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Effect of seed priming and foliar spray of boron, molybdenum on pigeonpea pea (*Cajanus cajan* L.)

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Abstract
A field experiment entitled Effect of seed priming and foliar spray of boron, molybdenum on pigeonpea pea (*Cajanus cajan* L.) was conducted during *Kharif* seasons of 2015 & 2016 *at* Department of Crop Physiology, C.S. Azad University of Agriculture & Technology, Kanpur to see the effect of seed priming and foliar spray of boron, molybdenum on growth characters, yield attributes and yield of pigeonpea pea (*Cajanus cajan* L.). The treatments comprised 8 treatments viz. control (dry seed), water soaked seed, seed soaking with boron (0.2%), seed soaking with molybdenum (0.02%), foliar spray of water, foliar spray of boron (0.2%), foliar spray of molybdemn (0.02%), seed soaking + fohiar spray of boron and seed soaking + foliar spray of molybdem (0.02% and 0.05%). The pigeonpea variety UPAS 120 sown in Randomized Block Design with three replications. Observations were recorded on growth yield attributing characters and yield of crop. Results revealed that by seed soaking + foliar spray of molybdenum @ 0.02% at 25 DAS + 0.85% at 45 DAS recorded significantly higher seed yield i.e. 1892.00 & 2005.00 ka ha^{-1} as well as numerically highest relative water content in leaf (90.08% & 86.7%), leaf chlorophyll intensity (64.30% & 64.10%) during 2015 and 2016, respectively. The maximum net income Rs. 54802 and Rs. 57772 per hectare and B:C ratio 2.24 and 2.31 recorded with the same treatment during 2015 and 2016, respectively, compared to control treatment.

Keywords: Pigeonpea, boron, molybdenum, seed priming, foliar spray

Introduction
Pulses are one of the important segments of Indian Agriculture after cereals and oil seeds. The split grains of the pulses called dal are excellent source of higher quality protein, essential amino acids, fatty acids, fibers, minerals and vitamins. Pulses also render improvement in soil health by enriching its N status, long term fertility and sustainability of the cropping systems. Pigeonpea need some macro and micronutrient for its normal growth. Some of these elements play an important role in the process of Rhizobium symbiosis; molybdenum is a constituent of the nitrogenase enzyme and every bacterium which fixes nitrogen needs molybdemn during the fixation process. Molybdenum has a positive effect on yield quality and nodule forming in legume crops.

Boron is a non metal micronutrient that is required for normal growth and development of the plant. It is an immobile micronutrient functions on cell wall strength and development, fruit and seed development, transport of sugar, development of hormone, membrane function, ribonuclic acid (RNA) metabolism, cell devison, respiration and Indol Acitic Acid (IAA) metabolism. (Goldbach HE *et al.*, 2001) [4].

Ali and Mishra (2001) [3] found a significant response when foliar application of boron were carried out. The highest yield was obtained when the boron application was carried out.

Seed priming is also an important physiological seed enhancement. It provides a low-cost practical solution to seed germination under stress conditions. Abiotic stress like variation in temprature and inadequate moisture during sowing time results in poor germination and poor plant stand leading to fall in crop yields. To harvest the full genetic potential, seed must germinate and seedling emerge quickly and uniformly, the process of seed priming performed. Thus keeping all above poitns in view the present investigation was formulated and conducted.

Material and Methods
The field experiments were conducted during two *Kharif* seasons of 2015 and 2016 at department of crop physiology, Chandra Shekhar Azad University of Agriculture & Technology, Kanpur, Uttar Pradesh, India under rainfed condition.

The soil of experimental sites are loamy sand having pH 7.7 to 7.8, EC 0.39 to 0.44 d Sm^{-1}, organic carbon 0.32% to 0.35% HCL extractable zinc 1.5 ppm. The average maximum and minimum temperature 29.9 °C and 19.7 °C during the experimental periods. The treatment comprised nine combination of concentration of Borax and molybdenum viz. T_0 control (dry seed), T_1 control (water soaked), T_2 seed soaking with boron (0.2%), T_3 seed soaking with molybdenum (0.02%), T_4 foliar spray (water), T_5 foliar spray of boron (0.1%), T_6 foliar spray of molybdenum (0.05%), T_7 seed soaking + foliar spray (0.2% boron at 25 DAS + 0.1% boron at 45 DAS) and T_8 seed soaking + foliar spray (0.02% molybdenum at 25 DAS+ 0.05% molybdenum 45 DAS) with widely accepted of pigeonpea variety UPAS 120 were tried in a randomized block design with three replications. A uniform use of NPK 20:40:40 kg/ha through diammonium phosphate was applied as basal to all treatment plots.

The UPAS-120 variety of pigeon pea 70 kg ha^{-1} was used for sowing. Plant to plant distance was maintained by thinning at 15 to 25 PAS. . Spraying of Boron and molybdenum at different concentrations as per treatment was done on plant foliage twice, i.e. 25 days and 45 days after sowing. The observation were recorded at the time of sampling. Chlorophyll intensity (%) was measured by SPAD 502 meter and RWC (%) was estimated by Barrs and Wealthor (1962) from top to second leaf by weather.

$$\text{Relative water content in leaf (RWC\%)} = \frac{\text{Fresh weight} - \text{Dry weight}}{\text{Turgid weight} - \text{Dry weight}} \times 100$$

Result and Discussion

Growth character's

The data presented in Table-1, revealed that seed priming with boron and molybdenum had non significant impact on plant height but significantly increased leaf water content, leaf chlorophyll intensity and branches per plant compared to control treatment. Similar finding were reported by Moosav *et al.* (2012). Among foliar spray treatments single spray of molybdenum (0.05%) recorded better than single spray of boron (0.1%) at 25 DAS. Seed priming with molybdenum (0.02%) + foliar spray of molybdenum (0.02%) at 25 DAS and one spay of Molybdenum (0.05%) at 45 DAS recorded maximum leaf turgidity (90.8% and 86.7%), leaf chlorophyll intensity (64.30% and 64.10%) and maximum primary branches per plant (10.6 and 11.8) during both years of experimentation as well as secondary branches (26.5 and 31.4). It might be due to molybdenum play, better role in seed germination and plant metabolism compared to boron which increased water content and chlorophyll production in plant body.

Table 1: Effect of treatments on growth attributes of pigeonpea.

Treatments	Plant height (cm)		Leaf relative water content (RWC %)		Leaf Chlorophyll intensity (%)		No. of Primary branches/ plant		No. of other branches	
	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016
T0 - Control (dry Seed)	150.8	160.1	83.0	83.1	55.70	55.81	7.5	8.7	18.7	24.4
T1- Control (water soaked seed)	151.4	160.9	83.3	83.9	61.95	62.02	8.0	8.9	20.3	25.3
T2- Seed soaking 0.2% boron	153.4	161.9	84.2	84.9	62.15	63.10	8.2	9.3	22.1	27.1
T3 - Seed soaking 0.02% molybdenum	154.1	162.0	84.5	84.1	62.45	63.27	9.2	9.7	23.2	27.4
T4- Foliar spray (water)	151.8	161.5	83.4	85.1	62.70	63.00	7.8	9.0	19.5	26.7
T5- Foliar spray of boron (0.1%)	152.8	162.9	83.1	85.3	63.10	63.29	8.1	9.9	21.2	27.9
T6- Foliar spray of molybdenum (0.05%)	155.4	163.0	85.2	85.7	63.30	63.35	9.9	10.3	24.1	28.4
T7- Seed soaking + foliar spray of boron @ 0.2% at 25 DAS + @ 0.1% at 45 DAS)	157.1	163.3	86.1	85.9	64.05	63.91	10.1	10.9	25.8	29.5
T8- Seed soaking + Foliar spray of molybdenum @ 0.02% at 25 DAS and @ 0.05% at 45 DAS	159.8	164.5	90.8	86.7	64.30	64.10	10.6	11.8	26.5	31.4
SE (d) ±	2.99	1.25	0.74	0.65	0.62	0.56	0.47	0.52	0.83	0.89
CD (P=0.05)	NS	NS	1.57	1.38	1.32	1.18	1.00	1.10	1.74	1.88

Yield attributes and yield

The data summarised in Table-2 exhibited that significantly maximum pods per plant was recorded under seed priming + two foliar spray of molybdenum @ 0.02% and 0.05% at 25 DAS and at 45 DAS. The number of pods was increased to the tune of 34.59 per cent and 32.36 percent during 2015 and 2016, respectively compared to control treatment. Similarly by application of molybdenum as seed priming with two foliar spray increased test weight of pigeon pea variety UPAS 120 to the tune of 24.77 percent and 29.96 percent during 2015 and 2016, respectively compared to control treatment.

Application of molybdenum as seed priming with two foliar spray (0.02% and 0.05%) at 25 DAS and at 45 DAS, significantly increased seed yield of pigeon pea to the tune of 30.37 percent and 24.60 percent during 2015 and 2016, respectively, compared to control treatment. Although application of boron as seed priming with two foliar spraying (0.2% and 0.1%) at 25 DAS and at 45 DAS increase seed yield to the tune of 23.57 percent and 24.24 percent during 2015 and 2016, respectively, compared to control treatment. This indicated that molybdenum and boron plays important role in increasing yield attributing characters as well as seed yield of pigeon pea. Several study proved that molybdenum act as structural component of nitrogenase which plays an active role in nitrogen fixation by *Rhizobium*, *Azotobacter* and algae and actinomycetes. It is also involved in the absorption and translocation of iron in plants. Similarly boron is involved in number of metabolic pathways, photoharmones and is necessary in plants to ensure flowering, development of pollen tube, pollen, fruits and seeds. These results are corroborated with the results of to Gay *et al.*, (2015) [1], Ahlawat *et al.*, (2007) [2], Ali and Mishra (2001) [3], Goldbach *et al.* (2001) [4] and Niwas Rao *et al.*, (2008) [5].

Table 2: Effect of treatments on pods/plant, 100 seed weight and seed yield (kg/ha) of pigeonpea variety UPAS-120

Treatments	Pods/plant		100 seed weight (g)		Seed yield (kg ha^{-1})	
	2015	2016	2015	2016	2015	2016
T0 - Control (dry Seed)	159	173	9.00	9.11	1531.00	1650.00
T1- Control (water soaked seed)	175	181	9.41	9.40	1685.00	1740.00
T2- Seed soaking 0.2% boron	181	192	9.82	10.62	1751.00	1792.00
T3 - Seed soaking 0.02% molybdenum	185	199	10.03	10.90	1802.00	1810.00
T4- Foliar spray (water)	170	189	9.64	10.05	1611.00	1705.00
T5- Foliar spray of boron (0.1%)	179	204	10.45	11.01	1858.00	1912.00
T6- Foliar spray of molybdenum (0.05%)	201	208	10.51	11.32	1881.00	1956.00
T7- Seed soaking + foliar spray of boron @ 0.2% at 25 DAS + @ 0.1% at 45 DAS)	209	214	10.92	11.53	1892.00	2005.00
T8- Seed soaking + Foliar spray of molybdenum @ 0.02% at 25 DAS and @ 0.05% at 45 DAS	214	229	11.23	11.84	1996.00	2056.00
SE (d) ±	3.00	3.27	0.32	2.27	380.00	367.00
CD (P=0.05)	6.37	6.86	0.68	0.58	798.00	770.00

Table 3: Effect of micronutrients on gross income, net return and B:C ratio of pigeonpea variety UPAS-120.

Treatments	Gross income (Rs./ha)		Net return (Rs./ha)		B:C Ratio	
	2015	2016	2015	2016	2015	2016
T0 - Control (dry Seed)	75785.00	81675.00	33785.00	39675.00	1.80	1.94
T1- Control (water soaked seed)	83408.00	86130.00	41408.00	44130.00	1.98	2.05
T2- Seed soaking 0.2% boron	86675.00	88704.00	44475.00	46504.00	2.05	2.10
T3 - Seed soaking 0.02% molybdenum	89199.00	89595.00	46999.00	47395.00	2.11	2.12
T4- Foliar spray (water)	79745.00	84398.00	37545.00	42198.00	1.88	1.99
T5- Foliar spray of boron (0.1%)	91971.00	94644.00	48971.00	51644.00	2.13	2.20
T6- Foliar spray of molybdenum (0.05%)	93110.00	96822.00	50110.00	53822.00	2.16	2.25
T7- Seed soaking + foliar spray of boron @ 0.2% at 25 DAS + @ 0.1% at 45 DAS)	93654.00	99248.00	49654.00	55248.00	2.12	2.25
T8- Seed soaking + Foliar spray of molybdenum @ 0.02% at 25 DAS and @ 0.05% at 45 DAS	98802.00	101772.00	54802.00	57772.00	2.24	2.31

Economics

The treatment (T_8) with application of molybdenum as seed priming with foliar spray at 25 and 45 DAS recorded maximum gross income (Rs. 98802.00 ha-1) and Rs. (101772.00 ha-1), net income (Rs. 54802.00 ha-1) and Rs. 57772.00 ha-1) and B:C ratio (1:2.24 and 1:2.31) during 2015 and 2016, respectively, compared to control treatment which recorded minimum gross income (Rs. net income and B:C ratio).

Based on above findings of results it may be concluded that application of molybdenum as seed priming with foliar spray at 25 DAS (0.02%) and at 45 DAS (0.05%) exhibited better growth characters, yield attributes seed yield and economics of pigeon pea followed by application of boron seed priming with foliar spray at 25 at 45 DAS pigeon pea which was inferior that molybdenum but superior to rest treatments.

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