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Role of Hydrophilic Biopolymers Concoction Seed Coating on Seed Germination and Field Performance of Blackgram (*Vigna mungo* L.)

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ABSTRACT

Background: Blackgrm is one of the most important pulse crops majorly cultivated in rainfed conditions of India. Soil moisture deficit, low and erratic rainfall, use of poor quality seeds, poor crop stand and improper crop management resulting in lower productivity in rainfed ecosystem. Reduced crop stand alone leads to 30% deficit in production. Availability of technology to overcome drought stress is one of the way to expand blackgram cultivation in dry tracks. Hydrophilic polymers may have great potential in restoration and reclamation, when used the polymers correctly and an ideal situations will have atleast 95% of their stores water available for plant absorption. There are N number of inorganic polymers available in the market, that can be applied in the form of soil application. Studies on Hydrophilic bio polymer seed coating to mitigate water stress is very megar or nil. Hence, the present study was formulated in blackgram as hydrophilic bio polymer seed coating on seed germination and field emergence.

Methods: Seed coating experiment consists of seven hydrophilic biopolymers (Ethyl cellulose, Methyl cellulose, Carboxyl methyl cellulose, Agar, Gum Arabic, Xanthangum and Carrageenan); two coating methods (dry and dry powder concoction). The germination test conducted in sand media with 60% Water Holding Capacity of sand and PEG induced water stress and evaluated for seed quality parameters against uncoated seeds. Field experiments conducted with water stress periods of 10 days, 20 days and 25 days after life irrigation and observed for biometric and yield parameters.

Result: Results revealed that blackgram seeds coated with bio polymerconcoctionof xanthan gum : carrageenan : Agar agar (4:1:1) @ 20 g/kg performed better in terms ofall seed quality parameters and withstand water stress upto 20 days after life irrigation with the yield increase of 53% over stressed control (Skipping irrigation for 20 days after life irrigation) and can be recommended as a pre sowing treatment for drought mitigation in blackgram.

Key words: Blackgram seeds, Dry Coating, Hydrophilic biopolymers, Moisture stress, Polymer Concoction, Seed germination, Water holding capacity.

INTRODUCTION

Blackgrm is one of the most important pulse crops in India. Matured dry seeds contain three -times higher protein content than cereals and constitute an important source of protein for a vegetarian diet of common people (Lakhanpaul *et al.,* 2000). 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 blackgram cultivation in dry tracks of Tamil Nadu, India by keeping all those things in mind the work has been initiated in black gram with Hydrophilic polymers. Since Hydrophilic polymers may have great potentialin restoration and reclamation, when used the polymers correctly and an ideal situations will have at least 95% of their stores water available for plant absorption (Johnson and Veltkamp, 1985) and can hold can hold 400-1500 g of water/g (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

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increased the water availability to plants. The superabsorbent polymers also prolonged water availability for plant use when irrigation stopped (Huttermann *et al.,* 1999). Nevertheless, studies on hydrophilic biopolymers application through seed treatment is very meager or nil. By seed coating the quantity of polymer required can be minimized and also the labour and time required for field application can be reduced with this view this research was initiated in black gram.

MATERIALS AND METHODS

Certified seeds of blackgram (VBN 8) with 75% germination and 9% moisture were collected from State Seed farm, Annapanni, Pudukkottai, Tamil Nadu used as base material for this study. Commercially available seven hydrophilic biopolymers *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 hydrophilic biopolymers *viz.,*Ethyl cellulose, Methyl cellulose, Carboxyl methyl cellulose, Agar, Gum Arabic, Xanthangum and Carrageenan with commercial grades were purchased from the market and studied for their polymerization and water holding capacities.

Polymerization and water holding capacity

One gram of each polymer was taken in a beaker separately and mixed with one ml of distilled waterand left undisturbed for 30 min. Another 5 ml of water was added based on absorption of water and left undisturbed for 30 min. Additional 5 ml of water was added at 30 min interval till the polymers get saturated and weight increase was measured as given below:

$$\frac{\text{Weight increased after absorption - Initial weight}}{\text{Initial weight}} \times 100$$

Study the effect of HPbiopolymers seed coating technique on PEG induced moisture stress

Dry coating method I

Seeds of blackgram var. VBN 8 with 75% germination and 9% moisture content were coated with three different polymers namely Xanthan gum (P1), Carrageen (P2) and Agar Agar (P3) @ 5 gm, 10 gm and 20 gm as given in (Table 1) and subjected to germination test.

Treatment details for the dry coating method I (Single polymer coating)

T_0: Untreated seeds.
T_1: 10 gm Xanthan gum + 1% same polymer as sticker @ 10 ml/kg of seeds.
T_2: 20 gm Xanthan gum + 1% same polymer as sticker @ 10 ml/kg of seeds.
T_3: 10 gm Carrageen+ 1% same polymer as sticker @ 10 ml/kg of seeds.
T_4: 20 gm Carrageen+ 1% same polymer as sticker @ 10 ml/kg of seeds.
T_5: 10 gm Agar Agar + 1% same polymer as sticker @ 10 ml/kg of seeds.
T_6: 20 gm Agar Agar + 1% Sticker @ 10 ml/kg of seeds.

Germination test

Germination test in quadruplicate using 25 seeds each with 4 replications was carried out. 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).

Observations on germination (%), seedling length (cm), dry matter production (g 10 seedlings^{-1}) and vigour index recorded.

The best performing treatments were identified and forwarded to the next level of experimentation.

Dry coating method II polymers in combinations

For improving the coating efficiency and drought tolerance capacity of the hydrophilic polymers seeds of blackgram var. VBN 8 with 75% germination and 9% seed moisture content were coated with the following polymers combinations (Table 2).

Treatment details for dry coating method II (Concoction coating)

T_0: Untreated seeds.
T_1: X:C:A (2:1:1) @ 20 g/kg + 1% same polymer mixer as sticker @ 10 ml/kg of seeds.
T_2: C:X:A (2:1:1) @ 20 g/kg + 1% same polymer mixer as sticker @ 10 ml/kg of seeds.
T_3: A:X:C (2:1:1) @ 20 g/kg + 1% same polymer mixer as sticker @ 10 ml/kg of seeds.
T_4: X:C:A (3:1:1) @ 20 g/kg + 1% same polymer mixer as sticker @ 10 ml/kg of seeds.
T_5: C:X:A (3:1:1) @ 20 g/kg + 1% same polymer mixer as sticker @ 10 ml/kg of seeds.
T_6: A:X:C (3:1:1) @ 20 g/kg + 1% same polymer mixer as sticker @ 10 ml/kg of seeds.
T_7: X:C:A (4:1:1) @ 20 g/kg + 1% same polymer mixer as sticker @ 10 ml/kg of seeds.
T_8: C:X:A (4:1:1) @ 20 g/kg + 1% same polymer mixer as sticker @ 10 ml/kg of seeds.
T_9: A:X:C (4:1:1) @ 20 g/kg + 1% same polymer mixer as sticker @ 10 ml/kg of seeds.

The treated seeds subjected to germination test and observed for germination (%), seedling length (cm), dry matter production (g 10 seedlings$^{-1)}$ and vigour index. The best seed coating treatments were identified and exposed to different water holding capacities of sand and PEG Induced water stress under laboratory conditions.

Germination test under moisture stress condition

Germination test in quadruplicate using 25 seeds each with 4 replications was carried out in sand method with 60% WHC of substrata. 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). To obtain 60% water holding capacity 180 ml of water was added to one kg of hot air oven dried sand.

PEG induced water stress

25 blackgram seeds in four replication was germinated on two layers of filter paper in petri dishes and incubated at 25±2°C at different stress level of -2, -4, -6, -8 and -10 bars with PEG-6000 and control. The petri plates were covered to avoid the loss of moisture by evaporation under laboratory condition for 7 days. Seeds were considered as germinated if they exhibited radicle extension by more than 2 mm. after 7 days the number of normal seedlings were counted and the mean expressed as Percentage (Basha *et al.,* 2015).

Evaluation of the efficacy of improved hydrophilic polymers seed coating under water stress condition in blackgram

The hydrophilic biopolymers concoction coated blackgram seeds subjected to the water stress under field conditions of Kudumiyanmalai, Pudukkottai during Feb-March 2021 and 2022.

Treatment details of field experiments

T_1: Control (No seed treatment with water stress).
T_2: 20 g Carageenan + 1% Carrageen as sticker @ 10 ml/kg of seeds.
T_3: Carrageenan : Xanthangum :Agar (4:1:1) ratio @ 20 g /kg of seeds +1 % Polymer mixer as sticker @ 10 ml/kg of seeds.
T_4 : Xanthangum : Carrageenan : Agar (4:1:1) ratio @ 20 g /kg of seeds+1 % Polymer mixer as sticker @ 10 ml/kg of seeds.

The Irrigation schedules

I_1 : 1st + life Irrigation +skipping irrigation for 10 days.
I_2 : 1st + life Irrigation+skipping irrigation for 20 days.
I_3 : 1st + life Irrigation+skipping irrigation for 25 days.

Seeds of blackgram var. VBN.8 with 75% germination and 9% seed moisture content were coatedwith the above mentioned seed treatments and subjected to the water stress under field conditions of Kudumiyanmalai, Pudukkottai during Feb-March 2021. The observations on field emergence (%), plant height (cm), leaf area, leaf area index, dry weight (g plant^{-1}) were recorded on 20 DAS, 40 DAS and 60 DAS and number of pods/plant and seed yield kg/ha were recorded.

On farm trials

The field trials were conducted during February and March 2022 at four centres/locations *viz*., ARS, Bhavanisagar AC and RI, Madurai, NPRC, Vamban and ARS, Vaigai dam. The blackgram (VBN 8) seeds were treated with Xanthan Gum + Carrageenan + Agar (4 : 1 : 1) @ 20 g/kg and exposed to field conditions against the untreated seeds under both regular agronomical practices and water stress for 20 days after life irrigation.

The treatment details are as follows

T_0 : Control (No seed treatment with recommended agronomical practices).
T_1 : Control (No seed treatment with water stress up to 20 days after life irrigation).
T_2 : Seed treatment with Xanthan Gum + Carrageenan + Agar (4 : 1 : 1) @ 20 g/kg of seeds with recommended agronomical practices.
T_3 : Seed treatment with Xanthan Gum + Carrageenan + Agar (4 : 1 : 1) @ 20 g/kg of seeds with water stress up to 20 days after life irrigation.

The following observations were recorded in all the centres

Parameters	Crop stage (DAS)		
Plant population/m^2	10	25	45
Plant height			
Leaf area (cm^2)	-	25	45
Leaf area index			
Chlorophyll content			
Days to first flowering			
Days to 50% flowering			
No. of. pods/plant			
No. of. seeds/pod			
100 seed weight (g)			
Seed yield/plant (g)			
Seed yield/plot (kg)			
Seed yield/ha (kg)			

RESULTS AND DISCUSSION

Water holding capacities of hydrophilic biopolymers

Among the seven hydrophilic biopolymers studied, only five biopolymers powders get polymerized and their 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). 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 Hydrophilic biopolymers seed coating in black gram

Blackgram seeds dry coated with 20 gm Carrageen+ 1% Carrageen as sticker @ 10 ml/kg of seeds performed better in terms of all seed quality parameters *viz.* (89%, 22.8 cm, 14.44 cm, 0.209 mg/10 seedlings and 3312 respectively for germination %, shoot, root length, dry matter production and vigour index over the control (85%, 22.09 cm, 12.38 cm, 0.196 mg/10 seedlings and 2939). The treatment was followed by the seeds coated with xanthan gum @20 g/kg of seeds. Among the two dosages of polymer powders 20 g performed better than the 10 g among all the three hydro philic polymer powders (Table 2).

Regarding dry polymer concoction coating blackgram seeds coated with X:C:A (4:1:1) @ 20 g/kg + 1% Polymer mixer as sticker @10ml/kg of seeds performed better than other treatments for seed quality parameters *viz*. (97%, cm respectively for germination %, 4246 vigourindex over the control (85 % and 2582). The results were on par with the seed quality parameters of C:X:A (4:1:1) @ 20 g/kg + 1% Polymer mixer as sticker @ 10 ml/kg of seedscoated seeds (97% and 4231) (Fig 1).

Effect of Hydrophilic polymer seed coating on moisture stress under lab condition

Blackgram seeds dry coated with 20 gm Xanthangum + 1% same polymer as sticker @ 10 ml/kg of seeds performed better in terms of all seed quality parameters *viz.* (82%, 22.8 cm, 15.3 cm, 0.152 mg/10 seedlings and 2286 respectively for germination %, shoot, root length, dry matter production and vigour index over the control (75%, 17.21 cm, 10.73 cm, 0.121 mg/10 seedlings and 1862). The % increase over the control was 7, 32, 24, 25, 23 respectively for germination

Table 1: Polymerization and water holding capacity of different polymers.

Hydrophilic polymer	Polymerization	Water absorption (ml/g of polymer)	Weight increase after water absorption (%)
Agar agar	Polymerized	5.46	516
Carboxyl methyl cellulose	Polymerized	2.20	192
Xanthan gum	Polymerized	38.27	3527
Carrageenan	Polymerized	34.17	3017
Gum acacia	Polymerized	1.26	103

Table 2: Effect of Hydrophilic polymer powder dry seed coating on seed germination and seedling vigour in blackgram (VBN 8).

Treatment	Speed of germination	Germination (%)	Shoot length (cm)	Root length (cm)	DMP (mg/10 seedlings)	Vigour index I
T_0	14.16	85 (67.21)	22.09	12.38	0.196	2939
T_1	14.11	87 (68.86)	22.11	12.93	0.199	3049
T_2	11.11	88 (69.73)	22.71	14.31	0.211	3258
T_3	12.23	88 (69.73)	22.4	13.68	0.198	3175
T_4	11.23	89 (70.63)	22.77	14.44	0.209	3312
T_5	11.21	87 (68.86)	21.88	13.03	0.199	3037
T_6	11.15	88 (69.73)	22.43	14.21	0.201	3224
Mean	12.17	87 (68.86)	22.34	13.56	0.201	3142
SEd	0.345	0.131	0.367	0.517	0.005	7.070
CD 1%	0.740*	0.283*	0.788*	1.122*	NS	15.16*
CD 5%	1.027*	0.392*	1.094*	1.557*	NS	21.05*

T_0: Untreated seeds; T_1: 10 gm Xanthan gum + 1% same polymer as sticker @10 ml/kg of seeds; T_2: 20 gm Xanthan gum + 1% same polymer as sticker @10 ml/kg of seeds; T_3: 10 gm Carrageen + 1% same polymer as sticker @10 ml/kg of seeds; T_4: 20 gm Carrageen + 1% same polymer as sticker @10 ml/kg of seeds; T_5: 10 gm Agar Agar + 1% same polymer as sticker @10 ml/kg of seeds; T_6: 20 gm Agar Agar + 1% Sticker @10 ml/kg of seeds.

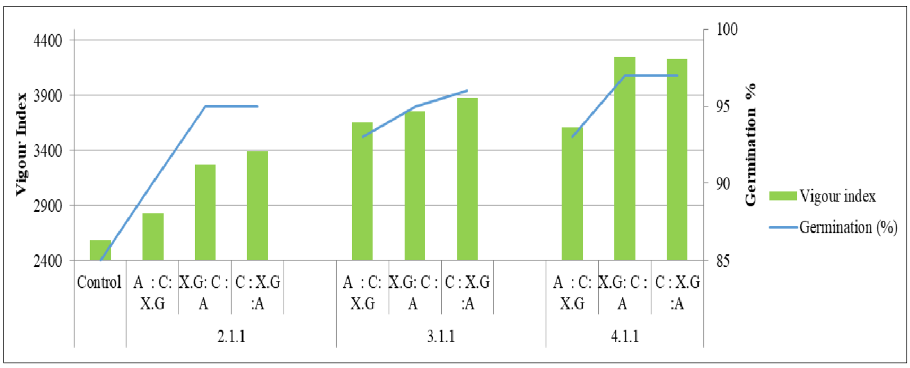

Fig 1: Effect of organic hydrophilic polymer concoction seed coating on seed germination and seedling vigour in blackgram (VBN 8).

%, shoot, root length, dry matter production, vigour index (Table 3).

Regarding dry polymer concoction coating blackgram seeds coated with X:C:A (4:1:1) @ 20 g/kg + 1% Polymer mixer as sticker @10ml/kg of seeds performed better than other treatments for seed quality parameters *viz*. (89%, 22.96 cm, 7 cm, 2666 cm respectively for germination %, shoot, root length, dry matter production and vigour index over the control (75%, 17.21 cm, 5.73 cm, 0.121 mg/10 seedlings and 1862). The % increase over the control was 14, 33, 22, 25, 23 respectively for germination %, shoot, root length, dry matter production, vigour index (Fig 2).

Effect of ogranic hydrophilic polymers seed coating under PEG induced water stress

Blackgram seeds coated with Xanthan Gum: Carrageenan: Agar (4:1:1) @ 20 g/kg recorded the maximum germination in the all stress level of PEG Induced water stress and the values recorded were 88%, 80%, 80%, 40%, 34% respectively for (-2), (-4), (-6), (-8) and (-10) bars. The poor germination % was noted in the untreated seeds (60, 36, 36, 22 and 10% respectively for 2), (-4), (-6), (-8) and (-10) bars (Fig 3). It was on par with Carrageenan: Xanthan Gum: Agar (4:1:1) @ 20 g/kg.

Table 3: Effect of hydrophilic biopolymers dry coating on seed germination and seedling vigour of blackgram seeds at 60% WHC of sand.

Treatment	Germination (%)	Shoot length (cm)	Root length (cm)	DMP (mg/10 seedlings)	Vigour index I
T_0	75 (60.00)	17.21	2.73	0.121	1862
T_1	81 (64.15)	22.81	5.24	0.152	2269
T_2	82 (64.89)	22.8	5.3	0.152	2286
T_3	80 (63.43)	20.89	3.77	0.131	2052
Mean	80 (63.43)	20.92	4.26	0.139	2117
SEd	0.31	0.617	0.051	0.001	8.010
CD 1%	0.67*	1.324*	0.111*	0.003*	17.18*
CD 5%	0.94*	1.838*	0.154*	0.004*	23.85*

T_0: Untreated seeds; T_1: 20 gm Xanthan gum + 1% same polymer as sticker @ 10 ml/kg of seeds; T_2: 20 g Carageenan + 1% Carrageen as sticker @ 10 ml/kg of seeds; T_3: 20 gm Agar Agar + 1 % Sticker @10 ml/kg of seeds.

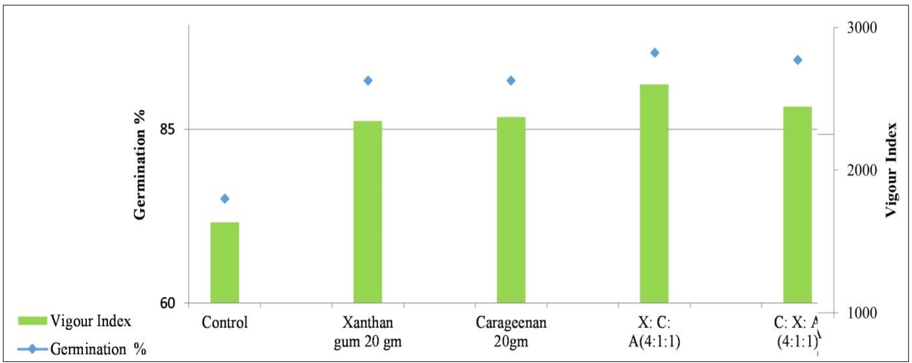

Fig 2: Effect of hydrophilic polymer seed coating technique on moisture stress of 60 % water holding cpacity on sand-under lab condition.

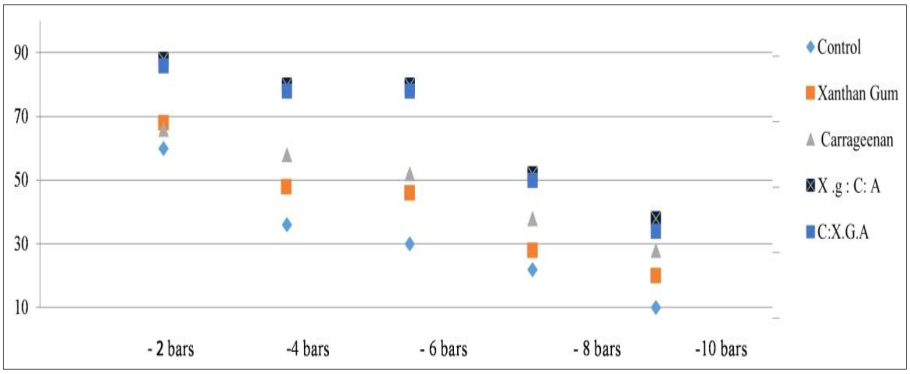

Fig 3: Effect of hydrophilic polymers seed coating on seed germination of blackgram under PEG induced water stress in lab condition.

Effect of ogranic hydrophilic polymers seed coating under field conditions

Among all treatments and irrigation schedules blackgram seeds coated with Xanthangum : Carrageenan: Agar (4:1:1) @ 20 g /kg of seeds can withstand water stress up to 20 days after life irrigation and outperformed other treatments and registered increase in 44%plant height and DMP, 55% for Number of pods/plant and 53% increased yield over control. Treatment mixture consisting of Xanthangum : Agar (4:1) @ 20 g/kg of seeds recorded next best value under water stress condition up to 20 days with 30%, 33%, 33% and 26% increase in plant height, DMP, Number of pods/ plant and yield, respectively over control (Table 4, 5, 6).

On farm trail results

Among the treatments, seed treatment with xanthan gum + carageenan + Agar (4:1:1) @ 20 g/kg + recommended agronomic practices of seeds recoded higher growth and yield parameters when compared to other treatment. The yield parameters of treated seeds with recommended agronomic practices recorded, 10% increase over the control with regular agronomical practices and treated seeds exposed to water stress for 20 days after life Irrigation and 17% increase over the control seeds exposed to water stress for 20 days after life irrigation. Whereas, the treated seeds exposed to water stress upto 20 days after life irrigation is on par with the control seeds with regular agronomical practices in growth parameters and yield parameters at all the four centers (Pooled means of all the four OFT centers in Table 7).

The hydrophilic biopolymers coating increased the Seed germination and seedling vigour in blackgram in ideal irrigation and water stress conditions upto 20 days after life irrigation. The results were in agreement with Dexter and Miyamoto (1959), they reported that there was a positive correlation observed between seed coating with hydrophilic compounds and seed germination in Sugar Beet. Baxter and Waters (1986), stated that in Sweet corn the seeds coated with hydrophilic polymers could accelerates the seed imbibitions rate, reducing the time required for full germination, since, the colloidal nature of the hydrophilic polymers seed coating provides a large surface area for water absorption. Akelah (2013) and Maya Hotta *et al.* (2016) reported that Super Absorbent Polymer coatings on seeds provide more efficient imbibition of water speed up germination and improved seedling growth. Polymer coating absorbs water from the surrounding soils and holds it at the seed surface, thus increasing both the germination speed and the total number of germinated seeds.

Water deficit is one of the abiotic stresses caused by less water source, extreme temperatures and low atmospheric humidity and it ultimately affects the productivity (Basha *et al*., 2015). *Xanthan gum* an excellent organic hydrophilic polymer it could hold (3727 times water) and it

Table 4: Effect of hydrophilic polymers seed coating on plant population, plant height, dry matter production in blackgram under water stress condition on 60 days after sowing.

Treatment details	Plant population on 60 DAS				Plant height (cm) on 60 DAS				Dry matter production (g/seedlings) on 60 DAS			
I1												
T1	500				48				10.11			
T2	500				51				10.89			
T3	500				51				11.04			
T4	500				53				11.66			
I2												
T1	430				33				7.68			
T2	488				40				9.98			
T3	500				43				10.21			
T4	500				48				11.03			
I3												
T1	400				19				4.21			
T2	453				21				5.00			
T3	469				23				5.03			
T4	476				26				6.67			
Mean	476				37				8.61			
	M	S	S @ M	M @ S	M	S	S @ M	M @ S	M	S	S @ M	M @ S
SEd	8.18	2.70	4.68	8.67	0.91	0.66	6.35	3.99	0.12	0.13	0.23	0.19
CD 5%	22.72*	5.68*	9.85*	22.92*	2.54*	7.70*	13.35*	8.47*	0.35*	0.28*	0.49*	0.44*

T_1 : Control (No seed treatment with water stress); T_2 : 20 g Carageenan + 1% Carrageen as sticker @ 10 ml/kg of seeds; T_3 : Carrageenan: Xanthangum : Agar (4:1:1) ratio @ 20 g/kg of seeds + 1% polymer mixer as sticker @ 10 ml/kg of seeds; T_4 : Xanthangum : Carrageenan: Agar (4:1:1) ratio @ 20 g/kg of seeds + 1% polymer mixer as sticker @ 10 ml/kg of seeds.

Table 5: Effect of hydrophilic polymers seed coating on leaf area leaf area index, number of pods plant^{-1}, seed yield plot^{-1}, seed yield ha^{-1} in blckgram under water stress condition.

Treatment details	Leaf areaon 60 DAS				Leaf area indexon 60 DAS				Number of pods/plant			
I1												
T1	1458				4.86				18			
T2	1820				6.06				18			
T3	1870				6.23				18			
T4	2749				9.16				20			
I2												
T1	1217				5.06				9			
T2	1311				4.37				12			
T3	2003				6.67				12			
T4	2271				7.57				14			
I3												
T1	596				1.98				3			
T2	890				2.84				4			
T3	1062				3.54				5			
T4	1907				6.35				6			
Mean	1601				5.39				12			
	M	S	S@M	M@S	M	S	S @ M	M @ S	M	S	S @ M	M @ S
SEd	28.60	30.79	50.88	57.68	0.02	0.08	0.14	0.09	1.94	1.07	1.86	2.25
CD 1%	322*	281*	488*	416*	0.06*	0.17*	0.30*	0.19*	5.40*	2.25*	3.90*	5.64*
CD 5%	NS	NS	NS	NS	0.10*	0.24*	0.41*	0.27*	8.96*	NS	NS	NS

T_1 : Control (No seed treatment with water stress); T_2 : 20 g Carageenan + 1% Carrageen as sticker @ 10 ml/kg of seeds; T_3 : Carrageenan : Xanthangum : Agar (4:1:1) ratio @ 20 g/kg of seeds + 1% polymer mixer as sticker @ 10 ml/kg of seeds; T_4 : Xanthangum : Carrageenan : Agar (4:1:1) ratio @ 20 g/kg of seeds +1% polymer mixer as sticker @ 10 ml/kg of seeds.

Table 6: Effect of hydrophilic polymers seed coating on seed yield in blckgram under water stress condition.

Treatment details	Seed yield/plot (kg)				Seed yield/ha (kg)			
I1								
T1	1.24				833			
T2	1.29				861			
T3	1.32				880			
T4	1.44				960			
I2								
T1	0.78				520			
T2	0.94				628			
T3	0.97				653			
T4	1.19				793			
I3								
T1	0.19				126			
T2	0.21				144			
T3	0.24				160			
T4	0.33				220			
Mean	0.84				564			
	M	S	S@M	M@S	M	S	S@M	M@S
SEd	0.0259	0.0237	0.041	0.361	24.01	12.95	22.43	27.66
CD 1%	0.072*	0.049*	0.086*	0.084*	66.65*	27.51*	47.14*	69.04*
CD 5%	0.119*	0.068*	0.118*	NS	73.09*	37.28*	64.57*	88.01*

T_1 : Control (No seed treatment with water stress); T_2 : 20 g carageenan + 1% carrageen as sticker @ 10 ml/kg of seeds; T_3 : Carrageenan : Xanthangum : Agar (4:1:1) ratio @ 20 g/kg of seeds +1% Polymer mixer as sticker @ 10 ml/kg of seeds; T_4: Xanthangum : Carrageenan : Agar (4:1:1) ratio @ 20 g/kg of seeds + 1% polymer mixer as sticker @ 10 ml/kg of seeds.

Table 7: OFT on the Effect of hydrophilic polymer seed coating on plant. Plant population (m^{-2}) and Seed Yield parameters in blackgram var (VBN 8).

Treatments	Pooled mean (of all the four OFT centres) Plant population and seed yield attributes				
	Plant population on 25 DAS	No. of pods $plant^{-1}$	Seed yield $plant^{-1}$	Yield $plot^{-1}$ (kg)	Yield ha^{-1} (kg)
T_0	33	52.68	14.86	1.110	556.0
T_1	27	41.91	10.47	0.957	478.5
T_2	33	61.15	16.03	1.218	609.0
T_3	33	57.49	15.43	1.122	561.3

T_0: Control (No seed treatment with recommended agronomical practices); T_1 : Control (No seed treatment with water stress up to 20 days after life irrigation); T_2: Seed treatment with Xanthan Gum + Carrageenan + Agar (4 : 1 : 1) @ 20 g/kg of seeds with recommended agronomical practices; T_3: Seed treatment with Xanthan Gum + Carrageenan + Agar (4 : 1 : 1) @ 20 g/kg of seeds with water stress up to 20 days after life irrigation.

is suitable for the preparation of SAP (Super Absorbent Polymer). Black gram seeds dry coating with Polymer concoction of Xanthan Gum: Carrageenan : Agar (4:1:1) @ 20 g/kg/Carrageenan : Xanthan Gum : Agar (4:1:1) @ 20 g seeds able to tolerate the water stress even under 10 bars and the germination percentage increase over the control was 24%. The results were in agreement with Maya Hotta *et al.* (2018). She 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. Fanta *et al.* (1978), reported that the hydrolyzed starch-graft-polyacrylonitrile or H-SPAN polymer can absorb water up to 2000 times their weight. Combinational or Polymer concoction coating increased the coating efficiency thereby drought tolerance capacity over the separate coating. Since, polymer combinations may give the double fold advantage in water absorption and consistency in growth stimulation. From the studies it could be concluded that the black gram seeds dry coated with hydrophilic biopolymers concoction of Xanthan Gum: Carrageenan : Agar /Carageenan : Xanthan gum: Agar mixture 4:1:1 @ 20 g/kg have the capability to promote seed germination under water stress condition. Apart from Hydrophilic biopolymers Concoction Seed Coating with 4:1:1 of xanthan gum : Carrageenan : Agar agar @ 20 g/kg is a eco-friendly seed coating method. Since the Xanthan gum extracted from *Xanthomonas Campestris*, Carageenan and Agar-Agar is extracted from Red sea weeds. are microbial or sea weed polysaccharides could improve the soil properties (Dehghan *et al.*, 2019 and Soldo *et al.*, 2020). Skipping of irrigation upto 20 days after life irrigation can controls the weed growth. The yield increase was 17-20% over the uncoated seeds. From the studies it could be concluded that blackgram seeds coated with dry polymer Concoction of Xanthan gum : Carrageenan: Agar (4:1:1) @ 20g/kg is a promising technique for maintaining a high water potential in rainfed ecosystems and can be recommended as a pre sowing seed treatment for mitigating water stress upto 20 days after life irrigation.

CONCLUSION

From the studies it could be concluded that blackgram seeds coated with dry polymer Concoction of Xanthan gum : Carrageenan: Agar (4:1:1) @ 20 g/kg is a promising technique for maintaining a high water potential in rainfed ecosystems and can be recommended as a pre sowing seed treatment for mitigating water stress upto 20 days after life irrigation.

Conflict of interest

All authors declare that this paper is our original research paper and they will bear full responsibility for the submission. All authors confirm that they have contributed significantly to the work and there is no conflicts of interest among them.

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