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Research Article

IMPACT OF SEED PRIMING AND SEED COATING TECHNIQUES ON RESISTANCE TO WATER STRESS IN GREENGRAM *CV.* CO 8

K. MALARKODI*
Agricultural Research Station, Bhavanisagar, 638451, Tamil Nadu Agricultural University, Coimbatore, 641003, Tamil Nadu, India
*Corresponding Author: Email - jujumalar2000@gmail.com

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Abstract: The field trails were raised during *Kharif* 2017, *Rabi* 2017-18, *Kharif* 2018 and *Rabi* 2018-19 to evaluate the effect of seed priming and seed coating techniques on productivity of green gram under water stress condition. The seeds were given with various treatments *viz*., Seed priming with water by adopting seed to solution ratio of 1:1 (T_2), Seed coating with TNAU seed coating polymer (4g / kg of seed) (T3) and Seed priming + Seed coating (T_2 +T_3 = T_4) and sown along with control seeds at different irrigation levels *i.e*., irrigation at IW/CPE ratio of 0.60 (M_1), irrigation at IW/CPE ratio of 0.48 (M_2) and irrigation at IW/CPE ratio of 0.36 (M_3). The result revealed that seeds of greengram cv.CO 8 exposed to seed priming with water (seed to solution ratio of 1:1) + seed coating with TNAU Nutricoat Polymer (4g / kg of seed) (T_4) recorded significantly higher seed yield per hectare of 1501 and 1570 kg/ha, respectively during *Kharif* and *Rabi* (pooled data of two years) by registering 20.3 and 21.6% increased yield over control irrespective of the irrigation level in addition higher yield attributing characters. Among the different irrigation levels, crop raised by using treated seeds under IW/CPE ratio of 0.48 (M_2) recorded significantly higher seed yield 1409 kg/ha during *Kharif* and 1465 kg/ha during *Rabi* followed by IW/CPE ratio of 0.36 (M_3) and IW/CPE ratio of 0.60 (M_1) highlighting the suitability of said seed treatment under water stress condition.

Keywords: *Seed Priming, Seed Coating, Nutricoat Polymer*

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Introduction

The seed is the most vital and crucial input for crop production, one of the ways to increase the productivity without adding appreciably to the extent of land now under cultivation by planting quality seed. Seeds are of immense biological and economic importance. They contain high protein, starch and oil reserves that help in the early stages of growth and development in a plant. The importance of quality seeds has been recognized from the time immemorial. The old scripture, Good seed in good soil yields abundantly. Seed quality has been treated as sacred, being an important factor in the improvement of agriculture and agrarian societies. Although the importance of seed was recognized in ancient agriculture, the need for organized seed production was identified only at the beginning of 20th century when Royal commission of Agriculture (1925) recommended spread of improved varieties and seed distribution. In the view to supply higher quality seeds to farmer's, researchers have developed new technologies called seed quality enhancement techniques like seed priming. Seed priming is a simple process in which it is a cost-effective technique to improve germination behavior of seeds, promote faster germination and uniformity in germination. During past two decades, seed coating technology has been developed enormously that provides an economical approach to seed enhancement, especially for larger seeded agronomic and horticultural crops. Seed coating is the process of applying finely grounded solid or liquids containing dissolved or suspended particles that is applied over the seeds to cover the natural seed coat without altering its shape and size [1]. Combinational treatments have their own properties in improving the vigour status of the seed with the significant increase over the individual treatments. During the combination of treatments like priming and coating, priming improves all the physiological, anatomical and biochemical parameters of the seed. Coating over the primed seed will strengthen the seedling during its developmental stages by hastening the nutrient availability to the seeds. Priming improves resistance of plants towards abiotic stress conditions [2]. Keeping these in view, the present experiment was conducted in greengram *cv.*CO 8 to evaluate the effect of seed priming and seed coating techniques on field emergence, crop growth and productivity under differential irrigation levels.

Materials and Methods

Genetically pure seeds of greengram *cv.*CO 8 was obtained from Agricultural Research Station, Tamil Nadu Agricultural University, Bhavanisagar formed the base material for the study. The field trials were raised during *Kharif* 2017, *Rabi* 2017-18, *Kharif* 2018 and *Rabi* 2018-19 at Agricultural Research Station, Bhavanisagar by imposing the following treatments by adopting split plot design having the main plot size of 16x5 m and sub plot size of 5x4 m with three replications and plant spacing of 45x20 cm.

Treatments

Main plot:

M_1- Irrigation at IW/CPE ratio of 0.60
M_2- Irrigation at IW/CPE ratio of 0.48
M_3- Irrigation at IW/CPE ratio of 0.36

Sub plot:

T_1 - Control
T_2 - Seed priming with water by adopting seed to solution ratio of 1:1
T_3 - Seed coating with TNAU Nutricoat polymer (4g / kg of seed)
T_4 - Seed priming + Seed coating (T_2 +T_3)

The recommended package of practices was followed uniformly for all the treatments except irrigation. The observations on field emergence (%), growth and yield attributing characters were recorded.

Field emergence (%)

Four hundred seeds from each treatment were taken at random and individually sown in raised beds of 3x3 m @ single seed per hill in eight different lines (@50 seeds per line) under field condition and irrigated immediately after sowing. The beds were watered periodically to maintain sufficient soil moisture and ten days after sowing the seedlings emerged with proper shoot and root were counted. The field emergence percentage was arrived by following the formula and mean expressed as percentage

Field emergence (%) = Number of seedlings produced / Number of seeds sown x 100

Number of pods / plants

The number of matured pods per plant was counted in each treatment and replication and the mean value expressed as whole number.

Pod yield / plant (g)

The pods produced from each of the plant were harvested as three pickings in twenty tagged plants in replication and treatment wise when they mature and were dried and weighed individually using digital electronic balance and the cumulative yield of all picking was reported as pod yield per plant and mean values expressed in gram.

Seed yield / plant (g)

Pods harvested in three pickings were dried, cleaned replication and treatment wise and threshed. The seeds were weighed and the cumulative yield of all pickings was reported as seed yield per plant in gram.

Seed yield / ha (kg)

Seed yield per plot obtained was computed to seed yield per hectare and the mean expressed in kilogram.

Statistical Analysis

The data obtained from various experiments were analysed for the 'F' test of significance [3]. The critical difference (CD) was calculated at 5 percent (P = 0.05) probability level and wherever 'F' value is non-significant it is denoted by 'NS'.

Result

Field emergence (%)

In the present study, the field emergence percentage recorded from the seeds imposed with seed priming with water (seed to solution ratio of 1:1) + seed coating with TNAU Nutricoat polymer (4g/kg of seed) (T_4) recorded significantly higher field emergence during *Kharif* (99.44%) and *Rabi* (99.71%) when compared to

Table-1 *Effect of seed priming and seed coating on field emergence (%) in green gram cv.CO 8*

Treatments	*Kharif* 2017 & 2018				*Rabi* 2017-18 & 2018-19			
	M_1	M_2	M_3	Mean (T)	M_1	M_2	M_3	Mean (T)
T_1	98.79	97.35	97.50	97.88	98.68	97.52	99.30	98.50
T_2	99.49	98.51	98.20	98.73	98.58	99.65	99.40	99.21
T_3	99.70	98.71	98.30	98.90	99.60	99.69	99.54	99.61
T_4	99.60	99.35	99.38	99.44	99.75	99.57	99.82	99.71
Mean (M)	99.40	98.48	98.35	98.74	99.15	99.11	99.52	99.26
	M	T	M x T		M	T	M x T	
SEd±	0.22	0.33	0.46		0.37	0.42	0.63	
CD(P=0.05)	NS	0.77	NS		NS	0.86	NS	

Table-2 *Effect of seed priming and seed coating on plant height at maturity stage (cm) in green gram cv.CO 8*

Treatments	*Kharif* 2017 & 2018				*Rabi* 2017-18 & 2018-19			
	M_1	M_2	M_3	Mean (T)	M_1	M_2	M_3	Mean (T)
T_1	39.23	36.68	35.74	37.22	38.35	36.63	35.31	36.76
T_2	39.63	39.43	38.97	39.38	38.74	38.01	38.57	38.44
T_3	41.28	39.08	38.62	39.66	37.42	40.6	39.75	39.26
T_4	43.01	39.98	37.02	40.00	41.04	40.33	39.54	40.30
Mean(M)	40.79	38.79	37.59	39.06	38.89	38.90	38.29	38.69
	M	T	M x T		M	T	M x T	
SEd±	0.58	0.43	0.76		0.44	0.51	0.89	
CD(P=0.05)	1.61	0.92	1.59		1.24	1.08	2.02	

Table-3 *Effect of seed priming and seed coating on days to first flowering in green gram cv.CO 8*

Treatments	*Kharif* 2017 & 2018				*Rabi* 2017-18 & 2018-19			
	M_1	M_2	M_3	Mean (T)	M_1	M_2	M_3	Mean (T)
T_1	27.5	27.0	26.5	27.0	27.5	26.5	26.5	26.8
T_2	27.0	26.0	26.5	26.5	26.5	26.0	25.0	25.8
T_3	27.5	26.5	27.0	27.0	26.5	26.5	26.0	26.3
T_4	26.5	26.0	26.5	26.3	26.0	25.5	25.5	25.7
Mean(M)	27.1	26.4	26.6	26.7	26.6	26.1	25.8	26.2
	M	T	M x T		M	T	M x T	
SEd±	0.22	0.30	0.50		0.24	0.34	0.56	
CD(P=0.05)	0.60	0.67	NS		0.67	0.72	NS	

Table-4 *Effect of seed priming and seed coating on number of pods/plant in green gram cv.CO 8*

Treatments	*Kharif* 2017 & 2018				*Rabi* 2017-18 & 2018-19			
	M_1	M_2	M_3	Mean (T)	M_1	M_2	M_3	Mean (T)
T_1	58.66	63.39	61.20	61.08	59.24	66.04	66.90	64.06
T_2	64.88	65.67	64.20	64.92	68.65	68.66	68.57	68.63
T_3	66.84	67.92	67.60	66.79	65.81	72.99	70.32	69.70
T_4	67.94	69.25	68.91	68.70	70.41	72.82	73.19	72.14
Mean(M)	64.58	66.56	65.73	65.62	66.10	70.13	69.74	68.63
	M	T	M x T		M	T	M x T	
SEd±	0.79	0.83	1.43		0.77	0.87	1.52	
CD(P=0.05)	1.59	1.74	3.01		1.76	1.84	3.46	

Table-5 Effect of seed priming and seed coating on pod yield / plant (g) in green gram cv.CO 8

Treatments	*Kharif* 2017 & 2018				*Rabi* 2017-18 & 2018-19			
	M_1	M_2	M_3	Mean (T)	M_1	M_2	M_3	Mean (T)
T_1	20.4	22.9	22.5	21.9	22.0	23.7	22.6	23.8
T_2	21.9	23.6	23.6	23.0	23.4	25.5	23.4	25.6
T_3	22.1	24.4	24.3	23.6	25.2	27.7	25.3	27.9
T_4	22.8	24.4	24.1	23.8	27.6	28.9	26.5	29.1
Mean(M)	21.8	23.8	23.6	23.1	24.6	26.5	24.5	26.6
	M	T	M x T		M	T	M x T	
SEd±	0.17	0.33	0.52		0.30	0.31	0.55	
CD(P=0.05)	0.47	0.69	NS		0.83	0.65	NS	

Table-6 Effect of seed priming and seed coating on seed yield /plant (g) in green gram cv.CO 8

Treatments	*Kharif* 2017 & 2018				*Rabi* 2017-18 & 2018-19			
	M_1	M_2	M_3	Mean (T)	M_1	M_2	M_3	Mean (T)
T_1	11.98	13.21	12.14	12.44	12.33	15.37	13.91	13.87
T_2	13.27	13.77	13.18	13.41	14.82	15.28	14.82	14.97
T_3	13.89	15.90	15.00	14.93	14.93	16.77	15.73	15.81
T_4	15.64	16.63	16.05	16.11	15.98	17.98	16.78	16.91
Mean(M)	13.70	14.87	14.08	14.22	14.51	16.35	15.31	15.39
	M	T	M x T		M	T	M x T	
SEd±	0.14	0.21	0.36		0.25	0.17	0.37	
CD(P=0.05)	0.40	0.44	0.76		0.72	0.37	0.90	

Table-7 Effect of seed priming and seed coating on seed yield (kg/ha) in green gram cv.CO 8

Treatments	*Kharif* 2017 & 2018				*Rabi* 2017-18 & 2018-19			
	M_1	M_2	M_3	Mean (T)	M_1	M_2	M_3	Mean (T)
T_1	1152	1221	1215	1196	1179	1244	1269	1231
T_2	1255	1325	1301	1294	1301	1414	1362	1359
T_3	1328	1493	1434	1418	1387	1530	1483	1467
T_4	1408	1596	1499	1501	1456	1670	1583	1570
Mean(M)	1286	1409	1362	1352	1331	1465	1424	1407
	M	T	M x T		M	T	M x T	
SEd±	13.20	17.84	30.91		5.98	12.51	19.69	
CD(P=0.05)	36.66	37.49	64.94		16.62	26.28	42.61	

control (pooled data of two years), irrespective of the irrigation levels. Among the irrigation levels and their interaction between MxT, the field emergence showed non significant difference [Table-1].

Plant height at maturity stage (cm)

Irrespective of the irrigation levels, significantly maximum plant height of 40.00 cm and 40.30 cm has been recorded by the crop, raised by using the seeds imposed with seed priming with water (seed to solution ratio of 1:1) + seed coating with TNAU Nutricoat polymer (4g/kg of seed) when compared to control, during *Kharif* and *Rabi* (pooled data of two years), respectively. Among the irrigation levels, the crop raised under Irrigation at IW/CPE ratio of 0.60 (M_1) showed significantly maximum plant height at maturity when compared to Irrigation at IW/CPE ratio of 0.48(M_2) and 0.36(M_3). The interaction due to MxT was significant which highlighted the superiority of said seed treatment under stress condition [Table-2].

Days to first flowering

The plants raised by utilizing the seeds imposed with seed priming with water (seed to solution ratio of 1:1) + seed coating with TNAU Nutricoat polymer (4g/kg of seed) came to flowering one day earlier than other treatments and control, irrespective of irrigation levels during both the seasons. Among the irrigation levels, crop raised under to IW/CPE ratio of 0.60 showed earlier flowering when compared to IW/CPE ratio of 0.48 and IW/CPE ratio of 0.36. Whereas, non significant difference was observed due to the interaction effect (M xT) [Table-3].

Number of pods /plant

The seeds imposed with seed priming with water (seed to solution ratio of 1:1) + seed coating with TNAU Nutricoat polymer (4g/kg of seed) (T_4) recorded significantly higher number of pods during *Kharif* (68.70) and *Rabi* (72.14) when compared to control (pooled data of two years), irrespective of the irrigation levels. In both the seasons, the number of pods per plant was significantly higher under irrigation at IW/CPE ratio of 0.48 followed by IW/CPE ratio of 0.36 and IW/CPE ratio of 0.60, irrespective of the treatments. The interaction due to MxT was significant which highlighted the superiority of said seed treatment under stress condition [Table-4].

Pod yield / plant (g)

Significantly maximum pod yield per plant of 23.8 and 29.1 has been recorded by the crop raised with the seeds imposed with seed priming with water (seed to solution ratio of 1:1) + seed coating with TNAU Nutricoat polymer (4g/kg of seed) when compared to control, during *Kharif* and *Rabi* (pooled data of two years) respectively, irrespective of the irrigation levels. Among the irrigation levels, the crop raised under irrigation at IW/CPE ratio of 0.48 (M_2) showed significantly maximum pod yield / plant {23.8 during *Kharif* and 26.5 during *Rabi* (pooled data)} followed by irrigation at IW/CPE ratio of 0.36(M_3) and 0.60 (M_1) which highlighted the superiority of said seed treatment under stress condition. The interaction due to MxT was non significant [Table-5].

Seed yield /plant (g)

The result showed that seeds imposed with seed priming + seed coating (T_4) recorded significantly maximum seed yield of 16.11g per plant during *Kharif* and 16.91g per plant during *Rabi* (pooled data of two years) followed by seed coating with TNAU Nutricoat polymer (4g / kg of seed) and seed priming treatments, irrespective of the irrigation levels. The crop raised under irrigation at IW/CPE ratio of 0.48 (M_2) showed significantly maximum seed yield / plant (14.87gram during *Kharif* and 16.35 gram during *Rabi*) followed by irrigation at IW/CPE ratio of 0.36(M_3) and 0.60 (M_1) which highlighted the superiority of said seed treatment under water stress condition. The interaction due to MxT was also showed significant difference [Table-6].

Seed yield (kg/ha)

The green gram seeds exposed to seed priming with water (seed to solution ratio of 1:1) + seed coating with TNAU Nutricoat polymer (4g/kg of seed) recorded statistically higher seed yield per hectare to the tune of 1501 and 1570 kg/ha, respectively during *Kharif* and *Rabi* (pooled data of two years four seasons) by

registering 20.3 and 21.6% increased yield over control irrespective of the irrigation level. Among the different irrigation levels, crop raised under IW/CPE ratio of 0.48 recorded higher seed yield followed by IW/CPE ratio of 0.36 and IW/CPE ratio of 0.60. The interaction due to MxT was also showed significant difference highlighting the superiority of said seed treatment under water stress condition also [Table-7].

Discussion

High and rapid germination, determine good stand establishment which results in higher yields. So fast and uniform germination are as important for superior crop production as is total germination while slow, asynchronous and unreliable germination and emergence due to low vigor seeds [4] leads to problems for successful crop production. Seed invigoration treatments have therefore, been developed to improve seed performance during germination and emergence. Most of these involve a period of controlled hydration of the seed to a point close to, but before, the emergence of the radicle after which the seeds are dried back to their initial moisture before sowing [5]. Such treatments include water soaking [6], priming [7] and presoaking seed treatment with plant growth regulators in many crops [8]. In the present study, the field experiments were conducted during *Kharif* 2017, *Rabi* 2017-18, *Kharif* 2018 and *Rabi* 2018-19 to evaluate the effect of seed priming and seed coating techniques on productivity of green gram under water stress condition by imposing the various treatments *viz*., seed priming with water by adopting seed to solution ratio of 1:1 (T_2), Seed coating with TNAU Nutricoat polymer (4g / kg of seed) (T_3) and seed priming + seed coating (T_2 +T_3 = T_4) and sown along with control seeds (T_1) at different irrigation levels *i.e*., irrigation at IW/CPE ratio of 0.60 (M_1), irrigation at IW/CPE ratio of 0.48 (M_2) and irrigation at IW/CPE ratio of 0.36 (M_3). The result revealed that seeds of greengram *cv.*CO 8 exposed to seed priming with water (seed to solution ratio of 1:1) + seed coating with TNAU Nutricoat Polymer (4g / kg of seed) (T_4) recorded significantly higher values for all the studied parameters *viz*., field emergence (%) plant height at maturity stage (cm), days to first flowering, number of pods /plant, pod yield / plant (g), seed yield /plant (g) and seed yield (kg/ha) than individual treatment either as priming nor coating and control seeds. The said treatment registered significantly higher seed yield per hectare of 1501 and 1570 kg/ha, respectively during *Kharif* and *Rabi* (pooled data of two years) by registering 20.3 and 21.6% increased yield over control irrespective of the irrigation level in addition higher yield attributing characters.

Among the different irrigation levels, crop raised by using treated seeds under IW/CPE ratio of 0.48 (M_2) recorded significantly higher seed yield 1409 kg/ha during *Kharif* and 1465 kg/ha during *Rabi* followed by IW/CPE ratio of 0.36 (M_3) and IW/CPE ratio of 0.60 (M_1) highlighting the suitability of said seed treatment under water stress condition. The enhancement in field emergence is due to combinational effect of seed priming and coating. This is the first study on combinational effect of priming and coating of seeds, hence no reports have been published about combinational effect of priming and coating of seeds previously in any of the crops. However, this might be due to soaking of seeds allows the hydration of membranes and proteins, and the initiation of various metabolic systems. These are arrested when the seeds are dried or moisture is withheld, but recommence when the seeds imbibe water for the second time [9]. The final germination percentage, fresh and dry weight of corn seed increased by seed priming significantly [10]. The germination improvement with hydropriming might be due to hydrolysis of complex nutrients into simple sugars that are readily utilized in the synthesis of auxins and proteins. The auxins so produced help to soften cell walls to facilitate growth and the proteins readily utilized in the production of new tissues [11]. The most seeds imbibed in water and sown in moist environment, germinate faster than untreated seeds [12]. The present study results are in line with bitter gourd [13], sorghum [14] and wheat [15].

Similarly, seed coating is the process in which additives are dissolved or dispersed in a liquid adhesive, usually a dyed solution of a polymer and into which the seeds are dipped or sprayed before drying [16]. Seed coating depends upon efficient exposure of seed to liquid to ensure an even coating. The result of present study is in line with [17] and suggests that the "ideal" coating would be neutral in its influence on the speed, uniformity and germination percentage of a seed lot. Increased plant height at maturity stage in the present study could be attributed to the production of plant growth regulators such as gibberellins, cytokinins and indole acetic acid; increased availability of minerals and other ions; and more water uptake [18,19]. It also indicating that initial vigour of the seeds expressed through seedlings were sustained upto the different phases of crop growth and also in improving the photosynthetic efficiency which are the causes for improved source-sink ratio that could have their impact on productivity [20]. Within the evaluated treatments days to first flowering vary only with single day. However, in pearl millet[21] and rice[22] the plants rose from seed treatment with Pseudomonas reached 50 percent flowering a week earlier than other. The treatment influence had also extended up to advancement in flowering and hike in other yield attributing characters *viz*., number of pods /plant, pod yield / plant (g), seed yield /plant (g) and seed yield (kg/ha). Higher grain and biomass yield in pre-germinated seeds could also be attributed to early germination and vigorous growth, consequently good crop establishment. Direct benefits due to seed priming and coating includes, faster emergence, better and more uniform stands, more vigorous plants, better drought tolerance, earlier flowering and higher grain yield in many crops [23]. These findings are in line with [24] who states that priming of wheat seed in osmoticum or water may improve germination and emergence and promote vigorous growth, improve tillering, earlier flowering, earlier maturity and producing higher grain yield. The wheat seed primed for 12 h had earlier emergence compared to untreated control which might due to increment of enzymes activity such as amylase, protease and lipase that have a great role in initial growth and development of embryo [25]. Early increase in activity of these enzymes results in faster initial growth of seedling therefore improvement in plant establishment result in higher yield. Increased tiller number in rice and wheat via applying seed priming treatment were observed [26]. Similar beneficial effects of seed priming were reported and revealed that seedlings were significantly faster in emergence, took fewer days to mature and gave significantly higher grain yield [27] which was in accordance with the present study.

Conclusion

The green gram seeds exposed to seed priming with water (seed to solution ratio of 1:1) + seed coating with TNAU nutricoat Polymer (4g / kg of seed) registered significantly higher seed yield per hectare of 1501 and 1570 kg/ha during *Kharif* and *Rabi* (pooled data of two years) by recording 20.3 and 21.6% increased yield over control respectively, irrespective of the irrigation level. The said treatment was found to significantly more effective in improving the seed yield under lower moisture levels of IW/CPE ratio of 0.48 (M_2) and IW/CPE ratio of 0.36 (M_3) compared to control.

Application of research: The study revealed that the initial improvement in seedling growth had resulted in increased crop growth characteristics which are expected to have direct impact on crop productivity under drought condition.

Research Category: Seed technology

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****Principal Investigator or Chairperson of research: Dr K. Malarkodi**
University: Tamil Nadu Agricultural University, Coimbatore, 641003, India
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Study area / Sample Collection: Agricultural Research Station, Bhavanisagar, 638451

Cultivar / Variety / Breed name: Greengram *cv.* CO 8

Conflict of Interest: None declared

Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.
Ethical Committee Approval Number: Nil

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