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Effect of Biopolymers and Synthetic Seed Coating Polymers on Castor and Groundnut Seed

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ABSTRACT

Currently seed coating polymers are being used by seed companies along with active ingredients such as insecticides and fungicides. Polymer coating acts as a temperature switch, regulating intake of water by seed coat, the stress imposed by accelerated ageing, which includes fungal invasion and improves the seedling emergence at changing soil moisture regime especially in the sub-optimal range (Scott, 1989; Sherin & Susan John, 2003). Chitosan is a carbohydrate biopolymer derived from deacetylation of chitin, which is found in the crustacean's shells, insect's cuticle, and cell wall of fungi. The results indicated that in general biopolymers were found to be superior in enhancing the germination, seedling vigour, growth parameters when compared to synthetic polymers in both castor and groundnut.

Key words: *Carbohydrate, Groundnut, Synthetic polymers, Seeds.*

INTRODUCTION

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[9]. Chitosan is a carbohydrate biopolymer derived from deacetylation of chitin, which is found in the crustacean's shells, insect's cuticle, and cell wall of fungi. The positive charge of chitosan confers the numerous and unique physiological and biological properties with great potential in a wide range of industries such as pharmacology, medicine, and agriculture[5]. Another important attribute of this natural compound is associated with its fungistatic or fungicidal properties against pathogens of various crops[2]. Seeds and seedlings are vulnerable to many physiological stresses and they can destroy germinating seeds and young plants, which are relatively tender and lack food reserves to recover from injuries or to survive extended period of stress. Particularly in groundnut, if the seed coat is lost, they will be more prone to the stress as well as diseases.

MATERIALS AND METHODS

Seed coat polymers of synthetic, commercial biopolymer and chitosan were used in the present study to carry out the experiment. The details of synthetic seed coating polymers and biopolymers are given below (Table 1.1).

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Table 1.1 Details of seed coating polymers

Polymer	Trade Name	Obtained From
Synthetic Polymer-I	Seed Polymer	M/s. Reliable corporation, Chennai (India)
Synthetic Polymer-II	Seed Coat	Mahendra Overseas Manufacturers, Gandhinagar (India)
Synthetic Polymer-III	Fleck Lite Plus Red Polymer	Centor India, Hyderabad (India)
Commercial Bioploymer	Biopolymer	Centor India, Hyderabad (India)
Chitosan	-	Sri Biotech Laboratories Pvt Ltd, Hyderabad (India)

Seed Coating

Synthetic and commercial biopolymer seed coat polymer solution was prepared by mixing the polymer with different concentrations (0.1%, 0.2%, 0.3%, 0.4% and 0.5%) per kg in 5 ml of sterile distilled water in clean, dry Eppendorff tube (10 ml) by pipette. The polythene bag was closed tightly and shaken till the seeds are uniformly coated (Basavaraj *et al*., 2008). For the preparation of chitosan solution, chitosan @ 0.20% and 0.25% per kg was weighed, mixed with water and to this 5 ml of 1% acetic acid was added to dissolve chitosan and soaked the seeds for 8 h [3]. The treated seeds were tested for their germination by rolled paper towel method (ISTA). Proper check was maintained for each treatment. The seed quality parameters in treated and untreated condition were recorded. The design of the experiment adopted was Completely Randomized Block Design with five replications.

RESULTS

A total of three different synthetic polymers (synthetic polymer-I, synthetic polymer-II, synthetic polymer-III), one commercial biopolymer with different concentrations (0.1, 0.2, 0.3, 0.4, and 0.5%) and natural biopolymer chitosan (0.2% and 0.25%) were used for seed coating to evaluate their effect on castor and groundnut seed. The data on germination, seedling vigour, growth parameters like root length, shoot length were recorded and presented in table 2.1 and 2.2.

In castor among all the treatments seed coated with chitosan @ 0.25% recorded highest seed germination (97.40%), root length (18.76 cm), shoot length (14.76 cm), vigour index-I (3236.88), fresh weight (19.24 g), dry weight (1.76 g) and vigour index-II (171.74) (Table 2.1) when compared to synthetic polymer I, II, III, commercial biopolymer and control.

Among the synthetic polymers higher germination was obtained in synthetic polymer-II at 0.3% (92.80%) which was on par with biopolymer at 0.1% (92.40%) followed by synthetic polymer-I at 0.1% (91.80%). Whereas the maximum root length (18.00 cm) was recorded with synthetic polymer-I at 0.1% followed by synthetic polymer-II at 0.3% (15.92 cm) and synthetic polymer-III with a root length of 15.56 cm at 0.1%. However maximum shoot length (13.92 cm) was recorded by biopolymer coated seed with 0.4% concentration followed by 0.3% (13.68 cm) and 0.1% (13.30 cm) of synthetic polymer-II. Maximum vigour index-I was obtained in synthetic polymer-II at 0.3% (2746.86) followed by biopolymer at 0.1% (2469.34) and 0.2% (2458.98). In case of fresh weight there is a variation among treatments, maximum fresh weight of 32.90 g and 28.68 g was recorded in synthetic polymer-II at 0.3% and 0.2% concentration respectively which was on par with biopolymer at 0.1% (28.28 g). Maximum dry weight was obtained in synthetic polymer-II at 0.3% (5.75 g) followed by 0.1% (5.22 g) and 0.4% (5.07 g) concentration. Seed coated with synthetic polymer-II at 0.3% recorded maximum vigour index-II (496.16) followed by 0.2% and 0.1% of the same polymer which recorded 442.78 and 398.05 respectively (Table 2.1).

Table 1.1 Effect of different synthetic seed coat polymers and biopolymers on germination and vigour of castor seed

Polymer	Conc.	Germination (%)	Root Length (cm)	Shoot Length (cm)	Vigour Index-I	Fresh Weight (g)	Dry Weight (g)	Vigour Index-II
Synthetic Polymer-I	0.1	91.80 (74.98)*****	18.00	8.66	2286.12	18.88	1.65	151.85
	0.2	91.20 (73.39)	13.70	11.10	2276.28	18.30	1.59	144.99
	0.3	90.60 (71.62)	14.20	10.30	2187.00	17.60	1.48	133.71
	0.4	90.00 (70.54)	12.70	11.50	2158.80	16.16	1.46	131.18
	0.5	85.80 (67.99)	15.20	9.02	2091.30	15.10	1.30	111.69
Synthetic Polymer-II	0.1	86.60 (72.36)	13.40	13.30	2331.80	17.80	1.46	126.18
	0.2	88.80 (72.16)	13.72	13.24	2427.24	18.80	1.49	132.46
	0.3	92.80 (77.08)	15.92	13.68	2746.86	19.62	1.64	151.80
	0.4	88.20 (71.08)	12.30	12.60	2212.32	19.22	1.47	129.29
	0.5	85.00 (66.47)	13.30	12.40	2184.78	18.90	1.39	117.98
Synthetic Polymer-III	0.1	73.80 (56.71)	15.56	7.74	1695.86	15.20	1.38	101.67
	0.2	80.60 (62.52)	14.60	7.90	1813.20	16.00	1.42	114.75
	0.3	86.40 (66.66)	14.18	10.42	2139.44	16.84	1.45	124.88
Polymer	**Conc.**	**Germination (%)**	**Root Length (cm)**	**Shoot Length (cm)**	**Vigour Index-I**	**Fresh Weight (g)**	**Dry Weight (g)**	**Vigour Index-II**
Synthetic Polymer-III	0.4	79.00 (63.88)	12.90	10.80	1909.74	14.52	1.36	107.25
	0.5	81.20 (64.32)	11.90	10.90	1833.82	12.62	1.32	107.49
Bio Polymer	0.1	92.40 (72.31)	15.20	12.30	2469.34	18.70	1.69	155.78
	0.2	91.80 (71.69)	14.62	12.80	2458.98	17.60	1.60	147.21
	0.3	88.80 (69.27)	14.50	12.70	2376.58	17.30	1.55	137.84
	0.4	87.20 (68.40)	14.32	13.92	2353.62	15.80	1.44	125.39
	0.5	84.20 (64.54)	13.62	12.10	2193.20	15.30	1.38	116.50
Chitosan	0.25%	97.40 (81.85)	18.76	14.76	3236.88	19.24	1.76	171.74
Chitosan	0.20%	90.00 (70.65)	17.92	13.42	2807.88	16.78	1.69	147.26
Check		87.20 (69.92)	15.60	13.18	2515.46	16.60	1.60	143.97
CD (p = 0.05)		4.42	0.80	0.60	115.50	0.47	0.04	4.11
SE(d)		2.22	0.40	0.30	58.06	0.24	0.02	2.07
SE(m) ±		1.57	0.28	0.21	41.05	0.17	0.02	1.46
CV (%)		5.04	4.33	4.10	4.01	2.20	2.24	2.48

***** Values in the parentheses are angular transformed and are the means of five replications

A similar trend was observed in groundnut. Among all treatments the highest germination (91.80%), root length (15.94 cm), shoot length (12.60 cm), vigour index-I (2620.14), fresh weight (39.76 g), dry weight (6.12 g) and vigour index-II (562.24) (Table 2.2) are recorded with chitosan (0.25%) than synthetic polymer-I, II, III, commercial biopolymer and control.

Among the synthetic polymers the maximum germination recorded when coated with synthetic polymer-I at 0.1% (87.60%) and 87.00% at 0.2% and synthetic polymer-II with a germination of 86.20% at 0.3%. However

there is a variation among treatments with regard to root length, maximum root length of 14.22 cm was observed in synthetic polymer-II at 0.3%, root length of 13.90 cm at 0.4% and 13.62 cm at 0.1% when treated with biopolymer. Similarly the shoot length was maximum (9.06 cm) when treated with synthetic polymer-II at a concentration of 0.3%, followed by biopolymer at 0.1% (8.10 cm). Treatments biopolymer @ 0.3% and synthetic polymer-II @ 0.2% were on par with each other recording a shoot length of 7.72 and 7.70 cm respectively. The vigour index-I was maximum (2006.51) when treated with synthetic polymer-II at 0.3%, followed by the same polymer at 0.4% with a vigour index of 1801.00 and synthetic polymer-I with 1641.94 at 0.1% concentration. Synthetic polymer-II recorded fresh weight and dry weight of 32.90 g and 5.75 g respectively at a concentration of 0.3% and a fresh weight of 28.68 g and 5.22 g dry weight at 0.2%. Biopolymer at a concentration of 0.1% recorded fresh weight of 28.28 g whereas dry weight of 5.07 g was recorded by synthetic polymer-II at 0.4%. Among all the treatments, maximum vigour index-II was recorded by synthetic polymer-II at 0.3% (496.16), 0.2% (442.78) and 0.1% (398.05) (Table 2.2).

Table 2.2 Effect of different synthetic seed coat polymers and biopolymers on germination and vigour of groundnut seed

Polymer	Conc.	Germination (%)	Root Length (cm)	Shoot Length (cm)	Vigour Index-I	Fresh Weight (g)	Dry Weight (g)	Vigour Index-II
Synthetic Polymer-I	0.1	87.60 (69.46)*	11.36	7.38	1641.94	25.26	3.23	283.61
	0.2	87.00 (68.96)	10.94	6.98	1558.48	22.16	2.86	249.10
	0.3	83.80 (66.26)	10.18	6.72	1416.46	19.32	2.47	207.07
	0.4	78.00 (62.08)	9.74	6.36	1254.70	19.12	2.27	176.51
	0.5	73.20 (58.82)	9.66	6.24	1164.24	18.02	2.11	154.23
Synthetic Polymer-II	0.1	83.00 (65.68)	11.88	7.30	1592.60	26.14	4.80	398.05
	0.2	84.80 (67.07)	12.88	7.70	1745.10	28.68	5.22	442.78
	0.3	86.20 (68.25)	14.22	9.06	2006.51	32.90	5.75	496.16
	0.4	84.40 (66.76)	13.90	7.44	1801.00	27.84	5.07	428.35
	0.5	79.60 (63.20)	13.40	7.18	1636.72	25.30	5.01	399.36
Synthetic Polymer-III	0.1	73.00 (58.72)	10.66	6.70	1266.82	19.36	2.74	200.61
	0.2	69.60 (56.58)	10.04	7.18	1198.38	18.80	2.46	171.27
	0.3	67.00 (54.99)	9.72	7.26	1137.90	18.26	2.20	147.38
Synthetic Polymer-III	0.4	61.40 (51.58)	9.46	7.46	1038.72	17.04	2.11	129.57
	0.5	51.60 (45.90)	8.62	7.84	849.48	16.02	2.03	104.43
Bio Polymer	0.1	86.20 (68.23)	13.62	8.10	1871.82	28.28	4.60	396.35
	0.2	81.80 (64.84)	13.06	7.72	1699.10	26.44	4.45	364.25

	0.3	76.60 (61.16)	12.36	7.36	1510.46	25.50	4.27	326.33
	0.4	76.60 (61.05)	11.88	7.28	1467.72	23.02	4.02	307.74
	0.5	63.60 (52.88)	11.52	6.70	1158.40	22.42	3.94	250.36
Chitosan	0.25 %	91.80 (73.36)	15.94	12.60	2620.14	39.76	6.12	562.24
Chitosan	0.20 %	89.40 (71.06)	14.12	10.42	2194.04	34.82	5.91	528.60
Check		85.00 (67.26)	14.60	8.76	1986.18	33.68	5.63	478.49
CD (p = 0.05)		2.85	0.40	0.34	82.87	1.63	0.27	28.65
SE(d)		1.43	0.20	0.17	41.66	0.82	0.14	14.40
SE(m) ±		1.01	0.14	0.12	29.46	0.58	0.10	10.18
CV (%)		3.61	2.65	3.50	4.23	5.24	5.59	7.27

***** Values in the parentheses are angular transformed and are the means of five replications

DISCUSSION

Perusal of the data indicated that in general biopolymers were found to be superior in enhancing the germination, seedling vigour, growth parameters when compared to synthetic polymers in both castor and groundnut. From the above study it was found that chitosan a natural polymer was superior among all the treatments which showed significant effect on germination, reduced the mean germination time and increased shoot length, root length, and dry weights. Similar results were obtained by Liqiang[4] in tomato. The tomato seed treated with 150 mg l^{-1} of chitosan showed highest germination rate, germination index, root fresh weight, germ fresh weight and vigour index than the untreated control. This enhanced effect may be due to the relative permeability of the plasma membrane which increased the concentrations of soluble sugars and proline, and enzymes like peroxidase and catalase activities[1]. Zhou *et al*.[11] reported that when peanut seeds were soaked in chitosan, exhibited an increased rate of germination. Vinod kumar *et al*.[10] while working with pigeonpea, used polymer coated seed and found highest germination (83.57 %), seedling length (27.52), seedling dry weight (85.17 mg) and vigour index (2810) than untreated seeds. Similarly Shakuntala *et al.*[7] treated sunflower hybrid RSFH-130 with seed coat polymer @ 5 ml kg^{-1} found best results in germination (97 %) and vigour index (3377) than control. The results of the present study also indicated that the synthetic polymers had a beneficial effect on castor and groundnut enhancing per cent germination, seedling vigour I and II.

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