Environment & Ecology 35 (3C) : 2232—2236, July—September 2017
Website: environmentandecology.com ISSN 0970-0420

Influence of Seed Fortification on Crop Growth and Seed Yield in Cluster Bean [*Cyamopsis tetragonoloba* (L.) Taub.] var Pusanavbahar

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Received 13 October 2016 ; Accepted 16 November 2016 ; Published online 5 December 2016

Abstract Field experiments were conducted to determine the effects of seed fortification on seed yield and quality of cluster bean during *kharif*, 2013 and *kharif ,* 2014. The seeds were fortified with different organic and inorganic nutrients viz. gibberellic acid @ 200 ppm, silisilic acid @ 2ml (silicilic acid is a beneficial element which is source of silicon with the chemical formula SiH_4O_4), KNO_3 @ 2%, $MgSO_4$ @ 1% $ZnSO_4$ @ 1%, pongamia leaf extract @ 1%, cow urine @ 10% (prepared by mixing 10 ml of fresh cow urine in 90 ml of distilled water) and water soaking. Unfortified seeds served as control. The results revealed that seed fortification with $MgSO_4$ @ 1% recorded higher plant height (59.77 cm), minimum days to 50% flowering (29.17 days) and maturity (117 days), higher number of cluster per plant (9.78), number of pods per plant (47.53), number of seeds per pod (8.20), dry matter accumulation (9.33 g/plant) and seed yield (1062 kg/ha) compared to control. Hence, seed fortification with $MgSO_4$ @ 1% could be recommended for cluster bean as a pre-sowing seed in vigorative treatment for better crop growth and higher seed yield in cluster bean.

Keywords *Guar*, $MgSO_4$, Seed fortification, Pusanavbahar.

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Introduction

Cluster bean [*Cyamopsis tetragonoloba* (L.) Taub.] popularly known as *guar* is a drought hardy, deep-rooted, annual legume, grown for feed, fodder, green manure, vegetable and seed. Of late, the crop has assumed great industrial importance because of occurrence of guar-gum in its endosperm and hence, the area under cluster bean is increasing every year. Good seed is a basic input in vegetable production. Successful olericulture program depends on the quality of seeds used for sowing. The major constrain in cluster bean crop is its low productivity. It may be

due to the fact that the crop is mainly cultivated in dry land areas. The major constraints for higher productivity in dry lands are the soil moisture deficit, poor soil management and poor crop production practices. Many researchers emphasized the need for exogenous application of growth stimulants for improving the germination and vigor status of seeds [1] as the growth and development of plants are under the control of endogenous level of growth regulating substances within the seed [2]. One of the improved seed production packages to increase the production or covering yield gap is adopting the proper presowing seed management practices. The means to fortify seeds for better seed yield and quality has become important and emphasized. Seed fortification is a process of soaking the seeds in bioactive chemicals especially growth regulators, organic acids and nutrients to invigourate the seeds resulting in hike in germinability and vigor and ultimate establishment and yield. The present investigation will emphasizes on the influence of seed fortification using organic and inorganic nutrients on plant growth and seed yield parameters of cluster bean.

Materials and Methods

Field studies were conducted to study the influence of seed fortification on crop growth, and seed yield of cluster bean var Pusanavbahar during *kharif*, 2013 and *kharif* 2014 at Agricultural Research Station, Pavagada, University of Agricultural Sciences, Bengaluru. The graded seeds were soaked in equal volume of different solutions of organic and inorganic nutrients viz., gibberellic acid @ 200 ppm, silisilic acid @ 2 ml, potassium nitrate @ 2%, $MgSO_4$ @ 1%, $ZnSO_4$ @ 1%, pongamia leaf extract @ 1%, cow urine @ 10% and water soaking for 3 h. The un-soaked dry seeds were considered as control. The soaked seeds along with un-soaked dry seed were surface dried for one day under laboratory conditions and sown in the field. The design adopted was randomized block design with three replications, in a plot size of 3×2.4 m^2. The crop was raised with normal package of practices and was harvested as onceover harvest method. Five healthy and normal plants were selected at random in each plot and tagged with a label for recording various observations on growth and yield parameters as detailed below.

Plant height (cm) : The plant height was measured from base of the plant to the tip of the main shoot having fully opened top leaf from the tagged plants at 30, 60 and 90 days after sowing and at maturity. The mean plant height was computed and expressed in centimeters (cm).

Days to 50% flowering : Daily counts were made in each plot starting from initiation of flowering after vegetative stage. The date on which 50% of the total plants flowered in each plot was recorded. The number of days taken to 50% flowering was computed from the date of sowing.

Days to maturity : The date on which 80% of the total pods in a plant turned yellowish brown color was recorded. The number of days taken to maturity was computed from the date of sowing till of the pods turned yellowish brown color.

Plant dry weight at harvest (g) : Five plants were chosen at randomly from each plot at the time of final harvest and were cut at ground level. The stem and pods were separated and air dried initially, then dried in hot air oven at 70°C till constant dry weight was obtained. Plant dry weight was expressed in grams per plant.

Number of clusters per plant : The number of clusters present in five randomly tagged plants was counted from individual plants. The average was calculated and expressed as number of clusters per plant.

Number of pods per cluster : The number of pods per cluster present in five randomly tagged plants was counted from individual plants. The average was calculated and expressed as number of pods per cluster.

Number of pods per plant : The number of pods present in five randomly tagged plants was counted from individual plants. The average was calculated and expressed as number of pods per plant.

Pod length (cm) : Ten pods from each plot were randomly selected and their length was measured from the base of the pod to tip of the pod. The average was

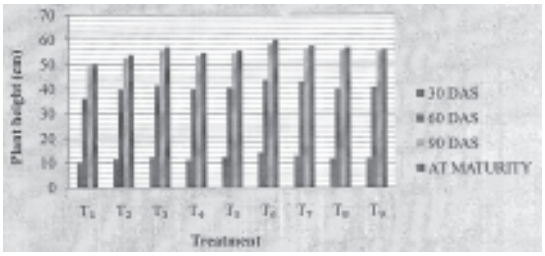

Fig. 1. Influence of seed fortification on plant height (cm) at 30, 60, 90 DAS and at maturity of cluster bean var Pusanavbahar (pooled data of *kharif*, 2013 and 2014).

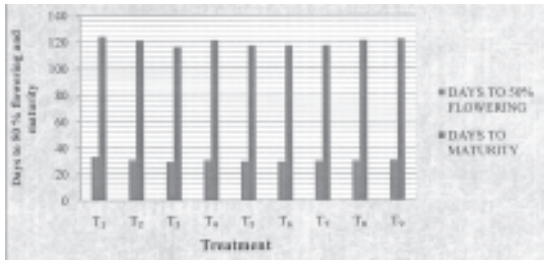

Fig. 2. Influence of seed fortification on days to 50% flowering, days to maturity of cluster bean var Pusanavbahar (pooled data of *kharif*, 2013 and 2014). T_1–Control, T_2–Water soaking, T_3–Gibberellic acid (200 ppm), T_4–Silisilic acid (2 ml), T_5–Potassium nitrate (2%), T_6–$MgSO_4$ (1%),T_7–$ZnSO_4$ (1%), T_8–Pongamia leaf extract (1%), T_9–Cow urine (10%).

computed and expressed as pod length in centimeters (cm).

Number of seeds per pod : Ten pods selected were used for recording the number of seeds per pod. Total numbers of seeds were counted and their average was expressed as number of seeds per pod.

Seeds yield per hectare (kg) : Seed yield obtained from each plot was computed for hectare and expressed in kilograms per hectare.

Results and Discussion

Since, cluster bean is mainly cultivated in marginal and rainfed areas, the major constraints for higher productivity are the inadequacy of soil moisture, poor fertility status of the soil and non-availability of seeds of improved varieties. To increase seed yield, various seed management techniques are to be standardized. Seed fortification is a physiological method of seed in vigoration that aids in improving the initialstamina of the seed through higher germinability, seedling vigor and initial field stand. It involves the impregnation of the needy substance into the seed through the imbibition phase and enriches the endogenous level of the required bioactive substances. Hence, the utility of inorganic and inorganic nutrients as seed

Table 1. Influence of seed fortification on plant dry weight @ harvest (g), number of clusters per plant, number of pods per cluster and number of pods per plant of cluster bean var Pusanav bahar (pooled data of *kharif*, 2013 and 2014.

Treatments	Plant dry weight @ harvest (g/plant)	Number of clusters per plant	Number of pods per cluster	Number of pods per plant
Control	7.94	6.17	4.28	27.63
Water soaking	8.46	7.37	4.45	34.40
Gibberellic acid (200 ppm)	9.16	9.00	4.88	47.08
Silisilic acid (2 ml)	8.65	8.56	4.72	39.33
Potassium nitrate (2%)	9.02	9.45	4.88	45.10
$MgSO_4$ (1%)	9.33	9.78	5.03	47.53
$ZnSO_4$ (1%)	9.28	9.45	5.02	47.12
Pongamia leaf extract (1%)	8.81	9.15	4.72	42.20
Cow urine (10%)	8.73	8.87	4.65	41.37
Mean	8.82	8.64	4.74	41.31
SEm±	0.09	0.32	0.11	0.85
CD @ 5%	0.26	0.97	0.34	2.55

Table 2. Influence of seed fortification on pod length (cm), number of seeds per pod, seed yield (kg/ha) of cluster bean var Pusanavbahar (pooled data of *kharif*, 2013 and 2014).

Treatments	Pod length (cm)	Number of seeds per pod	Seed yield (kg/ha)
Control	7.44	7.12	869
Water soaking	9.53	7.80	995
Gibberellic acid (200 ppm)	9.77	7.93	1044
Silisilic acid (2 ml)	9.47	7.40	1027
Potassium nitrate (2%)	9.74	7.62	1041
T_6–$MgSO_4$ (1%)	9.99	8.20	1062
$ZnSO_4$ (1%)	9.87	8.15	1046
Pongamia leaf extract (1%)	9.70	7.78	1041
Cow urine (10%)	9.71	7.87	1029
Mean	9.46	7.76	1017
SEm±	0.27	0.22	7.43
CD @ 5%	0.81	0.67	22.28

fortification agents were evaluated in the present study for improving the plant growth and seed yield of cluster bean. In the present investigation, seed fortification had a significant positive influence on the plant growth and seed yield of cluster bean.

The fortified seeds has recorded highest plant height at 30, 60, 90 DAS and at maturity. The highest plant height (14.06, 43.35, 58.23 and 59.77 cm respectively) was observed in seeds fortified with $MgSO_4$ @ 1%, followed by $ZnSO_4$ @ 1% (12.73, 42.87, 56.05 and 57.35 cm respectively). Unfortified seeds recorded lowest plant height (10.38, 36.15, 48.96 and 50.28 cm, respectively) (Fig.1). Increase in plant height might be due to the translocation of biomolecules to the aerial part of plants, and this perhaps occurs to an extent that is enough to increase hypocotyl size and the consequent increase in first node height hence suffucient to positively affect plant height. This increase in plant height was also due to the early availability of high energy compounds and vital biomolecules to the growing seedlings [3]. Similarly, in redgram pre-sowing treatment with chemical growth regulants improved the plant height and was due to redistribution of resources leading to cell enlargement and cell division [4]. The results uphold the findings of earlier studies made by other scientists in various crops [5—7].

Days taken to 50% flowering significantly differed due to seed fortification. The seeds fortified with $MgSO_4$ @ 1% and gibberellic acid 200 ppm @ taken minimum number of days to 50% flowering (29.17 days) followed by KNO_3 @ 2% (29.50 days) and $ZnSO_4$ @ 1% while, unfortified seeds taken the maximum days (33.17 days) for 50% flowering (Fig. 2). This could be because of their effect in the fast emergence of the seeds at the beginning as the correlation between days to 50% flowering and the days to maturity was significantly higher and positive. The reason may also be due to the early seed germination by utilizing the available soil moisture and the stimulatory effect of fortified seeds on seed germination and on the growth of the seedling was by the fertilizing effect active ingredients used in seed fortification. The results are in agreement with the findings of other scientists [8]. Seed fortification has resulted in early maturity of the cluster bean. Among the treatments, seeds fortified with $MgSO_4$ @ 1%, KNO_3 @ 2%, $ZnSO_4$ @ 1% matured earlier with 117 days compared to unfortified seeds (124 days) (Fig. 2). The water uptake by the fortified seeds is followed with denovo synthesis of hydrolytic enzymes [9]. This facilitates a shift in metabolic activities by speeding up the solubilization of stored food material and thereby helping in effective flower formation, fruit and seed development [10]. Plant dry weight at harvest showed significant variations due to seed fortification treatments and maximum dry weight was registered in $MgSO_4$ @ 1% (9.33 g) followed by $ZnSO_4$ @ 1% (9.28 g) while, lowest plant dry weight (7.94 g) was in unfortified seeds (Table 1). This might be due to effect of seed fortification which might have enhanced the nutrient uptake and there by increased the dry matter production. The increase in dry matter production due to above said treatment in the present study is in accordance with the report of various scientists in common bean and chickpea [11, 12].

The seed vigor extended due to fortification of cluster bean seeds had resulted in better plant growth as reflected in plant height, early maturity and higher plant dry weight. The effect of seed fortification treatments with various growth regulators, inorganic and

organic nutrients were found to be profound on the yield attributing factors. Besides, the growth factors the yield attributing factors viz., pod length (cm), number of clusters per plant, number pods per cluster and number pods per plant and number of seeds per pod were also found to be improved. Seeds fortified with $MgSO_4$ @ 1% has recorded maximum number of clusters per plant, number of pods per cluster and number of pods per plant (9.78, 5.03 and 47.53 respectively), followed by $ZnSO_4$ @ 1% (9.45, 5.02 and 47.12 respectively) whereas, unfortified seeds recorded lowest values (6.17, 4.28 and 27.63 respectively) (Table 1). The results are in conformity with the findings of other researchers in common bean, chickpea, blackgram and pigeonpea [7, 11, 13, 14]. Seeds fortified with $MgSO_4$ @ 1% recorded highest pod length (9.99 cm), number of seeds per pod (8.20) followed by $ZnSO_4$ @ 1% (9.87 cm, 8.15 respectively) at compared to unfortified seeds (7.44 cm, 7.12 respectively) (Table 2).

The improvement in yield attributing factors that were enabled by seed fortification with various growth regulators, inorganic and organic nutrients obviously resulted in higher seed yield. Seed yield per hectare (10062 kg/ha) was significantly higher in $MgSO_4$ (1%) fortified seeds as compared to unfortified seeds (869 kg/ha) (Table 2). Hence, it is concluded that for the production of quality seeds and improved productivity of cluster bean, seeds could be fortified with $MgSO_4$ or $ZnSO_4$ @ 1% as a pre-sowing seed in vigorative treatment.

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