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Influence of Seed Fortification with Micronutrients and Botanical on Plant Growth, Seed Yield and Quality of Pigeonpea (*Cajanus cajana* (L.) Millsp) var. BRG-2

Nagaraj Hullur, B. C. Channakeshava, M. Byregowda, H. E. Shashidhar, S. Narayanaswamy and P. Balakrishna

Department of Seed Science and Technology, College of Agriculture, UAS, GKVK, Bengaluru - 560065

Abstract

An experiment was carried out during *Kahrif* 2014 and 2015 at Department of Seed Science and Technology, UAS, GKVK, Bengaluru to know the influence of seed fortification with micronutrients and botanical on plant growth, seed yield and quality of pigeonpea. The results revealed that among seed fortification treatments seed fortified with $ZnSO_4$ @ 250 mg / kg of seed combined with Borax @ 100 mg / kg recorded significantly higher plant growth, seed yield and quality parameters.

Pigeonpea (*Cajanus cajan* (L.) Millsp) is one of the important protein rich (23.6 %) legumes of the semi arid tropics. In India, it is the second most important pulse crop after chickpea. Pigeonpea is grown under varied agro-climatic conditions and cropping patterns. The crop has inherent defects such as flower shedding, poor pod and seed setting and shriveling of seeds. These may be due to deficiencies of macro and micronutrients, growth promoting substances and biotic factors. To combat these factors seed fortification seems to be a simple technique economically feasible and viable one. Fortification of seeds with micronutrients and botanicals in place of commonly used materials should be cost effective, non-toxic and environment friendly. Chlorophyll molecules of leaf powder along with amino acid and humic acid present in soil rhizosphere will act as chelating agent and activate growth and development of fortified seeds leading to higher seed yield and quality (Balaji, 1990). Similarly, micronutrients promote plant growth, seed yield and quality by involving in metabolic processes, such as metabolism of nucleic acid, carbohydrate, protein and indole acetic acid, cell wall synthesis, membrane integrity and function, and phenol metabolism (Tanaka and Fujiwar, 2008). In view of this an investigation on seed fortification was initiated in pigeonpea seed production to enhance its productivity and quality of seeds.

An experiment was conducted to study the effect of zinc, boron and arappu (*Albizia amara*) leaf powder on growth, seed yield and quality of pigeonpea during *kharif* 2014 and 2015 at ZARS, UAS, GKVK, Bengaluru. The experiment consisted of eight seed fortification treatments *viz*., T_1 - without seed fortification (control), T_2 - $ZnSO_4$ @ 250 mg / kg of seed; T_3 - Borax @ 100 mg / kg of seed; T_4 - Arappu leaf powder @ 250 g / kg of seed; T_5 - $ZnSO_4$ @ 250 mg / kg of seed + Borax @ 100 mg / kg of seed; T_6 - $ZnSO_4$ @ 250 mg / kg of seed + Arappu leaf powder @ 250 g / kg of seed; T_7 - Borax @ 100 mg / kg of seeds + Arappu leaf powder @ 250 g / kg of seed ; T_8 - $ZnSO_4$ @ 250 mg / kg of seed + Borax @ 100 mg / kg of seed + Arappu leaf powder @ 250 g / kg of seed; and replicated three times and laid out in randomized block design. The spacing of 90 x 60 cm was followed with net plot size of 4.7 × 3.5 m. The pigeonpea variety BRG-2 was obtained from the National Seed Project, University of Agricultural Sciences, Bengaluru. Observations on plant height, number of branches / plant, days to 50 per cent flowering, number of pods / plant, pod length, pod weight / plant, seed yield / plot, seed yield / hectare and seed quality parameters like germination per cent, mean seedling length, mean seedling dry weight, seedling vigour index-I and II were recorded. The pooled data obtained during 2014 and 2015 was statistically analysed (Gomez and Gomez, 1976) and the results are presented in Tables I, II and III.

Seed fortified with $ZnSO_4$ @ 250 mg / kg of seed + Borax @ 100 mg / kg of seed recorded higher plant

TABLE I

Influence of seed fortification with micronutrients and botanical on growth parameters of pigeonpea var. BRG-2
(Pooled data of Kharif, *2014 and 2015)*

Treatment details	Plant height (cm)			Number of branches			Days taken to 50 % flowering
	40 DAS	80 DAS	At harvest	40 DAS	80 DAS	At harvest	
T_1	43.2	83.8	158.3	2.7	4.1	6.5	123.5
T_2	52.5	113.2	186.8	3.5	5.2	10.2	118.7
T_3	49.4	102.5	169.2	3.2	4.6	8.9	118.3
T_4	47.9	101.7	169.3	3.3	4.5	8.4	121.4
T_5	59.2	118.0	191.8	3.8	5.9	10.9	117.1
T_6	50.4	104.2	171.8	3.3	4.7	9.5	120.6
T_7	46.2	96.0	163.3	2.8	4.4	7.9	119.0
T_8	51.7	109.0	180.4	3.0	4.9	9.8	118.5
S. Em±	1.1	2.9	3.2	0.2	0.2	0.3	0.40
CD (P=0.05)	3.3	8.7	9.8	0.5	0.7	0.9	1.20
CV (%)	3.8	4.8	3.2	9.4	8.8	5.7	0.6

Treatment details: $\mathbf{T_1}$ -without seed fortification (control); $\mathbf{T_2}$ - $ZnSO_4$ @ 250 mg / kg of seed; $\mathbf{T_3}$ -Borax @ 100 mg / kg of seed; $\mathbf{T_4}$ –Arappu leaf powder @ 250 g / kg of seed; $\mathbf{T_5}$ -$ZnSO_4$ @ 250 mg / kg of seed + Borax @ 100 mg / kg of seed; $\mathbf{T_6}$ -$ZnSO_4$ @ 250 mg / kg of seed + Arappu leaf powder @ 250 g / kg of seed; $\mathbf{T_7}$ -Borax @ 100 mg / kg of seeds + Arappu leaf powder @ 250 g / kg of seed; $\mathbf{T_8}$ - $ZnSO_4$ @ 250 mg / kg of seed + Borax @ 100 mg / kg of seed + Arappu leaf powder @ 250 g / kg of seed

TABLE II

Influence of seed fortification with micronutrients and botanical on seed yield parameters of pigeonpea var. BRG-2 (Pooled data of Kharif, *2014 and 2015)*

Treatment details	No. of pods per plant	Pod length (cm)	Pod weight per plant (g)	Seed yield per plot(g)	Seed yield per ha(kg)
T_1	81.5	7.2	98.2	1414.2	857
T_2	111.7	10.7	129.2	3122.2	1892
T_3	134.4	9.2	149.7	2661.3	1613
T_4	110.4	8.7	117.3	1956.0	1185
T_5	138.8	11.0	167.6	3243.5	1966
T_6	121.1	9.7	108.1	2879.8	1745
T_7	103.8	8.2	141.8	1640.8	994
T_8	129.9	10.3	143.0	2986.3	1810
S. Em±	4.1	0.2	9.0	158.8	96
CD (P=0.05)	12.3	0.7	27.3	481.8	292
CV (%)	6.1	4.1	11.8	11.1	11.1

Treatment details: $\mathbf{T_1}$ -without seed fortification (control); $\mathbf{T_2}$ - $ZnSO_4$ @ 250 mg / kg of seed; $\mathbf{T_3}$ -Borax @ 100 mg / kg of seed; $\mathbf{T_4}$ –Arappu leaf powder @ 250 g / kg of seed; $\mathbf{T_5}$ -$ZnSO_4$ @ 250 mg / kg of seed + Borax @ 100 mg / kg of seed; $\mathbf{T_6}$ -$ZnSO_4$ @ 250 mg / kg of seed + Arappu leaf powder @ 250 g / kg of seed; $\mathbf{T_7}$ -Borax @ 100 mg / kg of seeds + Arappu leaf powder @ 250 g / kg of seed; $\mathbf{T_8}$ - $ZnSO_4$ @ 250 mg / kg of seed + Borax @ 100 mg / kg of seed + Arappu leaf powder @ 250 g / kg of seed

TABLE III

Influence of seed fortification with micronutrients and botanical on seed quality of pigeonpea var. BRG-2 (Pooled data of Kharif, *2014 and 2015)*

Treatment details	Germination (%)	Mean seedling length (cm)	Mean seedling dry weight (mg)	Seedling vigour index-I	Seedling vigour index-II
T_1	76.0	13.03	7.56	994	578
T_2	89.4	18.91	10.23	1692	913
T_3	82.0	16.08	8.79	1320	721
T_4	81.0	14.96	8.30	1213	673
T_5	90.5	20.06	10.94	1818	990
T_6	83.6	16.35	9.06	1369	757
T_7	79.8	14.50	7.85	1157	628
T_8	89.1	17.65	9.73	1573	866
S. Em±	0.5	0.29	0.17	23	15
CD (P=0.05)	1.3	0.84	0.51	68	45
CV (%)	1.1	3.50	3.8	3.4	4.0

Treatment details: $\mathbf{T_1}$ -without seed fortification (control); $\mathbf{T_2}$ - $ZnSO_4$ @ 250 mg / kg of seed; $\mathbf{T_3}$ -Borax @ 100 mg / kg of seed; $\mathbf{T_4}$ –Arappu leaf powder @ 250 g / kg of seed; $\mathbf{T_5}$ -$ZnSO_4$ @ 250 mg / kg of seed + Borax @ 100 mg / kg of seed; $\mathbf{T_6}$ -$ZnSO_4$ @ 250 mg / kg of seed + Arappu leaf powder @ 250 g / kg of seed; $\mathbf{T_7}$ -Borax @ 100 mg / kg of seeds + Arappu leaf powder @ 250 g / kg of seed; $\mathbf{T_8}$ - $ZnSO_4$ @ 250 mg / kg of seed + Borax @ 100 mg / kg of seed + Arappu leaf powder @ 250 g / kg of seed

height at 60, 80 DAS and at harvest (59.0, 118.0 and 191.8 cm, respectively) (Table I). An increase in the plant height due to $ZnSO_4$ and boron may be due to the favourable influence of these nutrients on metabolism and biological activity and thier stimulating effect on photosynthetic pigments and enzyme activity which in turn encourage vegetative growth of plants as was reported by Thalooth *et al.* (2006) in mung bean and Reddy *et al*. (2007) in pegionpea. Higher number of branches at 60, 80 DAS and at harvest (3.8, 5.9 and 10.9 per plant) was observed with $ZnSO_4$ @ 250 mg / kg of seed + Borax @ 100 mg / kg of seed. This is because of $ZnSO_4$ and boron played an important role in cell division and also formation of necessary component of cell wall and cell elongation (Dileepkumar *et al*., 2009).

Less number of days to 50 per cent of flowering was observed with seed fortified with $ZnSO_4$ @ 250 mg / kg of seed in combination with Borax @ 100 mg / kg of seed (117.0 days), followed by seed fortified with Borax @ 100 mg / kg of seed (118.3 days). Induction of earliness in days to 50 per cent flowering by zinc and boron may be due to their active involvement in physiological and biochemical processes of plant metabolism particularly in enhancement of carbohydrate metabolism that in turn might get reflected on induction of early flowering early as reported by Suman, (2002) in sunflower.

Seed fortified with $ZnSO_4$ @ 250 mg / kg of seed + Borax @ 100 mg / kg of seed recorded higher pod length (11.0 cm) and pod weight per plant (167.6 g) followed by that fortified with Borax @ 100 mg / kg alone (10.7 cm and 149.2 g, respectively) (Table II). Which may be because of the involvement of these micronutrients in translocation of dry matter to reproductive parts as reported by Ganapathy *et al*. (2008) in pulses.

Higher seed yield per plot was recorded in the treatment $ZnSO_4$ @ 250 mg / kg of seed + Borax @ 100 mg / kg of seed (3243.5 g) as compared to control (1414.2 g). Higher (1966 kg/ha) seed yield per hectare was noticed in seed fortification treatment with $ZnSO_4$ @ 250 mg / kg of seed + Borax @ 100 mg / kg of seed (Table II). The increase in yield components may be due to involvement of $ZnSO_4$ and boron in sugar translocation from complex compounds like carbohydrates. Boron plays a greater role in nitrogen based synthesis or utilization and involved in RNA metabolism (Johnson and Albert, 1967) which help in protein synthesis. Higher seed yield was reported by Srimathi *et al*., (2001) in soybean seeds fortified with boron.

Higher germination per cent was recorded with the treatment of $ZnSO_4$ @ 250 mg / kg of seed + Borax @ 100 mg / kg of seed (90.5%) followed by combination of micronutrients and botanical treatment *i.e.* $ZnSO_4$ @ 250 mg / kg of seed + Borax @ 100 mg / kg of seed + Arappu leaf powder @ 250 g / kg of seed (89.4%) and it was on par with $ZnSO_4$ @ 250 mg / kg (89.1%) treatment alone. Seeds fortified with $ZnSO_4$ @ 250 mg / kg of seed + Borax @ 100 mg / kg of seed recorded higher mean seedling length (20.06 cm), mean seedling dry weight (10.94 mg), seedling vigour index-I (1818) and seedling vigour index-II (990) (Table III). The improvement in seed quality parameters is attributed to positive effect of zinc and boron since they are employed in functional and structural component of several enzymes such as carbonic anhydrase, alcohol dehydrase, alkaline phosphatase, phospholipase, carboxypeptidase and RNA polymerase which are essential for normal metabolism functions as was reported by Anita *et al.* (2012) in mungbean .

Based on the above discussion, it is concluded that seed fortification with micronutrients increased significantly plant growth, seed yield and quality attributes in pigeonpea.

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