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Effect of micro-nutrients on morpho-physiological, biochemical parameters and yield in black gram (*Vigna mungo* L.)

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Abstract
The present investigation was carried out to study the effect of micro-nutrients on morpho-physiological, biochemical parameters and yield in black gram (*Vigna mungo* L.) *var*. GU-1 in completely randomized block design (CRBD) with four replications. The treatments consist of control (T_1), multi-micronutrient mixture (MN) grade-1 general (foliar spray) (T_2), MN mixture grade-2 for Zn deficiency (foliar spray) (T_3), MN mixture grade-3 for Fe deficiency (foliar spray) (T_4), MN mixture grade-4 for Fe and Zn deficiency (foliar spray) (T_5), MN mixture grade-5 general (soil application) (T_6) and micronutrient application as per soil test value (STV) (T_7). The study revealed that significant improvement observed in morpho-physiological traits, biochemical constituents and thereby yield due to the application of micronutrients. Among the different treatments, multi-micronutrient mixture (MN) grade-4 (T_5) treatment significantly improved the morpho-physiological parameters and thereby yield in black gram followed by the MN grade-2 (T_3) and MN grade-3 (T_4) as compared to control.

Keywords: black gram**,** multi-micronutrient mixture**,** Fe, Zn, morpho-physiological parameters

Introduction
Among the pulses black gram is the third important pulse crop in India after chickpea and pigeon pea. It occupies a unique place for its use as seed and in human diet. It belongs to the genus *Vigna* under the family Leguminosae. It is an annual pulse crop and native to central Asia. Black gram is grown mainly during *kharif* season.

Black gram is a rich protein food. It contains about 26% protein. This is almost three times that of cereals. It is also rich in vitamin A, B_1 and B_3. The chemical composition is crude protein 26.2 %, fat 1.2 %, carbohydrate 56.6 %, Ca 185 mg/100g, Fe 8.7 mg/100g, P 345 mg/100g and vitamins. Black gram also has medicinal properties, like curing diabetes, sexual dysfunction, nervous disorder, hair disorders, digestive system disorders and rheumatic afflictions. It is valued for its high digestibility and freedom from flatulence effect. It plays an important role in sustaining soil fertility by improving soil physical properties and fixing atmospheric nitrogen. Urd bean is a short duration, low input requiring crop that adds atmospheric N which is subsequently beneficial to succeeding crops.

In spite of significant importance of this crop, the yield is very low in India as well as in Gujarat probably due to its cultivation as it is mainly confined to the marginal and sub-marginal land under rainfed conditions. The major constraints for low yield of black gram are lack of micronutrient availability, high yielding and disease resistant varieties, proper plant protection measures and non-adoption of proper agronomic practices. Because of the short duration and adjustability under different cropping systems or situations, black gram has enormous potential in future which needs to be capitalized. Hence, it is imperative to increase the production per unit area per time to meet the requirement of ever increasing population of our country.

Soils are mostly deficient in micronutrients. The essential micronutrients for field crops are Fe, Zn, B, Cu, Mn, and Mo. Analysis of soil and plant samples has indicated that 49% of soils in India are potentially deficient in Zn, 12% in Fe, 5% in Mn, 3% in copper (Cu), 33% in boron (B) and 11% in molybdenum (Mo) (Singh *et al.*, 2008) [15]. The incidence of micronutrient deficiencies in crops has increased markedly in recent years due to intensive cropping, loss of top soil by erosion, losses of micronutrients through leaching, liming of acid soils, decreased proportions of farmyard manure compared to chemical fertilizers, increased purity of chemical

fertilizers and use of marginal lands for crop production. Therefore an optimum supply of micronutrients under balanced condition is very important for achieving higher productivity.

Among the various micronutrients, zinc has assumed greater significance due to wide occurrence of its deficiency in different agro-climatic regions of the country and spectacular response of field and fruit crops to its application. Poor productivity in black gram is also attributed to poor photosynthetic efficiency and lack of partitioning of photosynthates to pods for seed setting. Among the micronutrients; Fe, Zn and B improved the yield appreciably through foliar spray and soil application proved to be economical in different pulses. Foliar application of micronutrients may be 6 to 20 times more efficient than soil application, depending on soil type. Foliar application is credited with the advantage of quick and efficient utilization of nutrients, elimination of losses through leaching and fixation and regulating the uptake of nutrient by plants. Foliar spray is a short term approach not only for improving yield in deficient soils but also to achieve nutritional efficacy. Foliar application of nutrients using water soluble fertilizers is one of the possible ways to enhance the productivity of pulses like green gram and black gram. Foliar application of Zn at flowering stage improves plant's performance, yield and yield attributes of black gram.

Considering the constraints in the production potential of black gram it is worthwhile to study the influence of different micro nutrient treatments on the production potential of black gram. It is also of utmost importance to understand the physiological basis of yield variation due to micro nutrients.

Materials & Methods

The present investigation entitled effect of micro-nutrients on morpho-physiological, biochemical parameters and yield in black gram (*Vigna mungo* L.) *var.* GU-1 was carried out during 2016-17 at Department of Plant Physiology, B. A. College of Agriculture, Anand Agricultural University, Anand. The experiment was laid out in completely randomized block design (CRBD) with four replications to know the effect of micronutrients on various morpho-physiological, biochemical and yield components. The treatments consist of control (T_1), multi-micronutrient mixture (MN) grade-1 general (foliar spray) (T_2), MN mixture grade-2 for Zn deficiency (foliar spray) (T_3), MN mixture grade-3 for Fe deficiency (foliar spray) (T_4), MN mixture grade-4 for Fe and Zn deficiency (foliar spray) (T_5), MN mixture grade-5 general (soil application) (T_6) and micronutrient application as per soil test value (STV) (T_7).

The foliar spray @1% of mixture in each treatment was done at 30, 45 and 60 DAS. The multi-micronutrient mixture grade-5 (T_6) applied as soil application once before sowing as per recommendation @ 20 kg/ha. The treatment T_7 applied as soil test value once before sowing as per recommendation Fe @15 kg/ha and Zn @ 8 kg/ha.

Table 1: Contents of micronutrients in multi-micronutrient mixture

Sr. No.	Grade	Content (%)				
		Fe	Mn	Zn	Cu	B
1	MN Grade-1 (General)	2	0.5	4.0	0.3	0.5
2	MN Grade-2 (For Zn deficiency)	2	0.5	8.0	0.3	0.5
3	MN Grade-3 (For Fe deficiency)	6	1.0	4.0	0.3	0.5
4	MN Grade-4 (For Fe & Zn deificiency)	4	1.0	6.0	0.5	0.5
5	MN Grade-5 (Soil application)	2	0.5	5.0	0.2	0.2

The treatment plots were harvested at physiological maturity. Five plants from each plot were uprooted and collected for recording the observations of morpho-physiological characters. Pods from rest of plants from each net plot were collected and were processed for seeds. The seed yield was calculated both on plant basis and hectare basis.

Observation were recorded for plant height(cm), number of leaves, leaf area (cm^2), leaf area index, total dry weight (g), chlorophyll content (SPAD values), seed protein content (%), yield per plant (g), yield per hectare (q), harvest index (%). The data were statistically analyzed using ANOVA.

Results & Discussion

Morpho-physiological parameters

The effect of various multi-micronutrient mixture treatments at harvest was studied in black gram *var.* GU-1 under field condition. The result revealed in table 2, that all morpho-physiological, biochemical and yield parameters were significant in different treatments, indicating positive influence on these parameters.

Multi-micronutrient mixture (MN) grade-4 (T_5) recorded significantly the highest plant height (53.17 cm). However, it was remained at par with treatments MN grade-2 (T_3) (50.13 cm) and MN grade-3 (T_4) (48.41cm). Whereas, the treatment absolute control (T_1) recorded significantly the lowest plant height (42.44 cm). This may be due to adequate amount of micronutrient zinc activate plant enzymes which are involved in carbohydrate metabolism and also require for the synthesis of growth hormone auxin leading to cell enlargement and increase in normal cell division. These findings were in accordance with the work of Ibrahim *et al.* (2007)[7] in bean and Yadav *et al.* (2009) [20] in sesamum.

The effect of MN grade-4 (T_5) recorded significantly the highest number of leaves (23.01), leaf area (LA) (474 cm^2) and leaf area index (LAI) (1.578). The increased LA by MN grade-4 (T_5) might be due to increase in cell division, cell enlargement as well as induce more extensive and denser network of veins and ribs and there by increased foliar leaf area. In the present study LA and LAI decreased towards maturity might be due to increased senescence at the time of harvesting. Similar findings are reported by Gupta and Vyas (1994) [5] in soybean, Puste and Jana (1988) [12] in pigeonpea and Govindan and Thirumurugan (2000) [4] in green gram.

The perusal of data revealed that MN grade-4 (T_5) recorded significantly the highest total dry matter (TDM) (39.177 g) and remained at par with T_3 (35.877 g). The increase in TDM towards maturity may be due to indeterminate growth pattern, higher rate of CO_2 fixation and RuBP carboxylase activity during crop growth. These results are conformity with the finding of Govindan and Thirumurugan (2000)[4] in green gram, Bahure *et al.* (2016) [1] in soybean, Salwa *et al.* (2010) [13] in sesamum.

Table 2: Influence of micronutrients on morpho-physiological, biochemical and yield characters at harvest in black gram variety GU-1

Treatments	Height (cm)	Total dry wt. (g pl^{-1})	No. of leaves $plant^{-1}$	Leaf area (cm pl^{-1})	Leaf area index	Seed Yield pl^{-1} (g)	Seed Yield ha^{-1} (q)	Harvest index (%)	Seed protein content (%)	Chlorophyll content (SPAD)
T_1 : Control	42.44	27.07	17.97	315	1.048	8.80	8.10	23.23	21.8	10.04
T_2 : MN mixture grade-1 general (foliar spray)	47.33	32.52	20.17	391	1.302	11.82	9.46	26.33	24.4	11.77
T_3 : MN mixture grade-2 for Zn deficiency (foliar spray)	50.13	35.88	21.44	445	1.484	13.00	10.36	27.18	25.2	12.83
T_4 : MN mixture grade-3 for Fe deficiency (foliar spray)	48.41	32.99	20.81	425	1.417	12.50	10.06	26.88	24.7	12.33
T_5 : MN mixture grade-4 for Fe and Zn deficiency (foliar spray)	53.17	39.18	23.01	474	1.578	14.25	11.31	28.18	25.7	13.43
T_6 : MN mixture grade-5 general (soil application)	46.79	31.71	19.78	370	1.233	10.28	9.11	24.22	24.1	11.32
T_7 : Micronutrient application as per soil test value (STV)	44.35	29.55	19.19	347	1.190	9.70	8.72	24.00	23.4	10.98
S.Em. ±	1.63	1.14	0.59	20.27	0.068	0.72	0.40	0.69	0.64	0.43
C.D. @ 5%	4.85	3.38	1.77	60	0.201	2.14	1.17	2.05	1.88	1.28
C.V. %	6.88	7.03	5.87	10.27	10.23	12.60	8.27	5.38	5.26	7.30

Biochemical parameters

The MN grade-4 (T_5) recorded higher chlorophyll (13.43) and protein (25.7%) content. Whereas, minimum values were recorded in absolute control. The results obtained from these studies were in accordance with those reported by Gitte *et al.* (2005) [3] in sunflower, Krishnaveni *et al.* (2004) [9] in green gram, Hemantaranjan *et al.* (2000) [6], Zada *et al.* (2001) [21], Bhanavase *et al.* (1994) [2] and Vahedi and Yasari (2012) [18] in soybean.

Yield parameters

Among all the treatments the MN grade-4 (T_5) showed the maximum seed yield (14.25 g $plant^{-1}$), (11.31 q/ha) as compared to control. Grain yield is the manifestation of morpho-physiological, biochemical, biophysical and growth parameters. The beneficial influence of micronutrients might be due to the activation of various enzymes and the efficient utilization of applied nutrients resulting in increased yield components. The results obtained from this study were in accordance with those reported by Sritharan *et al.* (2005) [16] in black gram, Varma *et al*. (2004) [19] in pigeonpea, Selim (1992) [14] in soybean, Tripathy *et al.* (1999) [17] in groundnut, Patel *et al.* (2009) [11] in cowpea.

The treatment MN grade-4 (T_5) recorded higher harvest index (28.18) and remained at par with MN grade-1 (T_2), MN grade-2 (T_3) and MN grade-3 (T_4). These results are conformity with finding of Kobraee *et al*. (2011) [8], Mostafavi (2012) [10], Bahure *et al*. (2016) [1] in soybean. The increased harvest index could probably be due to beneficial effects of micronutrients treatments which helps in enhancement of photosynthesis and influencing plant growth and development. The increase in the vegetative characters may be due to enhanced cell division and quick cell multiplication, while the higher yield may be due to better carbon assimilation, better accumulation of carbohydrates and reduced respiration in plants.

Conclusion

Based on the above findings, it is inferred that the yield potential in black gram can be improved by using multi-micronutrient mixtures. The results also indicated a significant improvement in morpho-physiological traits, biochemical constituents and thereby yield due to the application of micronutrients. Among the different treatments, multi-micronutrient mixture (MN) grade-4 (T_5) treatment significantly improved the morpho-physiological parameters and thereby yield in black gram followed by the MN grade-2 (T_3) and MN grade-3 (T_4) as compared to control.

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