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Plant hormone based Seed coating formulation enhances seed germination, shelf life, moisture and stress tolerance of ridge gourd

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A B S T R A C T

Seed coating formulations developed in Department of Seed Science and Technology, was studied for their effect on seed germination and seedling vigour of ribbed gourd seeds. The seeds were subjected to seed coating with newly developed seed coating polymer formulations (I & II), in varied dosages and subjected to seed germination and seedling growth test in paper media and raised bed conditions. The seeds were also subjected to storage in ambient conditions along with control and assessed for effect on shelf life of seeds after six months of storage. The seeds coated with the recommended dosage of newly developed seed coating polymer formulation were subjected to sowing in sand media with a sub-optimal moisture level of (40 % WHC). In raised bed conditions, a per cent improvement of 15 per cent was recorded in formulation I @ 4g kg^{-1}, over control. The speed of germination, root length, shoot length, dry matter production and vigour index were found to record a per cent improvement of 33, 42, 29, 15 and 32 respectively, over control. The same treatment was found to record 92 per cent germination after 6 months of storage while the control recorded only 66 per cent. The seedling vigour was also concomitantly higher in coated seeds. Under moisture stress conditions (40 per cent WHC), ribbed gourd seeds recorded 34 per cent improvement in formulation I @ 4g kg^{-1}, over control seeds. The vigour of the seedlings as measured by the dry matter production (mg $seedling^{-10}$), was found to record 7 per cent improvement in coated seeds of ribbed gourd crops. In the light of the results of the present study, it was concluded that seed coating formulation (I) was more effective in improving the seed germination, seedling growth parameters, seed storage potential, and seed performance in moisture stress, in ribbed gourd.

Introduction

The seed is the generative dispersal unit, which enables plants to spread and survive through periods or seasons of less favourable conditions. High quality seed is the basis of successful agriculture.

In Tamil Nadu, in the year of 2012-13 total vegetable production area was 277.78 (000'ha) with the production of 7897.93(000'tonnes), in 2013-14 the area was 289.74 (000'ha) and production was to the tune of 8678.82 (000'tonnes). In, 2014-15, 9584.29 (000'tonnes) of seed production, was

taken up in an area of 305.29 (000'ha) (Anon, 2015). The seed production scenario assured the tremendous growth and there is a huge demand for quality seeds also.

Uniformity in growth and synchrony in development are highly desirable characters for mechanized cultural operations. Seed coating technology has developed rapidly during the past two decades and provides an economical approach to seed enhancement, especially for larger seeded agronomic and horticultural crops.

Film coating is as the process in which additives are dissolved or dispersed in a liquid adhesive, usually a dyed solution of a polymer, into which the seeds are dipped or sprayed before drying (Halmer, 1987). Scott (1989) defined seed coating as the process application of finely ground solids or liquids containing dissolved or suspended solids to form a more or less continuous layer covering the natural seed coat. This is accomplished with the original shape of the seed being largely unaffected.

Film coating is mainly seen as a more practical to eliminate pesticide dust hazards associated with treating, packaging and planting seed, as well as added protection against mechanical and human handlin2g. The seed coating should be more or less continuous to eliminate or minimize product dust off, as low dust-off is an important factor in worker safety (Taylor *et al.*, 2001). Film coating enables application of protective material in a very precise amount and with a minimal impact on the environment (Baudet and Peres, 2004). This besides polymer film coating is also seen a technology to encapsulate seeds with beneficial organisms (*Rhizobia* and other biologicals) on various crop seed (Devay*et al.*, 1991; Burris, 1992). Devay*et al.* (1991) found polymers to be effective carriers for applying biological control agents in cotton, with the polymers providing enough protection to sustain effective biological control. Kaufman (1991) suggests that the "ideal" coating would be neutral in its influence on the speed, uniformity and germination percentage of a seed lot. A better definition of an ideal coating might include a coating which would be neutral or have a beneficial influence on the speed, uniformity and germination percentage.

Against this back ground, seed coating formulations developed in Department of Seed Science and Technology, was studied for their effect on seed germination and seedling vigour of ribbed gourd seeds under normal and stress conditions as well as impact on storage life.

Materials and Methods

Genetically pure, seeds of ribbed gourd (Co 1) were obtained from Department of Vegetable Crops, Tamil Nadu Agricultural University, Coimbatore. Synthetic polymers and pigment obtained from Sudarshan General Traders, Sivakasi, served as the base material for preparing the seed coating polymer formulation. The composition standardized through previous experiments were mixed and homogenized to produce the new 'Seed Coating formulation".The components of the formulation are synthetic hydrophyllic acrylic polymer, pigment, emulsifier and growth stimulants. Formulation I consists of Gibberellic acid while Formulation II consists of Ethrel.

Experiment.1 Effect of Seed Coating Formulation on seed germination and seedling vigour of vegetable crops

The seeds of ribbed gourd seeds were subjected to seed coating with newly developed seed coating polymer formulations (I & II), in varied dosages as detailed below:

Treatments	Dosage
T0	Control
Formulation I	
T1	2 g kg^{-1}
T2	3 g kg^{-1}
T3	4 g kg^{-1}
Formulation II	
T4	2 g kg^{-1}
T5	3 g kg^{-1}
T6	4 g kg^{-1}

The coated seeds were subjected to seed germination test by sowing in raised beds laid in a 'shade net house' along with control. Observations were made on days to initial germination, days for 50% germination, days for maximum germination, speed of germination, germination, root length, shoot length, Vigour index II and dry matter production (ISTA, 2013).

Experiment.II Effect of Seed Coating Formulation on shelf life of coated seeds

The seeds of ribbed gourd seeds were subjected to seed coating with newly developed seed coating polymer formulations (I & II) , in varied dosages as detailed in Experiment I. The coated seedswere packed in moisture pervious containers and stored under ambient conditions (33ºC and 57% RH) for six months. Seed samples were drawn initially and after six months and subjected to the seed germination test by adopting 'roll towel method'. The coated seeds were packed in moisture pervious containers and stored under ambient conditions (33ºC and 57% RH) for six months. Seed samples were drawn initially and after six months and subjected to the seed germination test by adopting 'roll towel method'. The seeds were subjected to seed germination test (ISTA,2013) in a Room Germinator maintained at 95± 5 % RH and 25 ± 2^{o} C . Observations were made on days to initial germination, days for 50% germination, days for maximum germination, speed of germination, germination, root length, shoot length, Vigour index II and dry matter production (ISTA, 2013).

Experiment.III Effect of Seed Coating Formulation on seed germination and seedling vigour of vegetable crops under moisture stress conditions

The optimum dosage of seed coating formulation as standardised from previous experiment was forwarded for coating of ribbed gourd seeds as detailed below:

Treatments		Dosage
Control	T0	-
Formulation I	T1	4 g kg^{-1}
Formulation I	T2	2 g kg^{-1}

The seeds coated with the recommended dosage of newly developed seed coating polymer formulation were subjected to sowing in sand media with a sub-optimal moisture level of (40 % WHC), along with uncoated control seeds. For preparing the sand media of 40% water holding capacity, 120ml of water was mixed with one kilogram of sand (Venkatasubramanium, 2004).

The seeds were subjected to seed germination test (ISTA,2013) in a Room Germinator maintained at 95± 5 % RH and 25 ± 2^{o} C . Observations were made on days to initial germination, days for 50% germination, days for maximum germination, speed of germination, germination, root length, shoot length, Vigour index II and dry matter production (ISTA, 2013).

Statistical procedures

Data were analyzed using an analysis of variance (ANOVA) as a factorial combination of treatments. Means were separated on the basis of least significant difference (LSD)

only if F test of ANOVA for treatments was significant at the 0.05 or 0.01 probability level. Values in percent data were arcsine transformed before analysis.

Results and Discussion

The effect of varied dosages of 'new TNAU seed coating formulation'on ribbed gourd was experimented in paper medium and raised beds of shade net house. The results revealed that when tested in optimum conditions of room germinator in paper media, all the treatments recorded 100 per cent normal seedlings, irrespective of the seed coating dosage. While with respect to speed of germination, root length (cm), shoot length (cm), dry matter production (mg seedling^{-10}) and vigour index, formulation I @ 4g kg^{-1} recorded highest over control. When the seeds of coating treatments were evaluated in raised beds, formulation II (250 ppm ethrel) @ 2g kg^{-1} recorded highest germination (98 per cent); it was 20 per cent improvement over control. The per cent improvement recorded in formulation I @ 4g kg^{-1} was 15 per cent higher over control, while speed of germination, root length, shoot length, dry matter production and vigour index, the per cent improvement recorded was 33, 42, 29, 15 and 32 respectively in formulation I @ 4g kg^{-1} (Table 1, 2 &3).

The second experiment was conducted to study the effect of optimum dosage of seed coating formulation on shelf life of ribbed gourd seeds after six months of storage under ambient conditions. The observations recorded during storage experiment revealed that the formulation I (250 ppm gibberellic acid) @ 4g kg^{-1} recorded 39, 67, 61, 26, 20 and 67 per cent higher than control, for seed germination, speed of germination, root length, shoot length, dry matter production and vigour index, respectively (Table 4).

The third experiment was conducted to evaluate the effect of seed coating formulations on tolerance of crop seeds to moisture stress. In order to assess the stress tolerance, seeds were subjected to best dosage of seed coating formulations as standardized in the first two experiments. The coated seeds along with control were sown in 40% WHC (moisture stress condition). The data revealed that ribbed gourd seeds recorded 34 per cent improvement in formulation I @ 4g kg^{-1}, over control seeds. The vigour of the seedlings as measured by the dry matter production (mg seedling^{-10}), was found to record 7 per cent improvement in coated seeds of ribbed gourd crops(Table 5).

The results of all the three experiments have proven that coating of ribbed gourd seeds with optimum dosage of TNAU seed coating formulation is significantly effective in improving the initial seed germination and seedling vigour, enhancing the shelf life of seeds besides imparting resistance towards moisture stress.

Anon., (2002) reported that onion seeds coated with liquid polymer along with fungicide and nutrients improved the seedlings stand. Coating rice seeds with 5g polykote diluted with 70 mL of water kg^{-1} of seed enhances water uptake, thereby promoted early sprouting, and enhanced germination and seedling growth (Sabir-Ahamed, 2003).

Seeds of maize treated with polymer @ 3g kg^{-1} of seed dissolved in 5 mL of water recorded higher germination per cent, speed of emergence, seedling growth, dehydrogenase activity and chlorophyll content (Sherin, 2003).

Table.1 Effect of seed coating formulations on normal seedlings (%), abnormal seedlings (%) and dead seeds (%) of ribbed gourd in paper medium

Treatments		Normal seedling (%)	Abnormal seedling (%)	Dead seed (%)
	Control	100 (89.72)	0(+0.5)	0(+0.5)
Formulation I	**2g kg^{-1}**	100 (89.72)	0(+0.5)	0(+0.5)
	3g kg^{-1}	100 (89.72)	0(+0.5)	0(+0.5)
	4g kg^{-1}	100 (89.72)	0(+0.5)	0(+0.5)
Formulation II	**2g kg^{-1}**	100 (89.72)	0(+0.5)	0(+0.5)
	3g kg^{-1}	100 (89.72)	0(+0.5)	0(+0.5)
	4g kg^{-1}	100 (89.72)	0(+0.5)	0(+0.5)
Mean		**100 (89.72)**	**0**	**0**
SEd		NS	0.20	0.20
CD (P=0.05)		NS	0.43	0.43

(Figures in parenthesis indicate arcsine values)

Table.2 Effect of seed coating formulations on seed germination (%) and seedling vigour of ribbed gourd in paper medium

Treatments		Germination (%)	Speed of germination on 5th day	Root length (cm)	Shoot length (cm)	Dry matter production (mg seedlings^{-10})	Vigour Index
	Control	100 (89.72)	5.0	20.1	14.3	1252.8	125280
Formulation I	**2g kg^{-1}**	100 (89.72)	5.3	22.3	16.7	1271.9	127190
	3g kg^{-1}	100 (89.72)	5.3	22.7	16.9	1322.1	132210
	4g kg^{-1}	100 (89.72)	5.5	23.3	18.9	1367.2	136720
Formulation II	**2g kg^{-1}**	100 (89.72)	5.6	22.8	18.7	1346.6	134660
	3g kg^{-1}	100 (89.72)	5.3	21.8	15.2	1325.9	132590
	4g kg^{-1}	100 (89.72)	5.3	21.6	15.2	1302.8	130280
Mean		**100 (89.72)**	**5.3**	**22.1**	**16.6**	**1312.8**	**131276**
SEd		NS	0.06	0.21	0.25	20.22	1834.92
CD (P=0.05)		NS	0.12	0.44	0.53	42.05	3815.93

(Figures in parenthesis indicate arcsine values)

Table.3 Effect of seed coating formulations on seed germination (%) and seedling vigour of ribbed gourd in raised bed condition

Treatments		Germination (%)	Speed of germination on 5th day	Speed of germination on 14th day	Root length (cm)	Shoot length (cm)	Dry matter production (mg seedlings^{-10})	Vigour Index
	Control	82 (64.90)	3.9	4.6	5.3	22.7	1843.2	151142
Formulation I	**2g kg^{-1}**	92 (73.57)	4.5	5.1	6.0	26.0	1965.9	180862
	3g kg^{-1}	94 (75.82)	5.4	5.8	6.2	27.0	1971.5	185321
	4g kg^{-1}	94 (75.82)	5.8	6.1	7.5	29.3	2127.5	199985
Formulation II	**2g kg^{-1}**	98 (81.87)	5.5	5.9	5.8	24.0	1890.3	185249
	3g kg^{-1}	96 (78.47)	6.0	6.2	5.9	22.9	1892.9	181718
	4g kg^{-1}	94 (75.82)	5.4	5.8	5.7	23.0	1845.5	173477
Mean		**93 (74.66)**	**5.2**	**5.6**	**6.0**	**25.0**	**1933.8**	**179679**
SEd		1.79	0.09	0.07	0.10	0.50	22.51	2298.85
CD (P=0.05)		3.73	0.19	0.15	0.20	1.04	46.81	4780.73

(Figures in parenthesis indicate arcsine values)

Table.4 Effect of seed coating formulations on seed germination (%) and seedling vigour of ribbed gourd after 6 months of storage

Treatments		Germination (%)	Speed of germination on 5th day	Root length (cm)	Shoot length (cm)	Dry matter production (mg seedlings^{-10})	Vigour Index
	Control	66 (54.33)	3.0	2.8	8.5	880.6	58119
Formulation I	**2g kg^{-1}**	86 (68.03)	4.8	4.2	10.3	980.5	84323
	3g kg^{-1}	90 (71.57)	5.0	4.3	10.5	995.7	89613
	4g kg^{-1}	92 (73.57)	5.0	4.5	10.7	1054.3	96996
Formulation II	**2g kg^{-1}**	90 (71.57)	5.3	4.2	10.4	1089.6	98064
	3g kg^{-1}	86 (68.03)	4.8	4.0	10.1	976.2	83953
	4g kg^{-1}	84 (66.42)	4.5	4.0	9.8	970.4	81514
Mean		**85 (67.22)**	**4.6**	**4.0**	**10.0**	**992.5**	**84655**
SEd		1.10	0.06	0.05	0.14	9.00	808.36
CD (P=0.05)		2.27	0.12	0.09	0.29	18.73	1681.08

(Figures in parenthesis indicate arcsine values)

Table.5 Effect of seed coating formulations on seed germination (%) and seedling vigour of ribbed gourd under water stress condition (40% WHC)

Treatments		Germination (%)	Speed of germination on 5th day	Speed of germination on 14th day	Root length (cm)	Shoot length (cm)	Dry matter production (mg seedlings^{-10})	Vigour Index
	Control	58 (49.60)	1.8	2.9	17.9	12.6	1057.3	61323
Formulation I	**4g kg^{-1}**	78 (62.03)	3.8	4.4	19.3	13.4	1125.7	87805
Formulation II	**2g kg^{-1}**	65 (53.73)	2.0	3.2	18.8	12.8	1110.9	72209
Mean		**67 (54.94)**	**2.5**	**3.6**	**18.7**	**12.9**	**1097.9**	**73779**
SEd		0.53	0.04	0.04	0.23	0.08	12.89	645.45
CD (P=0.05)		1.10	0.08	0.08	0.49	0.17	27.08	1356.06

(Figures in parenthesis indicate arcsine values)

Ramya (2003) found that tomato seeds coated with pink polymer @ 3g kg^{-1} of seed recorded higher seed quality. Sorghum seeds slurry coated with 3g of polykote polymer per kg of seed registered maximum germination of 91 per cent and more seedling vigour compared to uncoated seeds (Saritha Devi, 2004).

Gesch (2005) reported that the maize seeds coated with temperature activated polymer increased the germination from 60 to 90 per cent of seed planted, were generally significantly greater than those of uncoated seed, which ranged from 49 to 68 per cent. The seeds treated with polykote namely yellow, black, red lower extract recorded significance increase in germination percentage over control (Keshavulu and Krishnaswamy, 2005).

Vinitha (2006) noted that in film coating showed that 6g white red polykote @ 6g kg^{-1} registered higher values for germination, root length, shoot length and vigour index than the uncoated seeds. The slurry coating of chilli seed with polycoat (3g kg^{-1} of seed) along with carbendazim (2g kg^{-1} of seed) and halogen mixture (3g kg^{-1} of seed) enhanced the germination and vigour index, whereas the infection was lessened compared to uncoated seeds and enhanced field emergence (Geetharani*et al.*, 2006).

Santhiya (2016) reported that seed coating polymer formulation was found to be effective in improving the seed germination characteristics as well as initial seedling vigour of cotton and maize.

In the light of the results of the present study, it was concluded that seed coating formulation (I) was more effective in improving the seed germination, seedling growth parameters, seed storage potential, and seed performance in moisture stress, in ribbed gourd. It is therefore recommended that ribbed gourd seeds can be subjected to seed coating with TNAU Seed Coating Formulation at recommended dosage so as improve the seed performance in field as well as to extend the seed storage life.

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