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Hydrophilic polymer seed coating on drought Mitigation in Black Gram Var. VBN 8 (*Vigna mungo* L.)

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ABSTRACT

An investigation was carried out to standardize the suitable hydrophilic polymer seed coating technique to withstand drought in rainfed Black gram cv. VBN 8. Seven organic hydrophilic polymers namely, Ethyl cellulose, Methyl Cellulose, Carboxyl Methyl Cellulose, Agar Agar, Xanthan Gum, Carrageenan and Gum Arabic were taken and their gel formation and water holding capacities were studied. Among all the polymers Xanthan Gum, Carrageenan, Agar Agar, Carboxy methyl cellulose and Gum Arabic showed higher potential in terms of gel formation and water holding capacity and were used for seed coating studies in three different concentrations (1, 2 and 3%) with two different dosages (20 ml and 40 ml /kg of seeds) and subjected to germination test under 60 % WHC of sand. Results revealed that seeds coated with 2 % carrageenan @ 40 ml /kg of seeds performed better in terms of all seed quality parameters under water stress which was on par with 2% Xanthangum@ 40 ml /kg coated seeds. Further the five identified polymers were tried in combinations. Each polymer were blended with other polymers in the ratio of 1:1 and 3:1 and studied for their stress avoidance potential under 60 % water holding capacity of sand. The results revealed that Blackgram seeds coated with 2 % Agar blended Carrageenan in the ratio of 3:1 @ 40 ml / kg performed better in terms of seed quality parameters and expressed promising effect in drought mitigation.

Key words : *Black gram, Hydrophilic polymers, Seed coating, Blended polymer coating, Water Holding Capacity (WHC), Seed quality characters and Seedling vigour.*

Introduction

In India, rainfed agriculture accounts for 40 per cent of the total geographical area and 60 per cent of the area under agriculture. It accounts for 67 m ha. of an estimated 143 m. ha. of net cultivated area. It produces 44 per cent of the country's food requirement while supporting 40 per cent of human and 60 per cent of livestock population (NBBSSLUP 2001). The low productivity under rainfed conditions is due to use of poor quality seeds, soil moisture deficit, low and erratic rainfall and improper crop management. For enhancing productivity, quality seeds play an important role along with improved package of practices.

Pulses play a significant role in Indian agriculture as they provide protein rich components in average human diet. They contain 20 – 24 per cent *i.e.,* about 2.5 times more amount of protein than in cereal grains and hence, offer the most practical means of eradicating malnutrition. India is the largest producer and consumer of pulses. The per capita availability has declined from 61.6 g/ day in 1965 to 37.0 g/ day in 2009 primarily due to increasing popula-

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tion and low increase in production of pulses (Lakhanpaul *et al.,* 2000). Pulses are typically rainfed crops with constant exposure to soil moisture deficit, low and erratic rainfall, use of poor quality seeds, poor crop stand and improper crop management resulting in lower productivity. Reduced crop stand alone leads to 30% deficit in production combined with erosion of economic value due unutiiization of applied inputs. Blackgrm is one of the most important pulse crops in India. Matureddry seeds contain three – times higher protein content in comparison to cereals and constitute an important source of protein for a vegetarian diet of common people. Furthermore, it plays a crucial role in sustaining the productivity of cropping system by adding atmospheric nitrogen to the soil, the area under black gram has not been expanded due to the want of irrigation facilities. Availability of technology to overcome drought stress is one of the way to expand black gram cultivation in dry tracks of Tamil Nadu.

Hydrophilic polymers may have great potential in restoration and reclamation projects where opportunity for post planting irrigation is limited and thus storing water available for plant establishment and to avoid desiccation is critical.

Woodhouse and Johnson (1991) classified polymers in to three groups: Starch Polyacrylamide graft polymers (Starch Copolymers), Vinyl alcohol - acrylic acid co polymers (polyvinyl alcohol) and acrylamide sodium acrylate co –polymers (cross linked polyacrylamide) all of theses hydrogels when used correctly and an ideal situations will have atleast 95 % of their stores water available for plant absorption (Johnson and Veltkamp, 1985). These substances can hold 400 – 1500 g of water per dry per gram of hydrogel (Wood house and Johnson, 1991; Bowman, and Evans, 1991).

Blodgett *et al.,* (1993) found that adding superabsorbent polymers to the soil matrix increased the water holding capacity and also increased the water availability to be used by plants. The superabsorbent polymers also prolonged water availability for plant use when irrigation stopped (Huttermann *et al.,* 1999). Nevertheless, studies on hydrophilic polymers application through seed treatment is very meager. By seed treatment the quantity of polymer required can be minimized and also the labour and time required for field application can be reduced. By keeping this concept in view this work has been initiated in balckgram.

Materials and Methods

Certified seeds of blackgram (VBN 8) with 90 % germination and 9 % moisture were collected from State Seed farm, Annapanni, Pudukkottai, Tamil Nadu used as base material for this study. Commercially available organic hydrophilic polymers *Viz.,* Ethyl cellulose, Methyl cellulose, Carboxyl Methyl cellulose, Agar Agar, Xanthan Gum, Carrageenan and Gum Arabic were collected from the market and used for this study.

Polymerization and water holding capacities of polymers

Seven commercial grade organic hydrophilic polymers *Viz.,* Ethyl cellulose, Methyl cellulose, Carboxyl methyl cellulose, Agar, Gum Arabic, Xanthangum and Carrageenan were assessed their polymerization and water holding capacities prior to experimental use.

Polymerization and water holding capacity

One gram of each polymer was mixed with one ml of distilled water and left undisturbed for 30 min. Another 5ml of water was added based on absorption of water and left undisturbed for 30 min. Additional 5ml of water was added at 30 min interval till the polymers achieved saturation capacity was adjudged when added water remained unabsorbed and weight increase was measured as given bellow.

$$\text{Per cent increase} = \frac{\text{(weight after absorption – initial weight)}}{\text{Initial weight}} \times 100$$

Standardization of Polymer Coating technique in blackgram

Seeds of balckgram Var. VBN 8 with 90% germination and 9 % moisture were coated with Xanthan gum, Carageenan, Agar Agar, Carboxy Methy Cellulose and Gum Arabic with three different concentrations (1, 2 and 3%) and two different dosages (20 ml and 40 ml /kg of seeds) and subjected to germination test under 60 % WHC of sand.

Standard Germination Test

Germination test in quadruplicate using 100 seeds each with 4 sub replications of 25 seeds were carried out in Sand Tray method. The treated seeds were sown in the tray filled with sand of 60 % water holding capacity (180 ml of water was added to one kg of dry stand) against the control. The test conditions of 25 ± 2°C and 95 ± 3% RH were maintained in the germination room. At the end of 7 days the number of normal seedlings were counted and the mean expressed as Percentage (ISTA, 2009).

Standardization of Blended polymers coating technique in blackgram

Seeds of balckgram Var. VBN 8 with 90% germination and 9% moisture were coated with 2 % Xanthan gum, Carageenan, Agar Agar, Carboxy methyl cellulose and Gum Arabic in 1:1 and 3:1 blending combinations @ 40 ml/kg of seeds and exposed to germination test @ 60 % water holding capacity of sand.

Results and Discussion

Polymerization, gel formation potential and water holding capacities of polymers

Among the seven polymers studied, only five polymers Agar Agar, CarboxyMethyl Cellulose, Xanthan gum, Carrageenan and Gum Arabic exhibited polymerization and higher water holding potential. Among the five polymers, water holding potential was recorded maximum in Xanthan gum (38.27 ml /g) which was followed by Carrageenan (34.17 ml /g) and the least potential was noted in Agar Agar (5.46 ml /g) followed by Carboxyl Methyl Cellulose (2.20 ml /g) and Gum Arabic (1.26 ml /g). The weight increase after water absorption was 3527 %, 3017%, 516 %, 192 %and 103% respectively for Xanthan gum, Carrageenan, Agar Agar, Carboxy Methyl cellulose and Gum Aarbic (Table 1). Ethyl cellulose and methyl cellulose were not completely dissolved in water and not get polymerized. The results were in agreement with Wood house and Johnson, (1991); Bowman and Evans, (1991). They reported that polymers can hold 400 – 1500 g of water per gram of hydrogel.

Effect of seeds coating with polymers under water stress condition

Among the four polymers, three concentrations (1,2 and 3%) and two dosages (20 ml and 40 ml /kg of seeds) blackgram seeds coated with 2 % Carrageenan @ 40 ml / kg significantly performed better in terms of all the seed quality attributes *viz.*, germination, seedling length and vigour index. The values recorded were 90 %, 24.30 cm and 2187 respectively for the germination, seedling length and vigour index. It was followed by 2 % Xanthan Gum @ 40 ml /kg (91 %, 22.68 cm and 2064). The least values were recorded in the control 75 %, 21.32 cm and 1599 respectively for germination, seedling length and vigour indexunder under60 % water holding capacity of the sand. The % increase over the control was 15, 13 and 36 respectively for germination, seedling length and vigour (Table 2, 3 and 4). The best treatments were forwarded to the next level in combinations as blends.

Effect of seed coating with blended polymers under water stress condition

In polymer combinations Agar blended with Carragennan in 3:1 ratio @ 40 ml / kg of seeds significantly performed over 1:1 combinations and 3:1 combinations of other polymers and control under 60 % water holding capacity. The values recorded were 86 %, 20.37 cm and 1752 respectively for germination %, shoot and root length (cm) and vigour index whereas the untreated seeds recorded the least values of 70 %, 9.21 cm and 645 respectively for germination, seedling length and vigour index (Fig. 1). The % increase over the control was 16, 121and 171 respectively for seed germination and seedling vigour under water stress.

Blended coating increased the drought tolerance

Table 1. Polymerization and water holding capacity of organic polymers

Sl. No.	Organic Hydrophilic polymer	Polymerization	Water absorption (ml/g of polymer)	Weight increase after saturation (g)	Weight increase after water absorption (%)
1.	Agar Agar	Polymerized	5.46	6.16	516
2.	Xanthan gum	Polymerized	38.27	36.27	3527
3.	Carrageenan	Polymerized	34.17	31.17	3017
4.	Gum Arabic	Polymerized	1.26	2.03	103
5.	CMC	Polymerized	2.20	2.92	192
6.	Ethyl cellulose	Un dissolved	Nil	Nil	Nil
7.	Methyl cellulose	Un dissolved	Nil	Nil	Nil

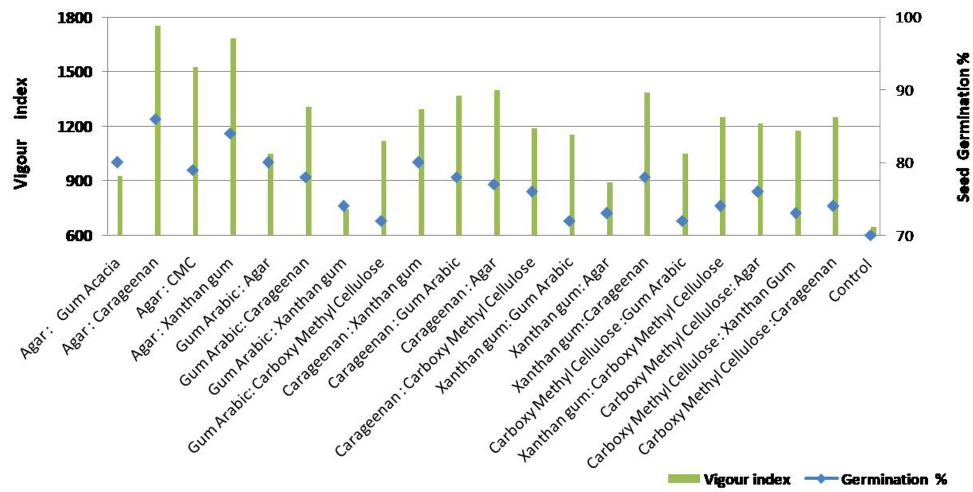

Fig. 1. Effect of seed coating with organic blended polymers on seed germination and seedling vigour of Blackgram VBN 8. under 60% WHC of sand

capacity over the separate coating. Since, blending may give the double fold advantage in water absorption and consistency in growth stimulation. Among the blending methods 3:1 blended yields higher performance over 1:1 blending, since the concentration of the polymers may higher or equal that will hinder the overall growth and performance. Moreover vice versa blending yields very poor performance. The results were in agreement with Hotta *et al.* (2018). They reported that in Durum wheat seeds coated with 1.5 % (w/v) agar/é-carrageenan blend hydrogel showed better seedling growth performance, since agar and carrageenan coating could have acted as growth stimulants and enhanced the germination speed of durum wheat seeds under drought condition.

Table 2. Effect of seeds coating with organic polymers on seed germination under 60 % WHC of sandin Blackgram VBN 8.

Treatment details	Concentration (C)								
	1%			2%			3%		
	Volume (V)								
	20 ml	40 ml	Mean	20 ml	40 ml	Mean	20ml	40 ml	Mean
Control					75 (60.00)				
Xanthan gum	85 (67.33)	81 (64.15)	83 (65.70)	89 (70.63)	91 (72.54)	90 (71.56)	85 (67.33)	76 (60.66)	81 (64.15)
Carrageenan	89 (70.63)	89 (70.63)	89 (70.63)	88 (69.73)	90 (71.56)	89 (70.63)	85 (67.21)	72 (58.07)	79 (62.72)
Agar Agar	80 (63.43)	79 (62.72)	80 (63.43)	84 (66.76)	83 (65.70)	84 (66.76)	82 (64.89)	74 (59.33)	78 (62.02)
Carboxyl Methyl Cellulose	79 (62.72)	74 (59.33)	77 (61.49)	81 (64.15)	81 (64.15)	81 (64.15)	68 (56.16)	60 (51.16)	64 (53.77)
Gum Arabic	76 (60.66)	78 (62.02)	77 (61.49)	79 (62.72)	80 (63.43)	80 (63.43)	64 (53.77)	55 (47.29)	60 (51.16)
Mean	82 (64.89)	80 (63.43)	81 (64.15)	84 (66.76)	85 (67.33)	85 (67.33)	77 (61.49)	67 (55.15)	72 (58.07)
Grand Mean					79 (62.72)				
	P	C	V	P × C	P × V	C × V		P × C × V	
SEd	1.103	0.855	0.698	1.912	1.561	1.209		2.704	
CD 1%	5.170*	2.936*	2.274*	1.857*	5.086*	4.152*		3.216*	
CD 5%	3.887*	2.208*	1.710*	1.396*	3.824*	3.122*		2.419*	

Table 3. Effect of seeds coating with organic polymers on seedling length (cm) under60 % WHC of sand in Blackgram VBN 8.

Polymer (P)	Concentration (C)								
	1%			2%			3%		
	Volume (V)								
	20 ml	40 ml	Mean	20 ml	40 ml	Mean	20ml	40 ml	Mean
Control	21.32								
Xanthan gum	18.37	21.46	19.92	22.19	22.68	22.44	19.96	18.27	19.12
Carrageenan	18.44	21.17	19.81	22.96	24.30	23.63	19.38	17.92	18.65
Agar Agar	17.62	17.23	17.43	20.94	21.03	20.99	19.05	17.95	18.50
Carboxyl Methyl Cellulose	18.25	19.85	19.05	20.68	20.67	20.68	17.63	16.97	17.30
Gum Arabic	19.49	19.42	19.46	20.54	20.71	20.63	20.20	17.04	18.62
Mean	18.43	19.83	19.13	21.46	21.88	21.67	19.24	17.63	18.44
Grand Mean	19.75								
	P	C	V	P × C	P × V	C × V		P × C × V	
SEd	0.091	0.070	0.057	0.157	0.129	0.100		0.223	
CD 1%	0.242*	0.187*	0.153*	0.419*	0.342*	0.265*		0.592*	
CD 5%	0.182*	0.141*	0.115*	0.315	0.257*	0.199*		0.445*	

Conclusion

From the studies it could be concluded that, blackgram seeds coated with 2 % Agar blended Carrageenan in the ratio of 3:1 @ 40 ml / the organic hydrophilic polymers have the capability to promote seed germination under drought conditions.

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