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Cumulative Effect of Botanical Seed Pelleting and Foliar Spray on Morpho Physiological, Leaf Chlorophyll, Gas Exchange and Yield Parameters in Black gram

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ABSTRACT

Background: Black gram is one of the important pulse crops of the world and India is the major producer and consumer of pulses in the world. One of the main reason for low productivity of pulses is that they are cultivated mostly in areas with low soil moisture and poor soil fertility. In order to overcome such adverse conditions, low-cost techniques like seed hardening/pelleting are preferred. Seed pelleting provides package of nutrients that influences seed or soil at the seed-soil interface. Since the cost involved is very less, an attempt has been made to study the effect of botanical seed pelleting and foliar spary on growth and yield parameters in black gram cv. CO 6.

Methods: Field experiments were conducted to evaluate the cumulative effect of botanical seed pelleting with pungam leaf powder @ 150g kg^{-1} and foliar spray of prosopis and moringa leaf powders with different concentrations (2%, 4%, 6% and 8%) on morpho physiological, leaf chlorophyll, gas exchange and yield parameters in black gram cv. CO 6 in the study. The observations on morpho physiological, leaf chlorophyll, gas exchange and yield parameters were recorded, statistically analysed and discussed here.

Result: From the results, it was found that among the treatments, seed pelleting with pungam leaf powder @ 150 g kg^{-1} + foliar spray of prosopis leaf powder @ 6% recorded higher morpho physiological parameters *viz*., plant height (48.73 cm), number of branches $plant^{-1}$ (8.78), dry matter production (14.83 g $plant^{-1}$), chlorophyll 'a' (1.03 mg g^{-1}), chlorophyll 'b' (1.11 mg g^{-1}) and total chlorophyll content (2.14 mg g^{-1}), photosynthesis and transpiration rates (27.33 mg CO_2 m^{-2} s^{-1} and 10.60 mg H_2O m^{-2} s^{-1}), intercellular CO_2 concentration and stomatal conductance (274.30 µ mol mol^{-1} and 0.82 mol^{-2} s^{-1}). This treatment also recorded lower number of days to first flowering (23.23 days), earliness in 50 per cent flowering (30.12 days) and also recorded higher yield parameters such as lengthier pods, more number of pods $plant^{-1}$, pod yield $plant^{-1}$, number of seeds pod^{-1}, seed yield $plant^{-1}$, seed yield ha^{-1} and hundred seed weight of 5.60 cm, 26.30, 8.20 g, 7.30, 5.30 g, 795.12 kg ha^{-1} and 5.83 g, respectively as compared to other treatments. To conclude, seed pelleting with pungam leaf powder @ 150 g kg^{-1} + foliar spray of prosopis leaf powder @ 6% proved to be the best in enhancing morpho physiological, growth and yield parameters.

Key words: Black gram, Botanical seed pelleting, Foliar spray, Growth, Yield parameters.

INTRODUCTION

Black gram (*Vigna mungo* L.) is the third important pulse crop of India and it is native to central Asia. It is extensively grown in West Indies, Japan and other tropical and subtropical countries. Black gram seeds are highly nutritious, containing higher amount of protein (24-26%) and also rich in vitamins (A_1, B_1, B_3) and minerals (potassium, phosphorus, calcium and sodium). In India, black gram is cultivated in an area of 33.334 lakh hectares, with a total production of 164.70 lakh tonnes. India is the major producer and consumer of pulses in the world accounting for 35 and 25 percent of the world's area and production under pulses respectively (Tiwari and Shivhare, 2016).

The main reason for low productivity of pulses is that they are grown mostly in marginal and rainfed areas with inadequate soil moisture and poor fertility status. To overcome such adverse edaphic conditions, techniques of seed hardening/pelleting are followed. Seed pelleting is one of the methods which results in modifying the physiological and biological nature of seed that are favourable for direct sown condition. It is a technique of seed encapsulation with either nutrients (organic or inorganic in nature) or pest or pathogen controlling agents. Seed pelleting with botanicals will give an initial boost for the germinating seeds and growing seedlings which can put forth better root and shoot growth and thereby enhance the drought tolerance resulting in increased yield. This provides an opportunity to package effective quantities of nutrients such that they can influence the seed or soil at the seed soil interface. The cost involved

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in seed pelleting is very less but the benefit to the farmers especially who depend on monsoon showers is more. Keeping the above aspects in mind, field experiments were undertaken to study the effect of botanical seed pelleting and foliar spary on morpho physiological, leaf chlorophyll, gas exchange parameters and yield in black gram cv. CO 6.

MATERIALS AND METHODS

Genetically pure seeds of black gram [*Vigna mungo* (L.) Hepper] cv. CO 6 obtained from Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India formed the base material for the study. Field experiments were carried out at the Experimental Farm in the Department of Genetics and Plant Breeding, Faculty of Agriculture, Annamalai University, Tamil Nadu, India (located at 11°24 N, latitude and 79°44 E longitude with an altitude of 5.79 metre above mean sea level) during 2015-2017.

Preliminary experiments were conducted with seed pelleting with leaf powders of two botanicals *viz*., pungam (*Pongamia glabra*) and prosopis (*Prosopis juliflora*) @ 50, 100, 150 and 200g kg^{-1} by using gum Arabica as adhesive to study the effect of seed pelleting on morpho physiological, growth and yield parameters of black gram and it was found that seed pelleting with pungam leaf powder @ 150g kg^{-1} as the best treatment which has recorded more values for morpho physiological, growth and yield parameters. Further to study the combined effect of seed pelleting and foliar spray, seed pelleting with pungam leaf powder @ 150g kg^{-1} along with foliar spray of prosopis and moringa fresh leaf extract was attempted.

Fresh young leaves of prosopis and moringa of about 100 g were taken into a mortar with a pinch of water (10 ml/ 100 g fresh material) and ground with a pestle. The juice was extracted by hand pressure and was filtered through the cheese cloth. The solution was re-filtered using No.2 Whatman filter paper. The extract was diluted with distilled water at a ratio of 1:32 (v/v) and used for foliar spray. The extract prepared was stored at 0°C and used within five hours from cutting and extracting and taken out only when needed for use. Hand sprayers were used to spray the extract. The above procedure was followed as per the method suggested by Fuglie (2000). Foliar spray was done with fresh leaf extract @ 2%, 4%, 6% and 8% as per the following treatments.

T_0 - Control.

T_1 - Seed pelleting with pungam leaf powder @ 150 g kg^{-1} + foliar spray of prosopis fresh leaf extract @ 2%.

T_2 - Seed pelleting with pungam leaf powder @ 150 g kg^{-1} + foliar spray of prosopis fresh leaf extract @ 4%.

T_3 - Seed pelleting with pungam leaf powder @ 150 g kg^{-1} + foliar spray of prosopis fresh leaf extract @ 6%.

T_4 - Seed pelleting with pungam leaf powder @ 150 g kg^{-1} + foliar spray of prosopis fresh leaf extract @ 8%.

T_5 - Seed pelleting with pungam leaf powder @ 150 g kg^{-1} + foliar spray of moringa fresh leaf extract @ 2%.

T_6 - Seed pelleting with pungam leaf powder @ 150 g kg^{-1} + foliar spray of moringa fresh leaf extract @ 4%.

T_7 - Seed pelleting with pungam leaf powder @ 150 g kg^{-1} + foliar spray of moringa fresh leaf extract @ 6%.

T_8 - Seed pelleting with pungam leaf powder @ 150 g kg^{-1} + foliar spray of moringa fresh leaf extract @ 8%.

The field experiments were conducted by adopting randomized block design (RBD) with three replications under normal field condition. The plot size was 4 × 2.5 m^2. The crop was raised with the spacing of 30 × 10 cm. All the recommended package of practices for black gram were followed and observations on morpho physiological, leaf chlorophyll, gas exchange and yield parameters were recorded.

Plant height was recorded by measuring the height of plant from ground level to the tip of main branch using a meter scale and the mean value was expressed in centimetre. The total number of branches $plant^{-1}$ was counted and the mean number of branches $plant^{-1}$ was recorded as whole number. The biomass production was recorded from ten seedlings selected at random, which were uprooted with the intact root system and washed with water to remove the soil particles, dried under shade for 24 h and then in the hot air oven maintained at 100°C for 24 h. The dried plants were cooled in desiccators for 30 minutes and the mean weight was recorded in grams.

The numbers of flowers opened were periodically counted from the date of sowing till harvest. The day on which 50 per cent of the flower opened was taken as days taken for 50 per cent flowering. Total number of pods in marked ten plants in each treatment was counted and mean number of pods per plant and pod length were recorded replication wise and the mean was expressed in whole number. The pods from ten randomly selected plants earlier tagged were separately harvested and the seeds from each pod were separated, counted and averaged out to get the number of seeds per pod. The pods from ten tagged plants in each treatment were hand shelled. The seeds were cleaned and weighed and the mean seed yield $plant^{-1}$ was expressed in grams. The seeds thus obtained were cleaned and weighed to arrive at the plot yield. Seed yield ha^{-1} was computed from the seed yield $plot^{-1}$ obtained in each of the treatment and expressed in kg ha^{-1}.

Estimation of leaf Chlorophyll content was done as per the procedure of Yoshida *et al*. (1971). Gas exchange parameters *viz*., leaf photosynthetic rate (Pn), transpiration rate (Tr), stomatal conductance (Cs) and intercellular CO_2 concentration (Ci) were measured from two uppermost fully expanded leaves from all the treatments using LICOR-6400XT Portable Photosynthetic System (Lincoln, USA) and expressed as mg CO_2 m^{-2} s^{-1}, mg H_2O $m^{-2}s^{-1}$, µmol mol^{-1} and mol m^{-2} s^{-1}, respectively. The data on the various parameters studied during the course of investigation were analysed statistically as per the procedure suggested by Panse and Sukhatme (1978). Wherever, the results found significant ('F' test), the critical differences (CD) were arrived at five per cent probability level.

RESULTS AND DISCUSSION

Morpho physiological parameters

In this present study, the results revealed that the seed pelleting and foliar spray treatments exhibited significant influence on all the growth attributes of black gram (Table 1). Among the treatments, seed pelleting with pungam leaf powder @ 150 g kg^{-1} + foliar spray of prosopis fresh leaf extract @ 6% recorded the highest plant height (48.73 cm). This was followed by seed pelleting with pungam leaf powder @ 150 g kg^{-1} + foliar spray with moringa fresh leaf extract @ 2% which recorded plant height of 46.94 cm. The control plants recorded the least plant height of 39.78 cm. Similarly, seed pelleting with pungam leaf powder @ 150 g kg^{-1} + foliar spray of prosopis fresh leaf extract @ 6% recorded the maximum number of branches $plant^{-1}$ (8.78) and highest dry matter production (14.83 g $plant^{-1}$). The treatment next in order was seed pelleting with pungam leaf powder @ 150 g kg^{-1}+ foliar spray of moringa fresh leaf extract @ 2%. The least values in number of branches $plant^{-1}$ (6.80) and dry matter production (11.90 g $plant^{-1}$) were recorded with the control. The minimum number of days to first flowering of 23.23 days was noticed with seed pelleting with pungam leaf powder @ 150 g kg^{-1} + foliar spray of prosopis fresh leaf extract @ 6% and the maximum number of days to first flowering of 28.62 was recorded with the control. Earliness in 50 per cent flowering within 30.12 days was noticed with the seed pelleting with pungam leaf powder @ 150 g kg^{-1} + foliar spray of prosopis fresh leaf extract @ 6%. This was followed by seed pelleting with pungam leaf powder @ 150 g kg^{-1} + foliar spray with moringa leaf powder @ 2% which registered 50 per cent flowering in 31.14 days. Number of days to 50 per cent flowering was found extended up to 35.04 days with the control plants.

The treatment of seed pelleting with pungam leaf powder @ 150 g kg^{-1} + foliar spray of prosopis fresh leaf extract @ 6% might have improved the growth of plant during early stage of the crop with increased vigour and associated stronger root system which in turn might have favoured the absorption of more soil moisture and nutrients enabling better growth that resulted in higher yield (Jegathambal, 1996). Similar observations were made by Amira Hagazi and Amal El-Shraiy (2007) in common bean. Plant height is very important criterion for a crop in providing more places for flower production leading to better yield. The foliar spray of *prosopis* leaf extract would have enabled better nutrient absorption, quick growth and increased plant height with increased number of branches. The increase in dry weight was claimed to be due to enhanced lipid utilization and enzyme activity due to the presence of bioactive substances like auxin in *prosopis* leaf extract (Rathinavel and Dharmalingam,1999). The higher dry matter accumulation due to seed pelleting cum foliar spray indicated the possible increase in seedling vigour (Basaria Begam, 2001).

Turna Doegan and Ahment Zeybek (2009) recorded significant differences between the pelleted and non pelleted seeds in terms of the height of the plants (cm), number of branches per plant and number of capsules in sesame.The cumulative effect of seed pelleting and foliar spray would have helped in better rooting, absorption of more nutrients resulting in higher growth parameters. Paddy seeds hardened with KCl 1% followed by pelleting with pongam

Table 1: Cumulative effect of botanical seed pelleting and foliar spray on morpho physiological parameters in black gram cv. CO 6.

Treatments	Plant height (cm)	Number of branches $plant^{-1}$	Dry matter production $plant^{-1}$ (g)	Days to 1st flowering	Days to 50% flowering
Control	39.78	6.80	11.90	28.62	35.04
Seed pelleting with pungam leaf powder @ 150 g kg^{-1} + foliar spray of prosopis fresh leaf extract @ 2%.	45.83	7.84	13.85	26.32	33.29
Seed pelleting with pungam leaf powder @ 150 g kg^{-1} + foliar spray of prosopis fresh leaf extract @ 4%.	43.82	7.48	13.42	27.15	33.64
Seed pelleting with pungam leaf powder @ 150 g kg^{-1} + foliar spray of prosopis fresh leaf extract @ 6%.	48.73	8.78	14.83	23.23	30.12
Seed pelleting with pungam leaf powder @ 150 g kg^{-1} + foliar spray of prosopis fresh leaf extract @ 8%.	44.98	7.61	13.76	26.94	33.23
Seed pelleting with pungam leaf powder @ 150 g kg^{-1} + foliar spray of moringa fresh leaf extract @ 2%.	46.94	8.56	14.80	24.41	31.14
Seed pelleting with pungam leaf powder @ 150 g kg^{-1} + foliar spray of moringa fresh leaf extract @ 4%.	46.12	7.98	13.92	25.86	32.64
Seed pelleting with pungam leaf powder @ 150 g kg^{-1} + foliar spray of moringa fresh leaf extract @ 6%.	42.13	7.35	13.00	28.34	34.28
Seed pelleting with pungam leaf powder @ 150 g kg^{-1} + foliar spray of moringa fresh leaf extract @ 8%.	42.00	7.20	12.90	28.00	34.17
Mean	44.48	7.73	13.59	26.41	33.06
SED	1.0664	0.1874	0.3263	0.6113	0.7670
CD (P=05)	2.2608	0.3973	0.6917	1.2959	1.6261

Table 2: Effect of botanical seed pelleting and foliar spray on leaf chlorophyll and gas exchange parameters in black gram cv. CO 6.

Treatment	Chlorophyll 'a' (mg g^{-1})	Chlorophyll 'b' (mg g^{-1})	Total chlorophyll (mg g^{-1})	Photosynthetic rate (mg CO_2 m^{-2} s^{-1})	Transpiration rate (mg H_2O m^{-2} s^{-1})	Intercellular CO_2 concentration (µmol mol^{-1})	Stomatal conductance ($molm^{-2}$ s^{-1})
Control	0.56	0.57	1.13	20.25	7.55	227.00	0.58
Seed pelleting with pungam leaf powder @ 150 g kg^{-1} + foliar spray of prosopis fresh leaf extract @ 2%.	0.65	0.67	1.32	26.40	9.60	265.50	0.70
Seed pelleting with pungam leaf powder @ 150 g kg^{-1} + foliar spray of prosopis fresh leaf extract @ 4%.	0.63	0.68	1.31	27.00	10.00	272.00	0.77
Seed pelleting with pungam leaf powder @ 150 g kg^{-1} + foliar spray of prosopis fresh leaf extract @ 6%.	1.03	1.11	2.14	27.33	10.60	274.30	0.82
Seed pelleting with pungam leaf powder @ 150 g kg^{-1} + foliar spray of prosopis fresh leaf extract @ 8%.	0.68	0.59	1.27	26.00	8.50	264.23	0.67
Seed pelleting with pungam leaf powder @ 150 g kg^{-1} + foliar spray of moringa fresh leaf extract @ 2%.	0.94	0.93	1.87	26.55	9.64	268.42	0.74
Seed pelleting with pungam leaf powder @ 150 g kg^{-1} + foliar spray of moringa fresh leaf extract @ 4%.	0.76	0.78	1.54	25.50	8.42	255.10	0.65
Seed pelleting with pungam leaf powder @ 150 g kg^{-1} + foliar spray of moringa fresh leaf extract @ 6%.	0.74	0.63	1.37	25.00	8.40	254.40	0.60
Seed pelleting with pungam leaf powder @ 150 g kg^{-1} + foliar spray of moringa fresh leaf extract @ 8%.	0.82	0.76	1.58	25.50	9.08	260.11	0.69
Mean	0.7567	0.74	1.50	25.50	9.09	260.11	0.69
SED	0.0192	0.0196	0.0387	0.6031	0.2207	6.1585	0.0169
CD (P=05)	0.0406	0.0416	0.0821	1.2786	0.4678	13.0559	0.0359

leaf powder @ 200g kg^{-1} recorded increased growth and biometric characters. It is possible that the bionutrients available in the pelleted seeds might have improved seedling growth resulting in higher growth parameters (Prakash *et al*. (2013). The benefits of seed treatment with prosopis and pungam leaf extracts to overcome the adverse condition were reported by Rathinavel and Dharmalingam (1999) in uppam cotton and Renugadevi *et al*. (2008) in clusterbean.

Leaf chlorophyll content and Gas exchange parameters

Among the treatments, seed pelleting with pungam leaf powder @ 150 g kg^{-1} + foliar spray of prosopis fresh leaf extract @ 6% recorded highest chlorophyll 'a' (1.03 mg g^{-1}), chlorophyll 'b' (1.11 mg g^{-1}) and total chlorophyll content (2.14 mg g^{-1}) and was followed by seed pelleting with pungam leaf powder @ 150 g kg^{-1} + moringa fresh leaf extract foliar spray @ 2% (0.94, 0.93, 1.87 mg g^{-1} respectively for chlorophyll 'a', chlorophyll 'a' and total chlorophyll content) and the minimum was recorded in untreated plants (Table 2). Among the gas exchange parameters studied *viz*., photosynthetic rate (P_n), transpiration rate (T_r), intercellular CO_2 concentration (C_i) and stomatal conductance (C_s), it was found that seed pelleting with pungam leaf powder @ 150 g kg^{-1} + prosopis fresh leaf extract foliar spray@ 6% recorded more photosynthesis and transpiration rates (27.33 mg CO_2 m^{-2} s^{-1} and 10.60 mg H_2O m^{-2} s^{-1}) followed by seed pelleting with pungam leaf powder @ 150 g kg^{-1} + prosopis fresh leaf extract foliar spray @ 4 % (27.00 mg CO_2 m^{-2} s^{-1} and 10.00 mg H_2O m^{-2} s^{-1}) and minimum values were recorded by untreated plants (20.25 mg CO_2 m^{-2} s^{-1} and 7.55 mg H_2O m^{-2} s^{-1}). Similarly seed pelleting with pungam fresh leaf extract @ 150 g kg^{-1} + foliar spray of prosopis fresh leaf extract @ 6% recorded higher intercellular CO_2 concentration and stomatal conductance (274.30 µ mol mol^{-1} and 0.82 mol^{-2} s^{-1}) whereas control plants recorded minimum values for the same parameters (227.00 µ mol mol^{-1} and 0.58 mol m^{-2} s^{-1}).

Chlorophyll content is found higher in plants treated with seed pelleting with pungam leaf powder @ 150 g kg^{-1} + foliar spray of prosopis fresh leaf extract @ 6%. Because of the invigorative effect of prosopis, the plants would have absorbed more nutrients from the soil and utilized for more chlorophyll production resulting in enhanced photosynthetic activity of treated plants (Sathiya Narayanan *et al.,* 2015). Similar results were reported by Parwar and Kadam (1981) in wheat. The increase in chlorophyll content might be due to the effect of pelleting cum foliar spray treatment over membrane protein synthesis and binding, that lead to more production of photoassimilatory surface and high chlorophyll content (Usha *et al.,* 1999). Similar results were reported by Mvumi Culver *et al*. (2012) in tomato.

A plant bio stimulant when applied singly as a foliar spray modifed plant growth and yield with positive alteration processes under salt stress condition (Rady *et al.,* 2013). Increased gas exchange parameters with botanical treatments was also reported by Prakash *et al*. (2013) in rice. Plants treated with prosopis leaf extract @ 1% recorded more photosynthesis, transpiration rates, intercellular CO_2 concentration and stomatal conductance (Sathiya Narayanan *et al*., 2016). Vigneshwari *et al.* (2005) observed improvement in physiological and biochemical parameters of hardened and pelleted seeds over control. Paddy seeds hardened with KCl 1% followed by pelleting with pongam leaf powder @ 200g/kg recorded increased gas exchange characters *viz*., leaf photosynthetic rate, transpiration, stomatal conductance, intercellular CO_2 concentration (Prakash *et al*., 2013).

Table 3: Cumulative effect of botanical seed pelleting and foliar spray on yield attributes in black gram cv. CO 6.

Treatments	Pod length (cm)	Number of Pods $plant^{-1}$	Pod yield $plant^{-1}$(g)	No. of seeds pod^{-1}	Seed yield $plant^{-1}$(g)	Seed yield ha^{-1} (kg)	100 seed weight (g)
Control	4.40	21.00	7.05	6.87	4.50	685.32	4.15
Seed pelleting with pungam leaf powder @ 150 g kg^{-1} + foliar spray of prosopis fresh leaf extract @ 2%.	5.20	25.32	7.87	7.16	5.13	773.00	5.60
Seed pelleting with pungam leaf powder @ 150 g kg^{-1} + foliar spray of prosopis fresh leaf extract @ 4%.	5.00	24.62	7.82	7.10	5.10	783.16	5.53
Seed pelleting with pungam leaf powder @ 150 g kg^{-1} + foliar spray of prosopis fresh leaf extract @ 6%.	5.60	26.30	8.20	7.30	5.30	795.12	5.83
Seed pelleting with pungam leaf powder @ 150 g kg^{-1} + foliar spray of prosopis fresh leaf extract @ 8%.	4.90	24.00	7.62	7.08	5.08	780.34	5.50
Seed pelleting with pungam leaf powder @ 150 g kg^{-1} + foliar spray of moringa fresh leaf extract @ 2%.	5.50	26.00	8.12	7.25	5.25	790.00	5.76
Seed pelleting with pungam leaf powder @ 150 g kg^{-1} + foliar spray of moringa fresh leaf extract @ 4%.	5.40	25.70	8.00	7.15	5.20	788.24	5.62
Seed pelleting with pungam leaf powder @ 150 g kg^{-1} + foliar spray of moringa fresh leaf extract @ 6%.	4.70	23.63	7.54	7.06	5.03	778.13	5.48
Seed pelleting with pungam leaf powder @ 150 g kg^{-1} + foliar spray of moringa fresh leaf extract @ 8%.	5.40	23.63	7.48	6.98	4.67	776.24	5.45
Mean	5.12	24.46	7.74	7.10	5.02	772.17	5.43
SED	0.1226	0.5821	0.1842	0.1682	0.1191	54.1691	0.1281
CD (P=05)	0.2599	1.2340	0.3904	0.3565	0.2525	114.8386	0.2715

Yield parameters

Among the treatments, seed pelleting with pungam leaf powder @ 150 g kg^{-1} + foliar spray of prosopis fresh leaf extract @ 6% produced lengthier pods, more number of pods $plant^{-1}$, pod yield $plant^{-1}$, number of seeds pod^{-1}, seed yield $plant^{-1}$, seed yield ha^{-1} and hundred seed weight of 5.60 cm, 26.30, 8.20 g, 7.30, 5.30 g, 795.12 kg ha^{-1} and 5.83 g respectively (Table 3). The treatment next in order was seed pelleting with pungam leaf powder @ 150 g kg^{-1}+ foliar spray of moringa fresh leaf extract @ 2%. The least values in pod length, number of pods $plant^{-1}$, pod yield $plant^{-1}$, number of seeds pod^{-1}, seed yield $plant^{-1}$, seed yield ha^{-1} and hundred seed weight of 4.40 cm, 21.0, 7.05 g, 6.87, 4.50 g, 658.32 kg ha^{-1} and 4.15 g. were recorded with the untreated control plants (T_1). Similar results were reported by Sathiya Narayanan *et al*. (2013), Sathiya Narayanan *et al.* (2016) and Srimathi *et al.* (2007). Paddy seeds of cv ADT 43 hardened with KCl 1% followed by pelleting with pongam leaf powder @ 200g/kg also recorded the increased yield characters (Prakash *et al*., 2013).

Increased yield parameters with prosopis leaf extract @1% along with foliar spray of salicylic acid @100 ppm recorded the higher seed yield and other parameters in black gram under dry land condition (Sathiya Narayanan *et al*., 2015). Seed pelleting with pungam leaf powder @ 150 g kg^{-1} + foliar spray of prosopis fresh leaf extract @ 6% might be attributed to increase in cell division, cell enlargement, increased number of leaves which eventually produced more number of pods. Similar results were found by Fugile (2001) in onion. Seeds hardened with *prosopis* leaf extract @ 1% recorded higher seed yield and yield attributing characters (Sathiya Narayanan *et al*. 2013 and Srimathi *et al.* 2007 in green gram and Sathiya Narayanan *et al*. 2016 in black gram).

CONCLUSION

It was concluded from the above that the seed pelleting with pungam leaf powder @ 150 g kg^{-1} + foliar spray of prosopis leaf powder @ 6% recorded higher seed yield and yield attributes in black gram when compared to other treatments and control.

REFERENCES

Amira M. Hagazi and Amal, Ei-Shraiy, M. (2007). Impact of salicylic and paclobutrazol exogenous application on the growth, yield and nodule formation of common bean. Australian Journal of Basic and Applied Sciences. 1: 834-840.

Basaria Begam, J. (2001). Seed hardening cum pelleting studies in blackgram cv. CO 5. M.Sc. (Ag.) Thesis, Tamil Nadu Agricultural University, Coimbatore.

Fuglie, L.J. (2001). The Miracle Tree: *Moringa oleifera*: Natural Nutrition for the Tropics. The multiple Attributes of Moringa. 172.

Fuglie, L.J. (2000). New uses of moringa studied in Nicaragua. ECHO Development Notes # 68. June, 2000.

Jegathambal, R. (1996). Pre-sowing seed treatment to augment productivity to sorghum cv. CO 26 under rainfed agriculture. Ph.D. Thesis, Tamil Nadu Agriculture University, Coimbatore.

Mvumi, C., Tagwira, F. and Chiteka, A.Z. (2012). Effect of *Moringa oleifera* leaf aqueous extract on growth and yield of rape and cabbage. African Journal of Biotechnology. 11(73): 13796-13800.

Parwar, H.K. and Kadam, R.M. (1981). Soaking of seed in solutions of different chemicals In relation to uptake of nutrients and protein content in wheat under rainfed conditions. Journal of MAU. 6(1): 75-76.

Panse, V.G. and P.V. Sukhatme. (1978). Statistical methods for agricultural workers. ICAR Publication, New Delhi.

Prakash, M., Sathiya Narayanan, G, Sunil Kumar, B. and Kamaraj, A. (2013). Effect of seed hardening and pelleting on seed quality and physiology of rice in aerobic condition. Agric. Sci. Digest. 33(3): 172-177.

Rady, M.M., Varma, C.B. and Howladar, S.M. (2013). Common bean (*Phaseolus vulgaris* L.) seedlings overcome NaCl stress as a result of presoaking in *Moringa oleifera* leaf extract. Scientia Horticulturae. 162: 63-70.

Rathinavel, K. and Dharmalingam, C. (1999). Seed hardening augment the productivity of cotton cv.LRA 5166 (*Gossypium hirsutum* L.). Madras Agricultural Journal. 86: 68-72.

Renugadevi, J., Natarajan, N. and Srimathi, P. (2008). Efficacy of botanicals in improving seeds and seedling quality characteristics of Cluster bean. Legume Res. 31: 164-168.

Sathiya Narayanan, G., Prakash, M. and Reka, M. (2015). Influence of seed hardening cum foliar treatments on biometric, physiological and yield parameters in black gram under dryland condition. Agric. Sci. Digest. 35(1): 1-6.

Sathiya Narayanan, G., Prakash, M. and Reka, M. (2016). Influence of seed hardening treatment on growth, gas exchange and yield parameters in black gram under drought condition. Legume Res. 39(2): 248-255.

Sathiya Narayanan, G., Prakash, M. and Sunilkumar, B. (2013). Quality seed production in mung bean under abiotic stress condition. Lap Lambert Academic Publishing Company, Germany. 43-34.

Srimathi, P., Kavitha, S. and Renugadevi, J. (2007). Influence of seed hardening and pelleting on seed yield and quality in green gram (*Vigna radiata* L.) cv. CO 6. Indian J. Agric. Res. 41: 122-126.

Tiwari, A.K. and Shivhare, A.K. (2016). Pulses in India Retrospect and Prospects. In. Publication of Govt. of India, Ministry of Agri. and Farmers Welfare (DAC and FW), Directorate of Pulses Development, Vindhyachal Bhavan, Bhopal, M.P. Publication No.: DPD/Pub.1/Vol. 2/2016.

Turna Doegan and Ahmet Zeybek (2009). Improving the traditional sesame seed planting with seed pelleting. African J. Biotechnol. 8(22): 6120-6126.

Usha, R.V., Mallaik, B.and Kumar Harish. (1999). Biochemical changes in French bean plant grown under different water stress levels and their effect on population of *Tetranychu surticae* (Acari; Tetranychidae). J. Acarol. 15: 25-28.

Vigneshwari, R, Natesan. P. Bharathi A., Vanangamudi K. and Methala C. (2005). Seed hardening and pelleting on physicological and biochemical characteristics of fingermillet (*Eleusine coracana*). Madras Agric. J. 92(4-6): 334-337.

Yoshida, S., Forno, D.A. and Cock. J.H. (1971). Laboratory Manual for Physiological studies of rice. IRRI, Philippines. 36-37.