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A Novel Seed Priming Technique for Enhancing Seed Vigour and Yield Potential in Marginal Vigour Seeds of Blackgram (*Vigna mungo* L.)

C. Vanitha[1], M. Kathiravan[2]

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ABSTRACT

Background: Seed priming is controlled hydration and dehydration that results in improved seed quality and yield. However, hydration-dehydration of fresh seeds would result in soaking injury especially in legumes. The disadvantage reported in pulses can overcome through pre-conditioning of seeds which allows the seeds to slow hydration and prevent the soaking injury. The conditioning of seeds in large scale is tedious and skill oriented. To overcome this problem, an innovative seed priming technology is essential for pulses to enhance the seed germination, vigour and seed yield.

Methods: Experiment was carried out at National Pulses Research Centre, Vamban during 2016-18. Seed priming technology was developed by using marginal vigour lot of blackgram. The marginal vigour seeds were packed in gunny bag up to 3/4th level and soaked in water for 2 h and 4 h and incubated for 2 h, 4 h and 6 h. After the incubation period, seeds were dried back to original moisture content (9.0%) and seed quality parameters were analyzed. The best performing organic priming concentrations under laboratory were forwarded to field trial and yield parameters were assessed.

Result: Marginal vigour lot of blackgram seeds packed in gunny bag and soaked in seaweed extract @ 0.4% for 2 h and incubated for 4 h significantly increased the seed quality parameters. Among the various organic priming, marginal vigour lot of blackgram seeds packed in gunny bag and soaked in seaweed extract @ 0.4% for 2 h and incubated for 4 h significantly increased the seed quality parameters and yield over hydro priming and control.

Key words: Blackgram, Germination, Marginal vigour seeds, Seaweed, Seed priming, Yield.

INTRODUCTION

Pulses are important source of dietary protein and calories for vegetarian masses and are usually grown with minimal input in marginal and stress prone environments. The productivity of the crop is declining over years due to various reasons. Of the several reasons attributed to this poor performance, seed quality is considered to be very important. Both in conventional and organic farming, the use of high quality seeds is one of the pre-requisites for an efficient crop production. Priming is a controlled- hydrations in which seeds are exposed to an external water potential sufficiently low to prevent radicle protrusion but stimulating physiological and biochemical activities (Bradford, 1986) and improve radicle emergence, speed of germination, seedling vigour, field establishment and seed yield (Taylor and Harman, 1990). Priming treatment has been suggested that the strategy activates a series of physiological processes that improve plant growth under stressful conditions (Varier and Dadlani, 2010) including the induction of antioxidant systems (Eisvand *et al*., 2011). However, hydration-dehydration of fresh seeds would result in soaking injury especially in legumes. Such a disadvantage reported in pulses could be overcome through pre-conditioning of seeds (Saha and Basu, 1984) which allows the seeds to slow hydration and prevent the soaking injury. The conditioning of seeds in large scale is tedious and skill oriented. To overcome this problem, an innovative and simple seed priming technology is essential for pulses to enhance the seed germination, vigour and seed yield.

National Pulses Research Centre, Pudukkottai-622 003, Tamil Nadu, India.
[1]Seed Centre, Tamil Nadu Agricultural University, Coimbatore-641 003, Tamil Nadu, India.
[2]Krishi Vigyan Kendra, Tirupur-641601, Coimbatore, Tamil Nadu, India.

Corresponding Author: C. Vanitha, Seed Centre, Tamil Nadu Agricultural University , Coimbatore-641 003, Tamil Nadu, India. Email: cvani_seed@yahoo.co.in

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MATERIALS AND METHODS

The experiment was conducted at National Pulses Research Centre, Vamban during 2016-2018 to develop an innovative seed priming technique for enhancing vigour and yield of blackgram seeds. Different lots of blackgram cv. VBN 6 were collected from National Pulses Research Centre, Vamban and dried to 9% moisture content.

Screening of vigour lots

If seed lots are with a high germination and emergence percentage, then priming is not likely to improve the emergence percentage very much. However, the advantage of priming will be more prominent in marginal vigour seeds. Screening of marginal vigour lot in blackgram was done to impose the priming treatment. Different lots of Blackgram cv. VBN 6 were selected based on the validity period (from date of seed testing) and conducted germination test. Seed quality parameters *viz.,* germination, speed of germination and dry weight were computed. Based on the results, seed vigour was categorized as high, marginal and low vigour. The experiment was conducted by adopting completely randomized factorial design (CRFD) with four replications.

Development of innovative priming technique

Marginal vigour lot of blackgram with 72% germination were packed in gunny bags up to 3/4th level and soaked in water for two different durations *viz.,* 2 h and 4 h. After the specified periods, the bags were removed from the water and kept on dunnage to drain the excess water and covered tightly with another gunny bag for incubation at different durations *viz.*, 2 h, 4 h and 6 h. After the incubation periods, seeds were dried back to original moisture content (9.0 %) and forwarded to seed quality analysis *viz.*, moisture imbibitions (%), germination (%), speed of germination, root length (cm), shoot length (cm), drymatter production, leachate aminoacid, catalase activity and lipid peroxide formation along with control.

Organic nutrients for seed priming

The best priming treatment (2h soaking and 4h incubation) was imposed to blackgram by utilizing the organic sources *viz.,* panchagavya 2%, humicacid 0.25%, seaweed extract 0.4%, vermiwash 10% and liquid biofertilizer 10%. The primed seeds were dried to reach the original moisture content (9.0%) and germination test was conducted. Final count on normal seedlings was recorded on seventh day and percent germination and other seed quality parameters were computed.

Assessment of seed priming on yield improvement

To assess the treatment performance under field condition, organic priming treatments *viz.*, humic acid (0.25%), vermiwash (10%), seaweed extract (0.4%), panchagavya (2%) along with hydropriming were imposed to marginal vigour seeds of blackgram cv.VBN 6 (72% germination). The primed seeds were sown in both *kharif* 2016 (June-September) and *rabi* 2016-17 (October-February) by adopting randomized block design (RBD) with four replications at experimental field of National Pulses Research Centre, Vamban (11°30'North and, 79°26' East and altitude of 122 m above MSL). The soil texture of the experimental field is sandy loam with acidic pH (5.82). The available carbon content (0.44 %), N,P and K is 184.2, 19.6 and 160.3 kg ha^{-1}, respectively. Plant physiological and yield parameters were recorded. The results were statistically analyzed (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

Screening of marginal vigour lot

Seeds of three months old lot recorded maximum germination (84%), speed of germination (12.78), root length (16.50 cm), shoot length (21.30 cm) and dry matter production (0.268 g 10 seedling^{-1}) than 10 months old lot (72%, 8.20, 13.57 cm, 18.90 cm and 0.183 g 10 seedling^{-1} respectively) and 15 months old lot (57%, 6.17, 11.80 cm, 16.14 cm and 0.146 g 10 seedling^{-1}) (Table 1). In general, high vigour lot is not suitable for evaluating performance of any presowing treatment and the present study also showed the same trend. So, based on the results, among the three different vigour lots, seven months old lot of blackgram with germination of 72% was selected as marginal vigour lot and used to develop seed priming treatments.

Development of seed priming technique

The results revealed that, marginal vigour blackgram seeds packed in gunny bag and soaked in water for 2 h and incubated for 4 h recorded maximum germination (83%), speed of germination (12.68) and drymatter production (0.245 g 10 seedling^{-1}) compared to control (72%, 9.19 and 0.170 g 10 seedling^{-1}, respectively) (Table 2). The water imbibition rate was regulated by the seeds packed in gunny bag and soaked in water for 2 h and incubated for 4 h (28.66%). Since blackgram is a leguminaceous crop, regulation of water imbibition is essential to prevent the seed coat cracking during drying back to original moisture content. The treatments with higher soaking duration and incubation recorded more than 29.0% imbibition rate which leads to radicle protrusion and seed coat cracking damage.

Table 1: Performance of different vigour lots of blackgram cv. VBN 6.

Treatments	Germination (%)	Speed of germination	Root length (cm)	Shoot length (cm)	Dry matter production (g seedlings^{-1})	Vigour index
Lot 1. (3 months old)	84	12.78	16.50	21.30	0.268	3175
Lot 2. (10 months old)	72	8.20	13.57	18.90	0.183	2207
Lot 3. (15 months old)	57	6.17	11.80	16.14	0.146	1592
Mean	70	9.05	13.95	18.78	0.199	2324
SEd	2.05	0.87	0.47	0.68	0.021	37.0
CD (p=0.05)	4.11	1.74	0.94	1.36	0.042	74.0

Organic seed priming

Among the various organic nutrients, marginal vigour blackgram seeds packed in gunny bag and soaked in seaweed extract @ 0.4% for 2 h and incubated for 4 h increased the germination (88%), speed of germination (16.87), drymatter production (0.405 g 10 seedling^{-1}) (Fig 1), root length (20.01cm), shoot length (18.04 cm), Vigour index (3664), catalase enzyme activity (1863 units g^{-1}) and reduced the production of abnormal seedlings (6.3%), leachate aminoacid [36.15 (mg g^{-1})] and lipid peroxidation (0.143 OD) over control (Table 3).

The improvement in germination and vigour of seedlings due to priming treatment might be as a result of advancement in seed metabolic activities (Rajpar *et al*. 2006). During seed priming, the first phase of germination ends with completion of imbibition process and hence the time taken from sowing to emergence is much reduced (Hegarty, 1970). The improvement in germination due to priming could also be ascribed to activation of cells, which results in enhancement of mitochondrial activity leading to the formation of more high energy compounds and vital biomolecules, which are made available during early phase of germination (Farooq *et al*. 2010). Tthe positive effects of seed priming are highly attributed to various biochemical phenomena such as improvement of the antioxidant defense system and restoration of metabolic activities through the synthesis of proteins and nucleic acids (Girolamo and Barbanti, 2012).

In this experiment, it was found that the seed priming with seaweed extract @ 0.4% recorded higher values for all the seed quality parameters. This might be due to presence of vitamins, nutrients and amino acids in the seaweed might have increased the germination of seeds thereby improve its emergence and vigour (Natarajan, 2003). Seed priming

Table 2: Effect of seed priming with water on seed quality characteristics in marginal vigour blackgram seeds cv.VBN 6.

Treatments	Imbibition rate (%)	Germination (%)	Speed of germination	Dry matter production (g 10 seedlings^{-1})
Control	-	72	9.19	0.170
2h soaking and 2h incubation	24.00	78	11.08	0.205
2h soaking and 4h incubation	28.66	83	12.68	0.245
2h soaking and 6h incubation	34.00	76	10.90	0.202
3h soaking and 2h incubation	36.60	78	11.54	0.230
3h soaking and 4h incubation	40.00	76	10.62	0.225
3h soaking and 6h incubation	38.53	75	10.63	0.196
Mean	33.63	76	10.92	0.210
SEd	0.92	0.48	0.53	0.013
CD (p=0.05)	1.84	0.96	1.06	0.26

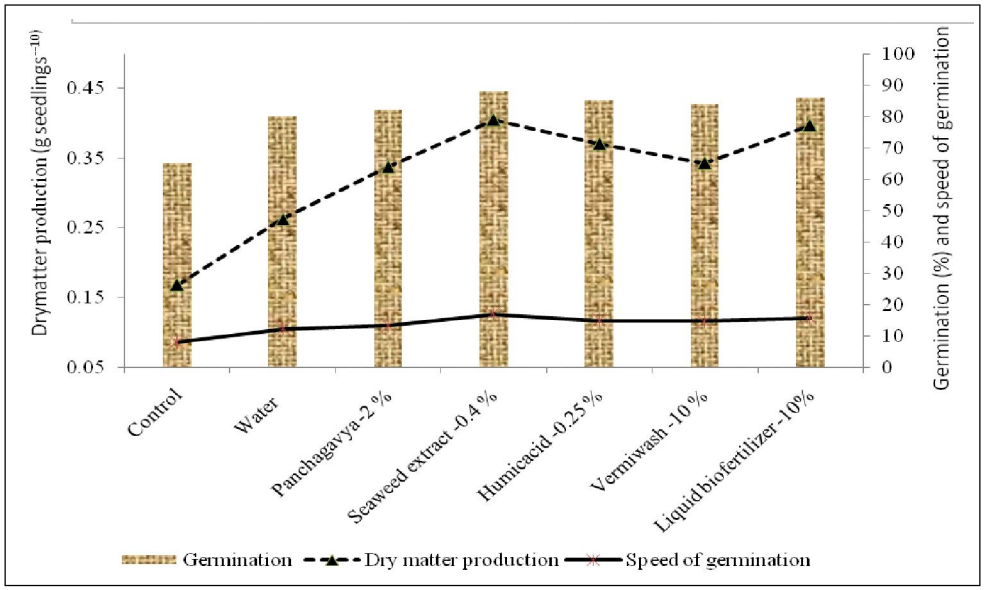

Fig 1: Effect of organic seed priming on seed germination (%), speed of germination and drymatter production (g seeding^{-10}) in blackgram cv. VBN 6.

has been successfully demonstrated to improve germination and emergence in many crops, particularly in vegetables and small seeded grasses (Arif *et al*., 2007). Organic priming was found to be more influential on low vigour seed lots of *C. chinense* and clusterbean (Ambika and Balakrishnan, 2015). The repair mechanism of priming was proved by Hernandez *et al*. (2014) in pepper and Mavi (2018) in capsicum; Andrade and Laurentin (2015) in sweet pepper.

Seed priming on yield improvement

Organic priming treatments were forwarded to field trial to assess the seedling vigour in terms of field establishment and yield enhancement. The pooled data showed that seed priming with seaweed extract @ 0.4% increased the field emergence (95%), leaf chlorophyll content (Table 4), plant dryweight (10.75 g), leaf area index (4.83) (Table 5) and net assimilation rate (0.51mg cm^{-2} d^{-1}) (Table 6). The same treatment was also reflected the similar trend of result for yield parameters *viz.,* number of pods per plant (58), number of branches per plant (6.1) (Fig 2), 100 seed weight (4.60 g) and seed yield (1075 kg) over control (44, 5.3, 4.34 g, and 936 kg, respectively over control) (Fig 3). Seed priming is a technique to reduce the time taken to protrude radicle and makes the germination quickly and uniformly. Many recent researches suggested that seed priming might be a useful way for better germination, seedling growth and yield (Mahipal *et al*. 2019). In this study also, primed seeds of blackgram produced vigorous plants in which, the physiological and yield components were the highest.

In order to achieve the highest possible yield, the physiological parameters especially Leaf Area Index must be higher to intercept more solar energy for higher dry matter accumulation (Major and Daynard, 1972). Relative growth rate and net assimilation rate as a measure of growth efficiency were highest in primed seeds and gain support from the work of Mir *et al*. 2010 and it is the amount of bio mass deployed into some storage organs like grain which is the ultimate objective of the best treatment. The Net Assimilation Rate (NAR) is a measure of net photosynthesis of leaves in crops. The higher NAR in primed seeds might be due to rapid vegetative growth, since the leaf nitrogen is related with NAR during grain filling period that enables the

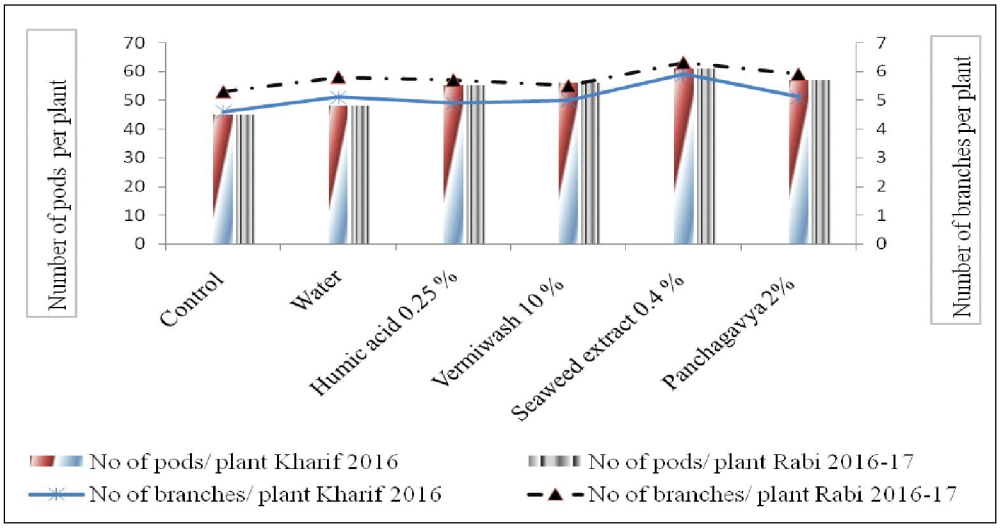

Fig 2: Effect of organic seed priming on number of branches and number of pods per plant in blackgram cv. VBN 6.

Table 3: Effect of seed priming with organic nutrients on seed quality in marginal vigour blackgram seeds cv.VBN 6.

Treatments	Root length (cm)	Shoot length (cm)	Vigour index	Abnormal seedling (%)	Leachate amino acids (µg g^{-1})	Catalase (units g^{-1})	Lipid peroxidation (OD)
Control	14.77	18.04	2210	12.2	47.54	1092	0.183
Hydropriming	17.97	20.81	2841	9.6	42.56	1335	0.174
Panchagavya 2%	18.75	21.71	3143	9.8	39.25	1552	0.156
Seaweed extract 0.4%	20.01	22.60	3664	6.3	36.15	1863	0.143
Humicacid 0.25%	18.58	21.41	3551	8.4	41.21	1425	0.160
Vermiwash 10%	19.16	21.70	3460	8.8	43.58	1520	0.155
Liquid Biofertilizer 10%	18.89	20.03	3510	11.0	46.21	1256	0.172
Mean	18.16	21.12	3237	9.4	42.36	1434	0.163
SEd	0.62	0.51	37.0	1.21	0.41	58.5	0.004
CD (p=0.05)	1.24	1.00	74.0	2.44	0.94	135.0	0.009

plant to have higher NAR (Kalarani, 1991). The increased leaf chlorophyll content in primed seeds reflects increased photosynthates production and dry matter accumulation. The reproductive output and drymatter accumulation are positively correlated (Carlos *et al.,* 1995) and in the present study the difference in drymatter accumulation was wider between priming treatment and control. Dry matter accumulation is an important index reflecting the growth and

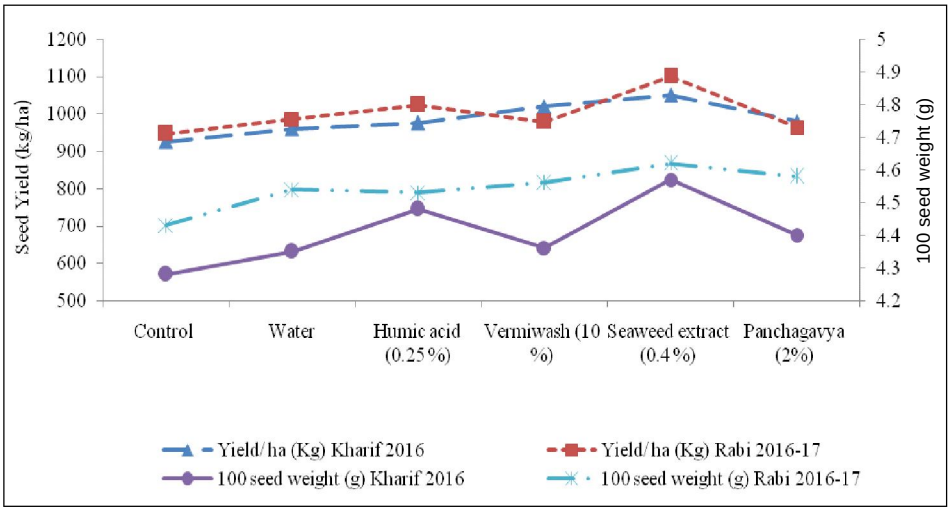

Fig 3: Effect of organic seed priming on seed yield (kg/ha) and 100 seed weight (g) in blackgram cv VBN 6.

Table 4: Influence of organic seed priming on physiological parameters in blackgram cv.VBN 6.

Treatments	Field emergence (%)		Pooled			Chlorophyll content (mg g^{-1})		Pooled		
	Kharif 2016	*Rabi* 2016-17	mean			*Kharif* 2016	*Rabi* 2016-17	Mean		
Control (Dry seeds)	86	88	87			0.72	0.83	0.78		
Water	92	92	92			0.79	0.92	0.86		
Humic acid (0.25%)	92	93	93			1.31	1.42	1.37		
Vermiwash (10%)	93	93	93			1.45	1.56	1.51		
Seaweed extract (0.4%)	95	95	95			1.62	1.78	1.70		
Panchagavya (2%)	94	93	94			1.26	1.47	1.37		
Mean	91	92	92			1.19	1.33	1.26		
			S	T	ST			S	T	ST
SEd	1.25	1.13	0.82	0.94	NS	0.12	0.09	0.11	0.07	0.21
CD (p=0.05)	2.51	2.25	1.65	1.88	NS	0.24	0.19	0.22	0.15	0.40

S- Season : T- Treatments

Table 5: Influence of organic seed priming on dryweight in blackgram cv.VBN 6.

Treatments	Dry weight (g/plant)					Leaf area index				
	Kharif 2016	*Rabi* 2016-17	Pooled mean			*Kharif* 2016	*Rabi* 2016-17	Pooled Mean		
Control (Dry seeds)	5.52	6.19	5.86			3.14	3.37	3.26		
Water	6.84	7.70	7.27			3.47	3.72	3.60		
Humic acid (0.25%)	8.66	9.73	9.20			4.11	4.41	4.26		
Vermiwash (10%)	7.65	8.60	8.13			3.93	4.09	4.01		
Seaweed extract (0.4%)	10.29	11.19	10.75			4.74	4.92	4.83		
Panchagavya (2%)	8.16	9.21	8.69			4.41	4.59	4.50		
Mean	7.85	8.77	8.32			3.96	4.18	4.08		
			S	T	ST			S	T	ST
SEd	0.42	1.12	0.37	0.34	0.66	0.32	0.61	0.21	0.32	0.53
CD (p=0.05)	0.83	2.25	0.75	0.69	1.34	0.65	1.23	0.43	0.65	1.05

Table 6: Influence of organic seed primingon NAR in blackgram cv.VBN 6.

Treatments	NAR (mg/cm²/day)		Pooled mean
	Kharif	*Rabi*	
	2016	2016-17	
Control (Dry seeds)	0.25	0.30	0.28
Water	0.30	0.35	0.32
Humic acid (0.25%)	0.40	0.46	0.43
Vermiwash (10%)	0.33	0.38	0.35
Seaweed extract (0.4%)	0.48	0.53	0.51
Panchagavya (2%)	0.36	0.39	0.38

metabolic efficiency of the plant which ultimately influence the yield of crop. The amount of total dry matter produced is an indication of the overall efficiency of utilization of resources and better light interception (Vijaysingh *et al*., 2017).

Seed vigour can affect yield in many ways even after eliminating the most obvious factor *viz.,* plant density. Reduced efficiency of sub cellular organelles such as mitochondria or chloroplast in low vigour seeds would explain the reasons for lesser yield in untreated seeds (Powell and Matthews, 1980). Higher values for physiological parameters in primed seeds could explain the efficient translocation of assimilates to the sink. In this study, the number of pods per plant was increased due to the priming treatment and had the significant yield increment when compared to control. Pod number and weight of seeds are major yield determining factors in pulses and these were greatly influenced by the priming treatments. In the present study, higher seed yield obtained from the primed seeds is an indication of maintenance of higher vigour due to seed priming treatment.

CONCLUSION

In blackgram, seed vigour and yield could be enhanced through seed priming technique *viz.*, packing of seeds in gunny bag, soaking in seaweed extract @4.0% for 2.0 h and incubation for 4.0 h.

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