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Nutrient composition and uptake as influenced by boron molybdenum and nickel in blackgram (*Vigna mungo* L. Hepper)

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Abstract
A field experiment was conducted on the Nutrient Composition and Uptake as Influenced by Boron Molybdenum and Nickel in Blackgram (*Vigna mungo* L. Hepper) at Agricultural college farm, Bapatla during *rabi*, 2017-18. It consisted of eight treatments of micronutrient application *viz.*, control (T_1), B (T_2), Mo (T_3), Ni (T_4), B+Mo (T_5), B+Ni (T_6), Mo+Ni (T_7) and B+Mo+Ni (T_8) with randomized block design concept and replicated thrice. The results revealed that combined soil application of boron, molybdenum and nickel as basal in the significantly increased and effected the composition of nutrients and uptake of blackgram. All combination treatments increased the NPK content and uptake in plant and seed to a greater extent than individual application.

Keywords: Blackgram, boron, molybdenum, nickel, NPK content and uptake

Introduction
Pulses are a very important crop for India. They are an important source of protein, grow quickly, generate good profits for farmers, and contribute to agricultural and environmental sustainability. The more farmers produce these crops and the more consumers eat them, the better off we'll all be. This is true everywhere, though it's especially true for my country of India, where the demand for pulses is higher than the supply and the challenge of meeting the demand through smarter farming and better technology is an essential part of national food security. Black gram (*Vigna Mungo* L.), is one of the important pulses crop, grown throughout the country. The crop is resistant to adverse climatic conditions and improves the soil fertility by fixing atmospheric nitrogen in the soil. Improving soil fertility is the most effective practice in increasing agricultural production. Micronutrients are essential elements that are used by plants in small quantities to orchestrate a range of physiological functions. Application of micronutrients increases the yield and quality of agricultural products.

Boron (B) is one of the most important trace elements, which is essential for normal life cycle of the plants. It influences the absorption of nitrogen, phosphorus, potassium. Boron plays a key role in sugar translocation, nodulation, nitrogen fixation, protein synthesis, sucrose synthesis, cell wall composition, membrane stability, K^+ transport, viability of pollen, pollen germination and pollen tube growth and pollination and seed set. Molybdenum has been shown to help in the nodulation, nitrogen fixation, photosynthesis, nitrogen assimilation, concentration of sugars and increase in the ratio of organic phosphorus/inorganic phosphorus. Nickel is an essential micronutrient for plant growth as a constituent of several metallo-enzymes. Boron application has been found to increase the contents of P, K, Na, Ca, Fe, Mn, Zn, Cu and B in cowpea seeds (Hassanein *et al.*, 1999) [5]. Enhanced N content in roots and shoots of pea plant under salinity conditions with boron application was reported by Bonilla *et al.*, (2004) [2].

Materials and Methods
A field experiment was conducted to study the Nutrient Composition and Uptake as Influenced by Boron Molybdenum and Nickel in Blackgram (*Vigna mungo* L. Hepper) at Agricultural College Farm, Bapatla during *Rabi* season of 2017-18. The experiment consisted of 8 treatments *viz.*, T_1- no micronutrient application (control), T_2- Borax @ 2.5 kg ha^{-1}, T_3- Ammonium molybdate @ 1.5 kg ha^{-1}, T_4- Nickel chloride @1 kg ha^{-1}, T_5- Borax @ 2.5 kg and Ammonium molybdate @ 1.5 kg ha^{-1}, T_6- Borax @ 2.5 kg and Nickel chloride @1 kg ha^{-1}, T_7-

Ammonium molybdate @ 1.5 kg and Nickel chloride @1 kg ha^{-1}, T_8- Borax @ 2.5 kg, Ammonium molybdate @ 1.5 kg and Nickel chloride @1 kg ha^{-1} and applied as basal. It was laid in randomized block design and replicated thrice. The soil was neutral in reaction, low in salinity and nitrogen, medium in available phosphorus and organic carbon and very high in potassium. The standard packages of cultural practices were followed throughout crop growth period. The data on nutrient content and uptake i.e Nitrogen in the plant material was determined by microkjeldahl distillation method as described by Bremner (1965) [3]. Phosphorous in the plant material was determined by vanadomolybdo phosphoric acid yellow colour method of Koening and Johnson (1942) described by Jackson (1967) [6]. Potassium was determined by direct feeding of the extract to the flame photometer after adjusting the instrument with suitable standards as per Jackson (1967) [6] the data were computed and analyzed as per the statistical procedures given by Panse and Sukhatme (1985) [8].

Results and Discussion

N, P, K content (%) and uptake (mg plant^{-1}) at flowering stage

Micronutrients B, Mo and Ni application significantly affected the content and uptake of N, P and K in blackgram at flowering stage. (Table 1) N content was noted significantly high in B+Mo+Ni application, which showed parity with B+Mo and B+Ni application. It was noted low in control, which showed parity with B, Mo and Mo+Ni applications. The uptake of N increased in all treatments over control, it was paramount in B+Mo+Ni treated plants, which showed no remarkable difference with other combination treatments and small in control. Within treatments T_2 to T_4, higher value for N uptake was noted in Ni treated plants, but it was on par with T_2 and T_3. The effect of B and Ni application alone on P content didn't vary with control, which showed the lowest. It was paramount in B+Mo+Ni treated plants. The treatments T_3, T_5, T_6 and T_7 resulted in P content on par with each other, greater than control and less than T_8. The uptake of P was found high in B+Mo+Ni treated plants and low in control. Next to T_8, higher uptake was noticed in other three combination treatments, which were on par with each other. P uptake in individual treatments was less than that in combination treatments and all were found on par.

Control treatment recorded the lowest K content and on par with that in boron and nickel treated plants. Where as in other treatments it was remarkable, higher over control and all were on par with each other. K uptake was significantly higher in B+Mo+Ni and B+Mo treated plants and lower in control. The next higher uptake of K was noted in Mo+Ni treated plants followed by B+Ni, which was on par with that in Mo and Ni treated plants, which in turn were found on par with B treated plants.

In summery these results envisaged that B+Mo and Ni application increases the content and uptake of N, P and K in blackgram. Boron alone didn't show the effect on N, P, K content. Mo alone caused increase in P and K content, while Ni alone caused increase only in N content. All combination treatments were on par in increasing in N and K content, while B+Mo+Ni application showed increase in P content to a greater degree than other three combinations. All combination treatments influenced the N uptake similarly, but in case of P uptake greater impact was noted in B+Mo+Ni treated plants and in K uptake, greater impact was noted in B + Mo+ Ni and B + Mo treated plants. These results were concurrence with findings of Hassanein *et al*. (1999) [5], Awomi *et al.* (2012) [1] and Golakiya and Patel (1986) [4] who reported that B and Mo influenced in the nutrient content and uptake of plant.

Table 1: Effect of micronutrients (B, Mo & Ni) on Nutrient content (%) and uptake (mg plant $^{-1}$) in Blackgram at flowering stage

Treatments	Nutrient content and uptake					
	N content (%)	N uptake (mg plant^{-1})	P content (%)	P Uptake (mg plant^{-1})	K content (%)	K Uptake (mg plant^{-1})
T1: Control	2.83	99.0	0.26	9.2	1.57	55.6
T2: Borax @ 2.5 Kg ha^{-1}	3.10	158.7	0.28	14.4	1.65	85.3
T3: Ammonium molybdate @ 1.5Kg ha^{-1}	3.06	161.7	0.31	16.2	1.80	96.5
T4: Ni $Cl_2.6H_2O$ @1.0 Kg ha^{-1}	3.24	172.5	0.29	15.6	1.75	93.8
T5: Borax @ 2.5&Ammonium molybdate @ 1.5 Kg ha^{-1}	3.30	228.7	0.32	22.1	1.85	128.2
T6: Borax @ 2.5 & Ni $Cl_2.6H_2O$ @1.0 Kg ha^{-1}	3.29	217.2	0.30	19.8	1.80	119.2
T7: Ammonium molybdate @ 1.5 & Ni $Cl_2.6H_2O$ @1.0 Kg ha^{-1}	3.20	219.8	0.33	22.8	1.84	127.8
T8: Borax @ 2.5 & Ammonium molybdate @ 1.5 & Ni $Cl_2.6H_2O$ @1.0 Kg ha^{-1}.	3.47	252.0	0.37	37.2	1.85	187.5
SE (m)±	0.13	4.91	0.01	1.4	0.07	8.6
CD (0.05)	0.38	14.9	0.04	4.2	0.23	2.63
CV (%)	6.83	12.0	8.25	11.95	7.36	13.28

Nutrient content (%) and uptake (mg plant^{-1}) at harvesting stage

Micronutrients B, Mo and Ni application significantly increased the content and uptake of N, P and K in blackgram at harvesting stage. (Table 2) N content observed in all treatment was found on par with one another. The uptake of N was significantly increased in all treatments over control. It was higher in B+Mo+Ni applied plants and the lower value was observed in control. The next higher value was noted in T_5 treatment (B+Mo) which showed parity with T_7 (Mo+Ni) and T_6 (B+Ni). In alone applications the higher N uptake was noted in T_3 treatment (Mo) and this showed parity with T_2 (B) and T_4 (Ni). The effect of B, Mo and Ni application alone and in combination on P content didn't show variation with control. The uptake of P also was found significantly higher in B+Mo+Ni treated plants and low in control. Next to T_8, the higher uptake was showed by T_5 treatment (B+Mo) and which showed purity with T_7 (Mo+Ni) and T_6 (B+Ni). Among alone applications the higher uptake was noted in T_3 (Mo) and this showed parity with T_2 (B) and T_4 (Ni) applied plants.

Control treatment recorded the lower K content and showed parity with T_3(Mo) and T_4(Ni) and the higher K content was observed in treatment applied combinedly with B+Mo+Ni (T_8), which showed parity with T_5(B+Mo), T_7(Mo+Ni) and T_6(B+Ni). The next higher value was found in T_2 (B alone application). The K uptake significantly higher in T_8 (B+Mo+Ni application) and lower in control. After T_8, the next higher value was in T_5 (B+Mo) which showed parity

with T_7 (Mo+Ni) and T_6 (B+Ni). With in alone applications Mo (T_3) showed higher K uptake and found on par with T_2 (B) and T_4 (Ni) treatments.

In summary, these results confirmed that B, Mo and Ni application increased the content and uptake of N, P and K in blackgram. At maturity B, Mo and Ni didn't show difference with control in N and P content, while B alone showed increase in K content over control and combination of three micronutrients didn't show variation in content of N and P compared to control but increased the K content. The three micronutrients combinedly and individually increased the uptake of N, P and K over control. Combination treatments showed more uptake of N, P and K than alone applications.

Table 2: Effect of micronutrients (B, Mo & Ni) on Nutrient content (%) and uptake (mg plant^{-1}) in Blackgram at harvest stage in plant

Treatments	Nutrient content and uptake					
	N content (%)	N uptake (mg plant^{-1})	P content (%)	P Uptake (mg plant^{-1})	K content (%)	K Uptake (mg plant^{-1})
T1: Control	1.50	210.9	0.14	19.1	1.33	187.9
T2: Borax @ 2.5 Kg ha^{-1}	1.62	276.3	0.15	25.4	1.48	251.5
T3: Ammonium molybdate @ 1.5Kg ha^{-1}	1.58	282.7	0.15	26.6	1.44	258.0
T4: Ni $Cl_2.6H_2O$ @1.0 Kg ha^{-1}	1.55	252.3	0.15	23.7	1.43	232.5
T5: Borax @ 2.5&Ammonium molybdate @ 1.5 Kg ha^{-1}	1.72	340.1	0.17	33.6	1.60	317.5
T6: Borax @ 2.5 & Ni $Cl_2.6H_2O$ @1.0 Kg ha^{-1}	1.68	312.7	0.17	31.2	1.55	288.9
T7: Ammonium molybdate @ 1.5 & Ni $Cl_2.6H_2O$ @1.0 Kg ha^{-1}	1.68	328.7	0.17	32.7	1.55	303.3
T8: Borax @ 2.5 & Ammonium molybdate @ 1.5 & Ni $Cl_2.6H_2O$ @1.0 Kg ha^{-1}.	1.74	387.6	0.17	38.4	1.65	368.5
SE (m)±	0.05	4.2	0.01	0.97	0.04	11.6
CD (0.05)	0.26	12.07	0.04	2.95	0.11	35.5
CV (%)	5.59	7.61	4.20	5.84	4.21	7.27

Nutrient content (%) and uptake (mg plant^{-1}) In Seed

Micronutients B, Mo and Ni application significantly affected the contents and uptake of N, P and K in seed of blackgram. Table 3 N contents was noted significantly high in the treatment applied with B+Mo+Ni, which showed parity with T_5 (B+Mo), T_6 (B+Ni) and T_7 (Mo+Ni). The next higher N content was noted inT_3 (Mo), which showed parity with T_2 (B). The lower N content was showed by control which was on par with T_4 (Ni). The uptake of N increased in all treatments. The significantly highest uptake was noted in T_8 (B+Mo+Ni) and the next higher value was noted in T_5 (B+Mo) followed by T_7 (Mo+Ni) and T_6 (B+Mo). Within individual applications T_3 (Mo) recorded more N uptake, which showed parity with T_2 (B) and followed by T_4 (Ni). The lower uptake of N was noted in control.

P content was noticed low in control which showed parity with T_4 (Ni) and high P content was noticed in T_8 (B+Mo+Ni) which showed parity with other combination treatments T_5 and T_6 (B+Ni), which intern found on par with T_7 (Mo+Ni). Alone application of B and Mo showed increased P contents than control and they were on par with each other. The uptake of P also was found significantly higher in T_8 (B+Mo+Ni) and lower in control. The next higher value was noticed in T_5 (B+Mo) followed by T_7 (Mo+Ni), which showed parity with T_6 (B+Ni). The next higher value was noticed in T_3 (Mo), which showed parity with T_2 and superior to T_4 (Ni).

The K content in seed was noticed low in control and T_4 (Ni). The higher P content was observed in T_8 (B+Mo), T_7 (Mo+Ni), T_6 (B+Ni) and T_2 (B). The next higher value was noticed in T_3 (Mo). The uptake of K was significantly high in T_8 treatment (B+Mo+Ni combinations) and the next higher K uptake was observed in T_5 (B+Mo) and in the order were T_6 and T_7, both were on par. Alone application of Mo (T_3) showed K uptake on parity with T_2 (B) and higher than T_4 (Ni). Control showed lower value than all treatments. Finally, these investigations concluded that B, Mo and Ni application alone and in combination increased the N, P and K contents in seed. Combination treatments resulted in more N, P and K than alone application. Except Ni, all micronutrients increased the N, P, K content, found high in combination of three nutrients followed by B+Mo. All treatments showed increase in NPK uptake of seed.

Table 3: Effect of micronutrients (B, Mo & Ni) on Nutrient content (%) and uptake (mg plant $^{-1}$) in seeds of Blackgram.

Treatments	Nutrient content and uptake in seeds					
	N content (%)	N uptake (mg plant^{-1})	P content (%)	P Uptake (mg plant^{-1})	K content (%)	K Uptake (mg plant^{-1})
T1: Control	2.35	475.4	0.41	82.6	0.55	112.1
T2: Borax @ 2.5 Kg ha^{-1}	2.81	672.7	0.47	111.8	0.75	178.7
T3: Ammonium molybdate @ 1.5Kg ha^{-1}	2.82	725.2	0.47	122.1	0.71	183.7
T4: Ni $Cl_2.6H_2O$ @1.0 Kg ha^{-1}	2.55	593.6	0.44	102.4	0.61	142.0
T5: Borax @ 2.5&Ammonium molybdate @ 1.5 Kg ha^{-1}	3.73	1066.7	0.55	156.3	0.79	226.9
T6: Borax @ 2.5 & Ni $Cl_2.6H_2O$ @1.0 Kg ha^{-1}	3.75	991.9	0.53	139.6	0.79	208.0
T7: Ammonium molybdate @ 1.5 & Ni $Cl_2.6H_2O$ @1.0 Kg ha^{-1}	3.68	991.9	0.52	140.0	0.76	203.7
T8: Borax @ 2.5 & Ammonium molybdate @ 1.5 ^{1} & Ni $Cl_2.6H_2O$ @1.0 Kg ha^{-1}.	3.86	1188.8	0.56	171.5	0.83	254.3
SE (m)±	0.09	22.6	0.01	3.5	0.03	5.9
CD (0.05)	0.28	69.3	0.04	10.6	0.08	18.0
CV (%)	4.94	4.67	4.20	4.68	6.24	5.40

Conclusions

From the present study it can be informed that, individual application of B, Mo and Ni at flowering stage, B alone didn't show the effect on N, P, K content in plant. Mo alone increased the P and K content, while Ni alone increased only the N content. At maturity no change over control was observed in N and P content, while B showed increase in K content. All combination treatments increased the N and K content on a par, while B+Mo+Ni showed greater increase in P content over others at flowering stage. Where as at maturity, T_5 to T_8 increased the K content only. The increase in uptake of NPK was high in combination treatments at both stages. P uptake was high in T_8 and of K was high in T_8 and T_5 at flowering stage. Except Ni, all micronutrients increased the NPK content in seed, found high in T_8 and T_5, while NPK uptake in seed increased with all treatments.

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