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Effect of seed pelleting with botanicals on germination and seedling growth of clusterbean under induced saline condition

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ABSTRACT

Cluster bean [*Cyamopsis tetragonoloba* (L.) Taub.] is an important legume crop. Investigations were undertaken to study the effect of seed pelleting with botanicals *viz., Pongamia pinnata*, *Prosopis juliflora*, *Vitex nigundo* and *Albizia amara*@ 50, 100, 150 and 200 g kg^{-1} of seed on germination and seedling growth of cluster bean under induced saline condition *viz*., EC_4, EC_8, EC_{12} and EC_{16}. The experimental results revealed that increased salinity caused harmful effects on germination and seedling growth in terms of germination %, speed of germination, root length, shoot length, dry matter production and vigour index. However, pelleting treatments increased these parameters with more pronounced effect by *Pongamia pinnata* leaf powder. Higher germination, growth and vigour of seedlings were recorded with *Pongamia pinnata* leaf powder treatment @ 200 g per kg. The next best levels of vigour index was recorded in treatments with *Pongamia pinnata* leaf powder @ 150g per kg and *Prosopis juliflora* leaf powder @ 200g per kg only at no salinity and low levels and in high levels of salinity, *Albizia amara* leaf powder treatment @ 200g per kg performed as the nest best treatment.

Key words: Clusterbean, Germination, Seedling, Seed pelleting.

INTRODUCTION

Cluster bean [*Cyamopsis tetragonoloba* (L.) Taub.] is an important legume crop grown in large scale under rainfed conditions at arid and semi arid regions of tropical India (Kumar and Rodge, 2012). It is grown as vegetable and fodder crop due to its rich nutrient content and as cash crop for its endospermic gum (30-35 per cent) present in seeds (Kumar and Singh, 2002). India produces about 80 per cent of the world production followed by Pakistan, USA, Italy, Morocco, Germany and Spain (Tripathy and Das, 2013; Punia *et al*., 2009). In India, Rajasthan is the major cluster bean producing state followed by Haryana, Gujarat, Uttar Pradesh, Punjab and Madhya Pradesh (USDA, 2014). The average productivity of cluster bean in India is 478 kg/ha (Bhatt *et al*., 2017). The crop is known for its exceptionally high adaptation towards poor and erratic rains as well as in problematic soil condition (Premalakshmi *et al*., 2017).

Though, the production of cluster bean in India is in increasing trend, the productivity of cluster bean remains low owing to adverse climatic conditions experienced at early stages of the crop (Bhatt *et al*., 2017). Hence, mitigation of early stage stress in cluster bean is very important to augment the crop growth and yield. The seed hardening and seed pelleting techniques are attempted to boost the germinating seeds and growing seedlings which ultimately increase yield under low rainfall and low soil moisture conditions. Further, seed pelleting techniques can put forth better root and shoot growth and enhance the drought tolerance resulting in increased yield (Georgin Opheliya, 2017).

Seed pelleting is the process of enclosing a seed with small quantity of inert material to facilitate precision planting. The inert material may create natural water holding media and also provide small amount of nutrients to young seedlings. It reduces the problem of thinning and gap filling and the chemicals required are also in low quantity. The present investigation was undertaken to study the effect of seed pelleting with botanicals on germination and seedling growth of cluster bean under induced saline condition.

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MATERIALS AND METHODS

Pot culture experiment was carried out in completely randomized block design with 17 treatments and three replications at Department of Genetics and Plant Breeding, Faculty of Agriculture, Annamalai University, Tamil Nadu, during 2016-2017. Seeds of cluster bean (*Cyamopsis tetragonoloba*) cv. *Pusa mausami* obtained from Palur Research Station, Panruti was used for the study. The sun dried leaves of Pungam (*Pongamia pinnata*), Prosopis (*Prosopis juliflora*), Nochi (*Vitex nigundo*) and Arappu (*Albizia amara*) were powdered using pestle and mortar and sieved through 0.10 mm wire mesh to get a fine leaf powder. The

seed pelleting materials were mixed in definite proportion to get different combinations as per the treatments and to get sufficient quantity of pelleting mixture to pellet known quantity of seed.

Process of pelleting:

Seed
↓
Adhesive
↓
Filler (leaf powders)

The seeds are uniformly coated with adhesive in correct quantity initially. Then the filler materials (leaf powders) are sprinkled on the coated seeds and are rolled on the filler material for effective and uniform coating. The thickness of the seed coating is dependent on the amount of sticker in relation to the amount of seed. The total mixing time should not exceed four minutes since prolonged agitation may damage the seeds or chips of pelleted coat.

Seeds were pelleted with leaf powders of *Pongamia pinnata*, *Prosopis juliflora*, *Vitex nigundo* and *Albizia amara* @ 50, 100, 150 and 200 g kg^{-1} of seed and a total of 17 treatments including a control were taken for this study. Germination and seedling vigour of seed pelleting treatments were studied by sowing the seeds in acid washed sand medium and grown under four levels of induced salinity *viz*., 4, 8, 12 and 16 EC. Sodium chloride (NaCl) solution at different concentrations (control/No salinity, 4, 8, 12 and 16 ds m^{-1}) was prepared to induce saline stress treatment. The quantity of salt solution added was in such a way that medium should have 80% turgidity without excess moisture content. The required salinity was maintained by assessing the salt level using EC meter. Control was maintained by irrigating with tap water and without salt solution. Germination and vigour parameters *viz.,* germination % (ISTA, 1999), speed of germination (Magurie, 1962), root Length (cm), shoot length (cm), seedling length (cm), dry matter production (Gupta *et al.,* 1993) and vigour index I and II (Abdul Baki and Anderson, 1973) were recorded and data were subjected to statistical analysis.

RESULTS AND DISCUSSION

Saline stress is one of the main factors limiting legume productivity (Lluch *et al.,* 2007). Seed germination is usually the most critical stage in seedling establishment, which determines successful crop production (Almansourie *et al.,* 2001; Bhattacharjee, 2008). In the present experiment, the data on mean germination percentage showed declining trend with increase in salinity levels (Table 1). The pelleting treatments significantly increased the germination percentage at all levels of salinity when compared with the control treatment The highest germination percentage was observed in treatment with *Pongamia pinnata* leaf powder pellets @ 200 g per kg (T_4) which recorded the maximum germination of 87.33 per cent at no saline condition, 85.00 per cent at EC_4, 84.66 per cent at EC_8, 80.33 per cent at EC_{12} and 74.33 per cent at EC_{16} levels (Table 1). The next

Table 1: Effect of seed pelleting on germination parameters of cluster bean cv. Pusa Mausami under saline conditions.

Seed pelleting treatments (T)	Germination percentage					Speed of germination				
	Control (No salinity)	Saline condition				Control (No salinity)	Saline condition			
		EC_4	EC_8	EC_{12}	EC_{16}		EC_4	EC_8	EC_{12}	EC_{16}
T_0-Control	72.33	70. 66	68.00	64.00	58.66	7.40	7.30	7.10	7.00	6.80
T_1- *Pongamia pinnata* leaf powder @ 50g / kg	81.33	79.00	77. 66	76. 66	65.33	9.00	8.80	8.20	8.00	7.80
T_2- *Pongamia pinnata* leaf powder @ 100g / kg	83.66	80.33	78.33	76.33	68.66	9.20	9.00	8.40	7.60	7.20
T_3- *Pongamia pinnata* leaf powder @ 150g / kg	85. 66	84. 66	80. 66	78. 66	72.33	9.30	9.10	9.00	7.80	7.40
T_4- *Pongamia pinnata* leaf powder @ 200g / kg	87.33	85.00	84. 66	80.33	74.33	9.50	9.30	9.10	8.80	8.50
T_5- *Prosopis juliflora* leaf powder @ 50g / kg	80. 66	75.00	73.33	71.33	68.66	8.60	8.00	7.80	7.50	7.00
T_6- *Prosopis juliflora* leaf powder @ 100g / kg	81. 66	78. 66	77. 66	75. 66	69.00	8.70	8.20	8.00	7.40	7.10
T_7- *Prosopis juliflora* leaf powder @ 150g / kg	83.33	79.33	78.00	76.00	70.33	8.90	8.40	8.20	7.50	7.20
T_8- *Prosopis juliflora* leaf powder @ 200g / kg	85.33	81.33	79.00	77.33	72.00	9.00	8.60	8.40	7.80	7.40
T_9- *Vitex nigundo* leaf powder @ 50g / kg	75. 66	74. 66	72. 66	70. 66	62.66	8.00	8.00	7.40	7.20	7.00
T_{10}- *Vitex nigundo* leaf powder @ 100g / kg	77.33	75.00	73.00	71.66	66.00	8.10	8.20	7.60	7.40	7.20
T_{11}- *Vitex nigundo* leaf powder @ 150g / kg	79.33	76.33	75.00	74.33	68.33	8.20	8.40	8.00	7.60	7.30
T_{12}- *Vitex nigundo* leaf powder @ 200g / kg	81. 66	79. 66	77. 66	75.33	70.66	8.40	8.60	8.20	7.80	7.40
T_{13}- *Albizia amara* leaf powder@ 50g / kg	73.33	71.00	70.33	70. 66	65.33	7.50	7.80	7.60	7.20	7.00
T_{14}- *Albizia amara* leaf powder@ 100g / kg	76. 66	73.33	71.00	71.00	68.00	7.70	8.00	7.80	7.40	7.20
T_{15}- *Albizia amara* leaf powder@ 150g / kg	78. 66	76. 66	75. 66	73. 66	71.66	7.70	8.20	7.8	7.60	7.40
T_{16}- *Albizia amara* leaf powder@ 200g / kg	80. 66	78.33	77.66	75.66	74.33	8.00	8.40	8.2	7.80	7.50
Mean	**79.76**	**77.24**	**75.53**	**73.65**	**68.24**	**8.42**	**8.37**	**8.05**	**7.61**	**7.32**
SEd	**0.61**	**0.51**	**0.65**	**0.62**	**0.71**	**0.17**	**0.13**	**0.24**	**0.18**	**0.28**
CD(p=0.05)	**1.23**	**1.02**	**1.32**	**1.24**	**1.43**	**0.35**	**0.26**	**0.48**	**0.36**	**0.56**

best treatment was *Pongamia pinnata* leaf powder pellets @ 150 g per kg (T_3). The mean data on speed of germination suggested that salinity has drastically delayed germination. The pelleting treatments significantly increased the speed of germination both under normal and induced saline condition. The highest speed of germination was recorded in *Pongamia pinnata* leaf powder pellets @ 200 g per kg (T_4), which recorded speed of germination of 9.50 at control condition, 9.30 at EC_4, 9.10 at EC_8, 8.80 at EC_{12} and 8.50 at EC_{16} levels, followed by 150 g per kg (T_3) in which the maximum speed of germination was recorded at control (9.30) and the minimum at EC_{16} levels (7.40).

The improvement in field emergence could be attributed to activation of cells, resulting in the enhancement of mitochondrial activity leading to the formation of more high energy compounds and vital biomolecules, which are made available during the early phase of germination (Ananthi *et al*., 2015). Salinity has delayed germination which has already been reported by Ayers and Westcot (1985) and Mensah and Ihenyen (2009). The variation in seed germination at higher levels of NaCl indicated that NaCl has direct harmful effects on common bean seed germination (Alihan Cokkizgin, 2012). This increase in seed vigour was also due to the early availability of high energy compounds and vital bio molecules to the growing seedlings. The *Prosopis juliflora* leaf powder contains saponin like substance which acts as a precursor of GA_3 (Manikandan and Srimathi, 2014). During pelleting, the leaf powder might have helped to regulate the soil moisture availability and thus enhanced seedling quality characters of the pelleted seeds.

It has been observed that increased saline concentration caused harmful effects on seedling growth in terms of root length, shoot length, and dry matter production. However, pelleting treatments increased these parameters at all levels of salinity when compared with the control treatment (Fig 1). In general, the highest seedling growth parameters *viz.,* root length, shoot length and dry matter production were recorded at control (14.46 cm, 17.33 cm and 0.56 g) followed by salinity levels from low (EC_4) to high (EC_{16}) (13.78 cm, 13.42 cm, 12.98 cm and 12.58 cm of root length at EC_4, EC_8, EC_{12} and EC_{16}; 16.39 cm, 15.85 cm, 15.19 cm and 14.65 cm of shoot length at EC_4, EC_8, EC_{12} and EC_{16}; 0.54 g, 0.53 g, 0.52 g, and 0.50 g of dry matter production at EC_4, EC_8, EC_{12} and EC_{16} conditions respectively) in pelleting treatment with *Pongamia pinnata* leaf powder @ 200g per kg. In control and low levels (EC_4 and EC_8) of salinity, the next best treatment was *Pongamia pinnata* leaf powder pelleting @ 150g per kg. However, in high levels of salinity, pelleting with *Albizia amara* leaf powder @ 200g per kg performed as the next best treatment. Similar results were observed by Khajeh-Hosseini *et al.* (2003) in soybean seeds and by Pujol *et al.* (2000) in four halophytes from south eastern Spain.

The increase in root length, shoot length and seedling length may be due to the cell wall extension and increased metabolic activities as reported by Afzal *et al*. (2002) in maize seeds. Increase in dry matter production with seed pelleting

Table 2: Effect of seed pelleting on vigour Index I & II of cluster bean cv. Pusa Mausami under saline conditions.

Seed pelleting treatments (T)	Vigour Index I					Vigour Index II				
	Control (No salinity)	Saline condition				Control (No salinity)	Saline condition			
		EC_4	EC_8	EC_{12}	EC_{16}		EC_4	EC_8	EC_{12}	EC_{16}
T_0-Control	2267.08	2009.00	1927.12	1781.76	1592.68	35.04	31.50	29.92	26.88	23.61
T_1- *Pongamia pinnata* leaf powder @ 50g / kg	2391.12	2304.43	2195.27	2141.68	1812.85	41.31	39.50	37.73	35.72	29.25
T_2- *Pongamia pinnata* leaf powder @ 100g / kg	2491.66	2366.40	2279.16	2186.52	1921.00	43.99	40.80	39.00	36.48	31.28
T_3- *Pongamia pinnata* leaf powder @ 150g / kg	2587.40	2513.28	2374.40	2290.08	2100.96	45.90	43.68	40.80	38.22	33.84
T_4- *Pongamia pinnata* leaf powder @ 200g / kg	2692.65	2590.80	2531.76	2389.60	2178.56	48.72	45.90	44.52	40.80	36.26
T_5- *Prosopis juliflora* leaf powder @ 50g / kg	2351.20	2198.25	2122.84	2039.83	1944.80	39.20	35.25	32.85	31.24	29.24
T_6- *Prosopis juliflora* leaf powder @ 100g / kg	2392.74	2296.32	2245.32	2166.00	1983.75	42.93	39.00	37.73	35.25	31.74
T_7- *Prosopis juliflora* leaf powder @ 150g / kg	2475.89	2338.40	2283.84	2204.00	2020.20	44.82	41.08	39.78	36.48	32.20
T_8- *Prosopis juliflora* leaf powder @ 200g / kg	2566.15	2408.94	2323.39	2248.40	2093.04	46.75	42.93	40.29	37.73	33.84
T_9- *Vitex nigundo* leaf powder @ 50g / kg	2220.00	2165.98	2082.96	1998.50	1760.80	36.75	35.52	33.12	30.80	26.66
T_{10}- *Vitex nigundo* leaf powder @ 100g / kg	2286.13	2210.25	2119.92	2041.25	1886.94	38.50	36.75	34.31	32.66	29.04
T_{11}- *Vitex nigundo* leaf powder @ 150g / kg	2359.73	2255.68	2199.00	2137.12	1953.64	41.08	38.00	36.00	34.78	29.92
T_{12}- *Vitex nigundo* leaf powder @ 200g / kg	2433.24	2359.73	2269.96	2176.50	2027.90	42.93	39.50	37.73	35.25	31.50
T_{13}- *Albizia amara* leaf powder@ 50g / kg	2158.61	2078.88	2035.60	2002.00	1839.50	35.88	32.66	31.50	30.10	27.30
T_{14}- *Albizia amara* leaf powder@ 100g / kg	2269.02	2154.23	2085.98	2054.03	1873.30	38.00	34.31	32.66	31.95	27.92
T_{15}- *Albizia amara* leaf powder@ 150g / kg	2335.32	2263.28	2217.75	2135.98	2061.84	40.56	37.24	36.00	32.85	31.24
T_{16}- *Albizia amara* leaf powder@ 200g / kg	2404.00	2329.08	2282.28	2201.25	2163.76	42.40	39.78	37.73	36.00	34.78
Mean	**2393.06**	**2284.88**	**2210.39**	**2129.09**	**1953.85**	**41.46**	**38.44**	**36.57**	**34.31**	**30.57**
SEd	**51.37**	**50.38**	**48.83**	**47.79**	**45.72**	**0.51**	**0.46**	**0.48**	**0.51**	**0.52**
CD(p=0.05)	**103.56**	**101.56**	**98.45**	**96.34**	**92.18**	**1.03**	**0.92**	**0.96**	**1.02**	**1.05**

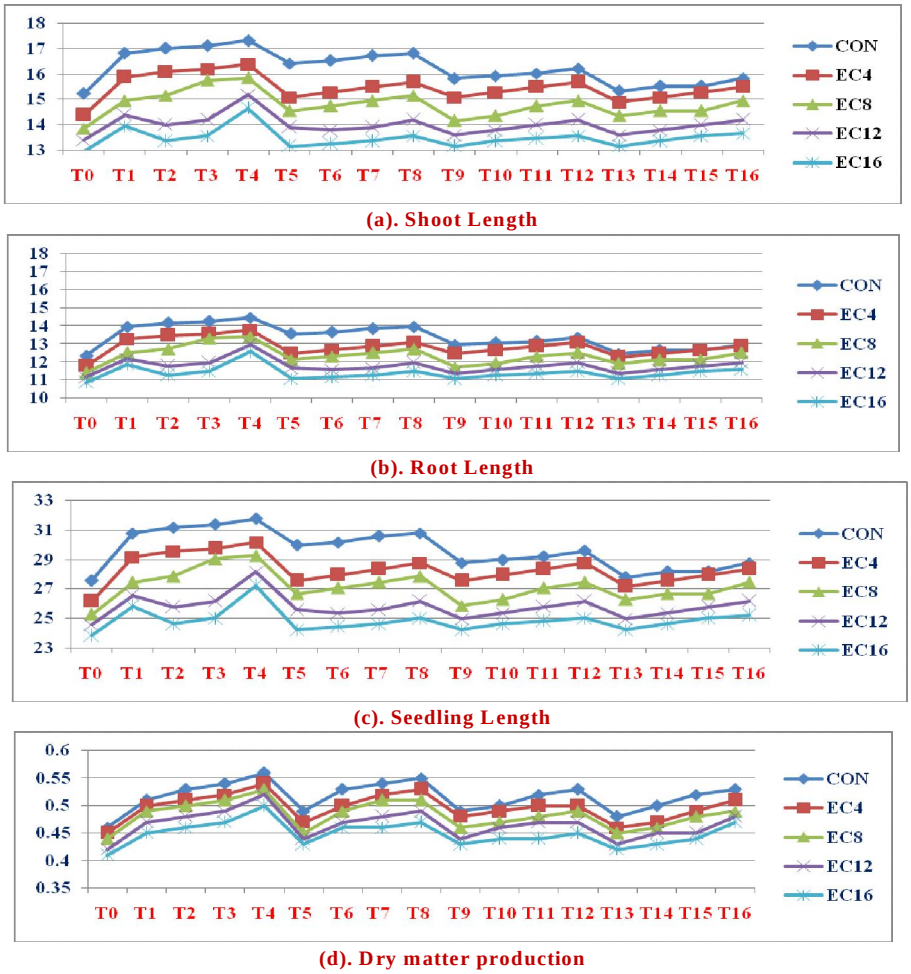


Fig 1: Effect of seed pelleting on a) shoot length, b) root length, c) seedling length and d) drymatter production in cluster bean cv. Pusa Mausami under saline conditions.

was also reported by Tamilmani (2012) in blackgram and Prakash *et al*. (2013) in rice. The increase in dry weight was claimed to be due to enhanced lipid utilization and enzyme activity due to the bioactive substances like auxin present in *Prosopis juliflora* leaf extract (Kathirvel and Kumudha, 2011). Similar observations of increased growth parameters with 1% *Prosopis juliflora* leaf extract treatment was reported in black gram by Sathiya Narayanan *et al*. (2016).

The bionutrients available in the pelleted seeds might have improved seedling growth resulting in higher growth parameters (Prakash *et al.,* 2013). The physiologically active substances present in the botanical leaf powders might have stimulated the germination and related processes resulting in more absorption of water due to elasticity of cell wall and development and increased vigour index (Sathish and Bhaskaran, 2013). The *Pongmia pinnata* leaves contain various alkaloids like pinnalin, pongamol, saponin, β-sitosterol and tannins (Savita Sangwan *et al.,* 2010). Presence of these substances in *Prosopis juliflora* and *Pongamia pinnata* leaf powders would have triggered the germination and seedling establishment processes thereby increase the uptake of nutrients resulting in enhanced growth and development. The influence of seed pelleting in rice (Prakash *et al*., 2013) and bhendi (Prakash *et al*., 2014) has already been reported.

Increased salinity concentration decreased the vigour index of cluster bean seedlings. In general, the highest vigour index I (2692.65, 2590.80, 2531.76, 2389.60, and 2178.56 at control, EC_4, EC_8, EC_{12} and EC_{16} conditions respectively) and vigour index II (48.72, 45.90, 44.52, 40.80 and 36.26 at control, EC_4, EC_8, EC_{12} and EC_{16} conditions respectively) were recorded in pelleting treatment with *Pongamia pinnata* leaf powder @ 200g per kg (Table 2). Al-Mutawa (2003) reported that increased salinity leads to decreased root length in chickpea. During soaking, seeds become physiologically advanced by carrying out some of the initial steps of that resulted in improved germination, seedling length, dry matter production and vigour index (Natesan, 2006). The finding of Ramesh Kumar and Muthukrishna (2015) in okra and chilli seeds and Georgin Ophelia (2017) in black gram also corroborates with the results of present study. Increased seedling growth observed due to *Pongamia pinnata* leaf powder is in concomitant with the reports of Harish Babu *et al.* (2005) who observed

increased shoot length, seedling dry weight and vigour index. The effect of *Prosopis juliflora* and *Albizia amara* leaf powder treatments in enhancing vigour of seedlings is in line with the observations of Ananthi *et al.* (2015) and Sathish Kumar *et al.* (2014) respectively.

To conclude, seed pelleting with *Pongamia pinnata* leaf powder @ 200g per kg can be recommended for cultivation of cluster bean under saline conditions to get higher yield.

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