and period of storage on seed quality parameters of groundnut

Character	Treatment (d.f=8)	Error (d.f=18)	Total (d.f=26)
Initial germination (%)	9.25*	0.70	3.33
Germination (%) at 1 MAS	36.00*	1.81	12.33
Germination (%) at 2 MAS	46.03*	2.11	15.62
Germination (%) at 3 MAS	27.73*	1.85	9.81

Germination (%) at 4 MAS	33.34*	4.51	13.38
Initial root length (cm)	1.48*	0.10	0.52
Root length (cm) at 1 MAS	0.90*	0.09	0.34
Root length (cm) at 2 MAS	0.47*	0.02	0.16
Root length (cm) at 3 MAS	0.36*	0.03	0.13
Root length (cm) at 4 MAS	0.50	0.33	0.38
Initial shoot length (cm)	1.17*	0.42	0.65
Shoot length (cm) at 1 MAS	0.74*	0.20	0.37
Shoot length (cm) at 2 MAS	0.34*	0.09	0.17
Shoot length (cm) at 3 MAS	0.39*	0.15	0.23
Shoot length (cm) at 4 MAS	1.22*	0.41	0.66
Initial seedling dry weight (mg)	700.11*	273.59	404.83
Seedling dry weight (mg) at 1 MAS	485.41	267.14	334.30
Seedling dry weight (mg) at 2 MAS	564.51*	123.64	259.29
Seedling dry weight (mg) at 3 MAS	632.93*	195.03	329.77
Seedling dry weight (mg) at 4 MAS	2042.74	1191.32	1453.30
Initial seedling vigour index-I	65280.08*	4775.00	23391.94
Seedling vigour index-I at 1 MAS	82344.75*	3079.37	27468.71
Seedling vigour index-I at 2 MAS	71908.00*	2736.77	24020.23
Seedling vigour index-I at 3 MAS	39890.67*	2660.96	14116.25
Seedling vigour index-I at 4 MAS	33615.90*	5406.29	14086.17
Initial seedling vigour index-II	13309324*	1565003	5178641
Seedling vigour index-II at 1 MAS	26396956*	23911537	9777818
Seedling vigour index-II at 2 MAS	26564204*	1453162	9179632
Seedling vigour index-II at 3 MAS	18207787*	1505668	6644788
Seedling vigour index-II at 4 MAS	14291587*	5389250	8128431
Initial speed of germination	3.98*	0.07	1.28
Speed of germination at 1 MAS	2.98*	0.11	0.99
Speed of germination at 2 MAS	4.04*	0.72	1.74
Speed of germination at 3 MAS	3.90*	0.27	1.39
Speed of germination at 4 MAS	3.20*	0.23	1.14
Initial field emergence (%)	6.06*	1.22	2.71
Field emergence (%) at 1 MAS	10.50*	0.77	3.76
Field emergence (%) at 2 MAS	10.20*	0.85	3.72
Field emergence (%) at 3 MAS	15.08*	1.88	5.94
Field emergence (%) at 4 MAS	16.25*	2.25	6.56
Initial per cent seed rot	7.06*	0.77	2.71
Per cent seed rot at 1 MAS	8.95*	1.70	3.93
Per cent seed rot at 2 MAS	11.73*	2.66	5.45
Per cent seed rot at 3 MAS	10.16*	2.29	4.71
Per cent seed rot at 4 MAS	16.41*	4.07	7.87
Initial per cent seed infection	11.25*	0.92	4.10
Per cent seed infection at 1 MAS	14.91*	1.18	5.41
Per cent seed infection at 2 MAS	17.33*	2.33	6.94
Per cent seed infection at 3 MAS	10.16*	2.29	4.71
Per cent seed infection at 4 MAS	13.25*	3.51	6.51

MAS – Months after storage * Significant at 5% probability level

Table 2: Effect of seed treatment on germination (%), root length and shoot length of groundnut during storage

Treatment	Germination (%)					Root length (cm)					Shoot length (cm)				
	Storage period (in months)														
	Initial	1	2	3	4	Initial	1	2	3	4	Initial	1	2	3	4
T_1	80.00	75.00	69.67	63.33	57.33	10.92	9.87	9.52	8.77	5.78	19.49	18.83	17.27	15.95	10.47
T_2	81.00	78.00	73.33	65.33	60.33	11.80	10.78	9.70	8.78	6.00	18.96	18.15	17.38	15.70	11.66
T_3	82.33	80.00	73.33	66.00	58.00	12.84	11.42	10.22	8.94	5.65	20.22	18.92	17.46	16.20	11.52
T_4	81.00	78.67	73.00	65.00	59.00	11.72	10.27	9.77	8.51	6.00	19.83	18.67	17.21	15.53	11.58
T_5	84.67	80.00	73.67	67.00	60.67	11.92	11.17	9.98	8.63	5.93	19.83	18.87	17.55	15.62	11.46
T_6	81.00	79.00	74.00	66.00	57.67	11.72	10.70	10.10	8.92	6.65	19.22	18.47	17.39	15.81	11.24
T_7	83.67	81.67	78.33	71.00	65.00	12.28	11.43	10.73	9.34	6.73	19.86	19.25	17.99	16.50	12.18
T_8	81.33	80.33	74.33	68.00	61.67	11.38	10.80	10.08	8.98	6.57	19.04	18.88	17.46	15.79	11.00
T_9	79.00	70.33	64.00	60.00	53.00	10.45	10.20	9.45	8.09	5.84	18.17	17.57	16.69	15.28	10.09
Mean	81.56	78.11	72.63	65.74	59.19	11.67	10.74	9.95	8.77	6.13	19.40	18.62	17.38	15.82	11.25
C.D (0.05)	1.45	2.33	2.51	2.35	3.68	0.56	0.53	0.28	0.34	NS	1.13	0.78	0.55	0.69	1.11
S.Em.±	0.48	0.78	0.84	0.79	1.23	0.19	0.18	0.09	0.11	0.33	0.38	0.26	0.18	0.23	0.37

T_1: Trichoderma harzianum T_2: Tebuconazole
T_3: Polymer-1 + Trichoderma harzianum T_4: Polymer-2 + Trichoderma harzianum
T_5: Polymer-1 + tebuconazole T_6: Polymer-2 + tebuconazole
T_7: Polymer-1 + tebuconazole + Trichoderma harzianum T_8: Polymer-2 + tebuconazole + Trichoderma harzianum T_9: Control

Table 3: Effect of seed treatment on seedling dry weight and seedling vigour index of groundnut during storage

Treatment	Seedling dry weight (mg)					Seedling vigour index-I					Seedling vigour index-II				
	Storage period (in months)														
	Initial	1	2	3	4	Initial	1	2	3	4	Initial	1	2	3	4
T_1	610.13	594.04	520.54	488.89	377.81	2432	2152	1866	1566	933	48801	44516	36278	30958	21640
T_2	603.31	587.42	521.10	507.71	366.82	2492	2257	1986	1600	1065	48880	45831	38206	33175	22128
T_3	616.77	606.37	527.82	500.50	358.70	2722	2427	2030	1659	996	50463	48521	38708	33029	20786
T_4	613.02	600.28	519.33	503.78	367.60	2555	2277	1970	1562	1036	51036	47236	37914	32752	21678
T_5	630.09	610.11	530.82	510.97	427.65	2688	2403	2028	1625	1055	52674	48810	39091	34244	26017
T_6	622.16	604.49	524.24	500.14	361.96	2506	2305	2034	1632	1032	50217	47750	38792	33012	20880
T_7	640.29	621.75	549.03	533.07	353.46	2689	2505	2250	1835	1230	53575	50780	43026	37844	22991
T_8	629.71	610.75	535.21	511.02	350.10	2475	2384	2047	1685	1083	51215	49070	39788	34753	21594
T_9	590.25	580.59	498.28	482.17	333.97	2261	1954	1673	1402	844	46624	40829	31887	28934	17687
Mean	617.30	601.76	525.15	504.25	366.45	2536	2296	1987	1619	1030	50387	47516	38188	33187	21693
C.D (0.05)	28.59	32.96	19.23	24.14	NS	119.45	95.93	90.44	89.17	127.12	2162.59	2710.01	2083.88	2121.00	4013.10
S.Em.±	9.55	11..008	6.42	8.06	19.92	39.89	32.04	30.20	29.78	42.45	722.27	905.10	695.98	708.00	1348.00

T_1: Trichoderma harzianum
T_2: Tebuconazole
T_3: Polymer-1 + Trichoderma harzianum
T_4: Polymer-2 + Trichoderma harzianum
T_5: Polymer-1 + tebuconazole
T_6: Polymer-2 + tebuconazole
T_7: Polymer-1 + tebuconazole + Trichoderma harzianum
T_8: Polymer-2 + tebuconazole + Trichoderma harzianum
T_9: Control

Table 4: Effect of seed treatment on Speed of germination and field emergence (%) of groundnut during storage

Treatment	Speed of germination					Field emergence (%)				
	Storage period (in months)									
	Initial	1	2	3	4	Initial	1	2	3	4
T_1	15.09	13.64	12.50	11.33	10.94	80.33	78.00	74.33	65.00	58.33
T_2	14.45	13.84	11.57	12.04	11.78	80.67	78.67	74.00	64.67	59.67
T_3	15.56	14.05	13.47	12.46	11.81	82.33	78.67	74.33	66.33	61.33
T_4	15.70	14.39	13.43	12.64	12.24	81.33	79.00	73.67	65.00	60.00
T_5	16.59	14.52	13.45	12.97	12.49	81.67	80.33	74.00	67.33	62.33
T_6	15.95	14.45	13.33	12.46	12.11	81.67	79.00	74.00	65.00	60.00
T_7	17.00	16.18	15.22	14.05	13.24	83.67	82.33	76.67	69.67	64.67
T_8	16.13	14.93	13.80	12.67	12.14	82.33	79.67	75.00	67.33	61.67
T_9	13.20	12.50	11.47	9.93	9.60	78.67	75.33	69.67	61.67	56.67
Mean	15.52	14.28	13.14	12.28	11.82	81.41	79.00	73.96	65.78	60.52
C.D (0.05)	0.48	0.59	1.47	0.91	0.83	1.91	1.53	1.60	2.38	2.60
S.Em.±	0.16	0.20	0.49	0.30	0.28	0.64	0.51	0.53	0.79	0.87

T_1: Trichoderma harzianum
T_2: Tebuconazole
T_3: Polymer-1 + Trichoderma harzianum
T_4: Polymer-2 + Trichoderma harzianum
T_5: Polymer-1 + Tebuconazole
T_6: Polymer-2 + Tebuconazole
T_7: Polymer-1 + Tebuconazole + Trichoderma harzianum
T_8: Polymer-2 + Tebuconazole + Trichoderma harzianum
T_9: Control

Table 5: Effect of seed treatment on per cent seed rot and per cent seed infection of groundnut during storage

Treatment	Per cent seed rot					Per cent seed infection				
	Storage period (in months)									
	Initial	1	2	3	4	Initial	1	2	3	4
T_1	7.33	9.00	13.67	18.00	21.00	4.67	7.33	10.33	17.33	18.00
T_2	4.33	7.33	10.67	16.33	18.33	2.33	4.67	8.00	13.33	15.33
T_3	4.67	8.67	12.00	15.33	18.67	3.33	7.00	9.67	15.33	16.33
T_4	7.33	8.67	12.00	16.00	18.00	3.67	7.33	9.33	15.67	16.00
T_5	4.00	6.67	10.67	14.67	16.67	2.67	4.33	7.00	14.33	14.67
T_6	5.67	7.33	11.33	15.33	17.33	2.67	4.67	8.33	14.67	15.33
T_7	4.00	4.67	10.00	14.00	15.33	2.33	3.67	6.67	12.00	14.00
T_8	4.00	6.00	10.67	15.33	17.33	2.67	4.00	8.00	14.00	15.33
T_9	7.33	10.33	16.33	20.00	22.67	6.33	9.00	13.00	19.33	20.00
G.M	5.41	7.63	11.93	16.11	18.44	3.41	5.78	8.93	15.11	16.10
C.D.(0.05)	0.41	0.88	0.81	0.74	0.88	0.49	0.40	0.44	1.05	0.83
S.Em.±	0.14	0.29	0.27	0.24	0.29	0.17	0.14	0.14	0.35	0.31

T_1: Trichoderma harzianum
T_2: Tebuconazole
T_3: Polymer-1 + Trichoderma harzianum
T_4: Polymer-2 + Trichoderma harzianum
T_5: Polymer-1 + Tebuconazole
T_6: Polymer-2 + Tebuconazole
T_7: Polymer-1 + Tebuconazole + Trichoderma harzianum
T_8: Polymer-2 + Tebuconazole + Trichoderma harzianum
T_9: Control

Percent seed rot and percent seed infection were recorded to assess the seed health during storage. Across the treatments and storage periods under study, the per cent seed rot varied from 4.0% in initial month of seed treatment to 22.67% at four months after storage (Table-5). The seed treatments *viz*., polymer-1 + tebuconazole + *Trichoderma harzianum* (4.00%), polymer-2 + tebuconazole + *Trichoderma harzianum* (4.00%) and polymer-1 + tebuconazole (4.00%) showed significantly less per cent seed rot at initial month of storage. These treatments exhibited less per cent seed rot even at the end of storage period compared to other treatments. These results are in conformity with the findings of Baig (2005) [1] who reported that seed treatment with fungicide and bioagent suppressed the seed borne mycoflora and maintained strong membrane integrity in soybean. Mean per cent seed infection was observed to be increased gradually from initial month (3.41%) to four months after storage (16.10%) with a mean increase of 78.81%. Shelar (2007) [12] also reported the increase in microflora with the increase of storage period in soybean. At initial month, seed treatment with polymer-1 + tebuconazole + *Trichoderma harzianum* (2.33%) and tebuconazole (2.33%) exhibited significantly low per cent seed infection which were at par with polymer-2 + tebuconazole + *Trichoderma harzianum* (2.67%). Across the storage period studied revealed that seed coating with polymer-1 + tebuconazole + *Trichoderma harzianum*, polymer-1 + tebuconazole, polymer-2 + tebuconazole + *Trichoderma harzianum* and tebuconazole treatments showed less per cent seed infection compared to other treatments. Lower seed infection was noticed in the treatments in combination with tebuconazole while other treatments recorded comparatively higher seed infection. This might be due to the fact that fungicide have arrested the growth of storage fungi. Lower seed infection with chemical protectants + biofriendly polymer was reported in chilli (Manjunatha, 2008) [5].

The study revealed that, seed coating with chemical and biocontrol agent based polymers showed better seed quality parameters over the biocontrol agent or fungicide alone. This might be due to the suppression of the activity of soil borne pathogens or fungi by seed treatment which improved seed germination, vigour, field emergence and establishment of healthy seedlings. Improvement of seedling emergence in seed coating with polymer might be due to regulated rate of water uptake, reduced imbibition damage and improved germination per cent.

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