RESEARCH ARTICLE

EFFECT OF MICRONUTRIENT APPLICATION ON GROWTH, YIELD ATTRIBUTES, GRAIN AND BIOLOGICAL YIELD OF URDBEAN (*VIGNA MUNGO* L.)

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Abstract: A field experiment was conducted during the summer 2019 at Crop Research Centre of S.V.P. University of Agriculture and Technology, Meerut (U.P.) to study the effect of micronutrient application on growth, yield attributes, grain and biological yield of Urdbean (*Vigna mungo* L.). The soil of the experimental field was well drained, sandy loam in texture, low in organic carbon and available nitrogen, medium in available phosphorus, potassium, sulphur and slightly alkaline in reaction. The nine treatments of nutrient management *viz*., Control**,**foliar spray of water at 20 & 40 DAS, foliar spray of zinc sulphate (0.5%) at 20 & 40 DAS, foliar spray of ferrous sulphate (0.5%) at 20 & 40 DAS, foliar spray of copper sulphate (0.1%) at 20 & 40 DAS, foliar spray of zinc sulphate (0.5%)+ ferrous sulphate (0.5%) at 20 & 40 DAS, foliar spray of zinc sulphate (0.5%)+ copper sulphate (0.1%) at 20 & 40DAS, foliar application of ferrous sulphate (0.5%) + copper sulphate (0.1%) at 20 & 40 DAS and foliar application of zinc sulphate (0.5%) + ferrous sulphate (0.5%) + copper sulphate (0.1%) at 20 & 40 DAS were laid out in RBD with three replications. Urd variety PU-31 was sown on March 18 and harvested on June 16, 2019. Results revealed that growth parameters *viz.* plant height, number of branches/plant, number of trifoliate leaves/plant, dry matter accumulation/plant, and leaf area index were significantly higher under foliar application of zinc sulphate (0.5%) + ferrous sulphate (0.5%) + copper sulphate (0.1%) at 20 & 40 DASwhich was significantly superior over rest of the treatment at all the stages of crop growth. Similarly, yield components *viz*, pod length (cm), number of pod/plant, number of grains/pod, and 1000 grain weight was found significantly higher with foliar application of zinc sulphate (0.5%) + ferrous sulphate (0.5%) + copper sulphate (0.1%) at 20 & 40 DAS which was significantly superior over rest of the treatment. The study also revealed that grain, straw and biological yield were recorded significantly higher in the treatment with foliar application of zinc sulphate (0.5%) + ferrous sulphate (0.5%) + copper sulphate (0.1%) at 20 & 40 DAS which was significantly higher than rest of the treatments.

Keywords: Biological yield, Growth, Micronutrient, Urdbean

INTRODUCTION

Urdbean (*Vigna mungo* L.) is a widely grown annual pulse crop belongs to family fabaceae. It is extensively grown under varying climatic conditions and soil types in India. It is also cultivated in many tropical and sub-tropical countries of Asia, Africa and Central America, although, India, Pakistan, Bangladesh, Burma and Sri Lanka are the principal countries contributing to the world production. India is the world largest producer as well as consumer of urd bean. It is 3rd most important pulse crop of the country after chickpea and pigeon pea. In India, crop is grown in an area of about 5.03 m ha and production is about 3.28 m t with the average productivity of 652 kg/ha (DES,GOI, 2017). The urdbean is mainly grown in the states of Madhya Pradesh, Uttar Pradesh, Rajasthan, Bihar, Punjab, Maharashtra, West Bengal and Tamil Nadu. It is mostly grown as a rainfed during *Kharif* and as irrigated crop in *summer* in Northern India and in winter in Peninsular and Southern India. Its seed contain 25-26% protein, 60% carbohydrate, 1.5% fat, and considerable amount of minerals, amino acids and vitamins and thereby important for food and nutritional security point of view. It is also capable of maintaining and restoring soil fertility through biological nitrogen fixation (BNF). It's also improves physical, chemical and biological properties of soil. Nutrients play an important role in determining the yield potential in pulses. Yield potential of urd bean is also very low due to the fact that, the crop is mainly grown in rainfed conditions with poor management practices and also due to various physiological, biochemical as well as inherent factors associated with crop. Its productivity may be improved through the application of macro and micronutrients by improving the physiological efficiency of plants which could offer sufficient positive role in increasing the crop yield.

Balanced fertilization is necessary to increase the productivity of Urdbean. Regular and judicious use of fertilizer not only helps in raising good crop yield but also help farmer to gain consistent profit. But even today, the large number of farmers are not applying recommended dose of fertilizer to this crop. As a consequence of technological innovation, farmers have realized the importance of nitrogen but still do not use phosphorus, secondary elements and organic manures. The optimum doses of nutrient for different crops were determined decades ago but the fertility status, crop varieties and their inputs have

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under gone a considerable change, so there is a need to give a fresh look to fertilizer requirement of crops in general and as specifically to Urdbean. Foliar application is credited with the advantage of quick and efficient utilization of nutrients, minimizing/elimination of losses through leaching and fixation and thereby helps in regulating the uptake of nutrient by plants (Manonmani and Srimathi, 2009). Fertilizer applied to the soil at the time of sowing is not fully available to the plants as the crop approaches maturity. Among the micronutrients, iron plays an important role by involving electron transport, redox reactions and functions as cofactors. Iron is a constituent of nitrogenase the enzyme essential for N_2 fixation by rhizobia and other microorganisms. Iron deficiency in plants occurs mostly in calcareous and alkaline soils. Zinc plays a significant role in various enzymatic and physiological activities of the plant body. Zinc catalyses the process of oxidation in plant cells and plays a vital role in transformation of carbohydrates, regulates the consumption of sugar, increases the source of energy for the production of chlorophyll, adds in the formation of auxins and promotes absorption of water. Copper is also one of the essential micronutrients for plant growth. It is involved in numerous physiological functions as a component of several enzymes, mainly those which participate in electron flow, catalyze redox reactions in mitochondria and chloroplasts (Harrison *et al*., 1999; Hansch and Mendel, 2009). However, in excessive quantities copper becomes toxic as it interferes with photosynthetic and respiratory processes, protein synthesis and development of plant organelles (Agarwal *et al*., 1995).

In U.P, low yield level is due to the fact that the crops are generally grown under poor management condition without proper application of nutrients, irrigation and plant protection measures, where these factors are reported to greatly affect yield and quality of Urdbean. The Farmers need awareness, proper knowledge and skills in production technology as they have better perception of the use of micronutrient in crop production is gaining importance now a days in almost all crops. Keeping in view the above facts and realizing the low yield of pulses due to improper nutrient management, the present experiment entitled “Effect of micronutrient application on growth, yield attributes, grain and biological yield of Urdbean (*Vigna mungo* L.)”is planned with the objectives to study the effect of micronutrient (especially Zn, Fe, and Cu) application on growth parameters, yield attributed and yield of Urdbean.

MATERIALS AND METHODS

The proposed study was at the Crop Research Centre, S.V.P. University of Agriculture and Technology, Meerut (U.P) to study the effect of micronutrient application on growth, yield attributes and yield of Urdbean (*Vigna mungo* L.). The experiment was laid out in randomized complete block design (RCBD) with treatments T_1 Control (No spray), T_2 Foliar spray of water at 20 & 40 DAS, T_3 Foliar spray of Zinc sulphate (0.5%) at 20 & 40 DAS, T_4 Foliar spray of Ferrous sulphate (0.5%) at 20 & 40 DAS, T_5 Foliar spray of Copper sulphate (0.1%) at 20 & 40 DAS, T_6 Foliar spray of Zinc sulphate (0.5%) + Ferrous sulphate (0.5%) at 20 & 40 DAS, T_7 Foliar spray of Zinc sulphate (0.5%) + Copper sulphate (0.1%) at 20 & 40 DAS, T_8 Foliar application of Ferrous sulphate (0.5%) + Copper sulphate (0.1%) at 20 & 40 DAS, and T_9 Foliar application of Zinc sulphate (0.5%) + Ferrous sulphate (0.5%) + Copper sulphate (0.1%) at 20 & 40 DAS and replicated three times with net plot size 4.0 m x 3.0 m. The variety PU-31 was sown and harvested respectively on March 18 and June 16, 2019.

The soil of the experimental field was well drained, sandy loam in texture, low in organic carbon and available nitrogen, medium in available phosphorus, potassium and slightly alkaline in reaction. Certified seed of PU-31 variety of urdbean was procured from local market and sown @ 25 kg ha^{-1} on 18.03.2019 with a row to row distance 30 cm and plant to plant distance 10 cm, dose of fertilizer was applied at the rate of 20:50:0 kg/ha using DAP. Plant population was maintained by thinning after the emergence count. All other practises were kept normal and uniform for all the treatments. Weeds were controlled in the field through hand weeding. Irrigations were applied at critical stages and crop was harvested when 80 to 90 percent pods were ripened. After sun drying threshing was done.

RESULTS AND DISCUSSION

In urd bean, various yield attributing characters were significantly influenced by foliar application of nutrients. Yield attributes are building up on the basis laid down by growth parameters and the sum total of yield attributes are ultimately reflected in the form of yield. The maximum plant height, number of branches/plant, number of trifoliate leaves/plant, dry matter accumulation/plant andleaf area indexwere observed infoliar sprayof Zinc sulphate (0.5%) +Ferrous sulphate (0.5%) + Copper sulphate (0.1%)at 20 & 40 DAStreatment which was significantly higher than rest of the treatments. The application of zinc, iron and copper showed significantly higher plant height (Table 4.1) than control and foliar spray of water treatments at all the stages of crop growth.

The highest number of branches (Table- 4.2) were observed with foliar application of zinc sulphate (0.5%) + ferrous sulphate (0.5%) + copper sulphate (0.1%) at 20 & 40 DAS which was significantly higher than rest of the treatments and the lowest in control. Higher number of branches per plant could be possibly due to increased number of nodes and better development of plant under enhanced availability of micronutrients which could encourage the carbohydrate synthesis in urd bean applied in foliar form. Similarly, highest number of trifoliate leaves **(**Table 4.3**)** wereobserved with foliar application of zinc sulphate (0.5%) + ferrous sulphate (0.5%) + copper sulphate (0.1%) at 20 & 40 DAS which was significantly higher than rest of the treatments and lowest in control at all the growth stages of crop.The increase in number of trifoliate leaves with foliar application of micro nutrients may be ascribed due to sufficient availability of zinc, iron and copper to plant which enhanced catalytic or stimulatory effect on most of the physiological and metabolic processes of plant.

The maximum leaf area index (Table 4.4) was recorded with foliar application of zinc sulphate (0.5%) + ferrous sulphate (0.5%) + copper sulphate (0.1%) at 20 & 40 DAS which was significantly superior to rest of the treatments and was lowest in control.The maximum leaf area at peak flowering contributes to better yielding ability in grain legumes is a pre-requisite to determine the photosynthetic activity.It may be attributed to the favorable influence of iron and other nutrients on the metabolism, biological activity and stimulatory effect on chlorophyll pigments and enzymatic activity which in turn increased vegetative growth of plants resulting in higher value of growth attributes.The significantly higher dry matter accumulation (Table 4.5) was measured with foliar application of zinc sulphate (0.5%) + ferrous sulphate (0.5%) + copper sulphate (0.1%) at 20 & 40 DAS while minimum dry matter accumulation was recorded in control plots at all the stages of crop growth. Dry matter accumulation is the sum of overall growth of the plant like plant height, number of branches and leaf area which indicate higher chlorophilic area with improved photosynthetic efficiency which in turn resulted into higher dry matter accumulation. Similar findings were also given by Kannan *et al.* (2014) and Malik *et al.* (2015).

Yield attributes *viz.* pod length (cm), number of pod/plant, number of grains/pod and 1000 grain weight (Table 4.6) were found significantly higher with foliar application of zinc sulphate (0.5%) + ferrous sulphate (0.5%) + copper sulphate (0.1%) at 20 & 40 DAS while the lowest value of these parameters were recorded under control treatments. The increase in yield was due to increase in number of pods per plant, number of grains per pod, 1000 seed weight and number of branches by the application of micronutrient either singly or in combination through spray had enhancing effect on seed yield and also improved the morpho-physiological and biochemical constituents in urd bean. Foliar application of nutrients, especially the micronutrients has direct impact on accelerated cell division and cell enlargement, root growth and plant vigour which resulted in higher grain and straw production. So, the increase in seed and haulm yield in urdbean is due to zinc which had beneficial effect on chlorophyll content and also indirectly influences the photosynthesis and reproduction.Therefore, foliar application of micronutrients is a proper way for supplying optimum nutrition to crop for completion of its vegetative and reproductive phase and obtaining higher value of yield attributes. Similar findings were also given by Singh (2017), Malek *et al.* (2018) and Mahilane and Singh (2018).

Data presented in Table 4.6 revealed that application of nutrient management treatment significantly increased the grain, straw and biological yield of urd bean. Significantly higher grain, straw and biological yield over rest of the treatment were recorded under foliar application of zinc sulphate (0.5%) + ferrous sulphate (0.5%) + copper sulphate (0.1%) at 20 & 40 DASand the lowest in control. This might be due to better absorption of nutrients applied through foliage leading to better activity of functional root nodules resulting in more leaf area, dry matter production and uptake of nutrients. This could have led to more flower production and subsequently pod formation and other yield attributing characters. Similar findings were also given by Sahu *et al.* (2008)and Ghasemian *et al.* (2010).The highest values of harvest index was recorded with foliar application of ferrous sulphate (0.5%) + copper sulphate (0.1%) at 20 & 40 DAS which was significantly higher than rest of the treatmentsand the lowest harvest index was recorded in control plot. This might be due to higher partitioning effect and grain yield in this treatment resulted into higher values of harvest index.

Table 1. Effect of micronutrientsapplication on plant height (cm) at different stages of crop growth.

Treatment	**Plant height (cm plant^{-1})**			
	25 DAS	**50 DAS**	**75 DAS**	**At harvest**
Control (No spray)	13.16	22.91	33.61	34.97
Foliar spray of water at 20 & 40 DAS	13.55	23.27	34.20	35.67
Foliar spray of Zinc sulphate (0.5%) at 20 & 40 DAS	14.35	24.82	35.84	36.95
Foliar spray of Ferrous sulphate (0.5%) at 20 & 40 DAS	14.20	24.48	35.34	36.86
Foliar spray of Copper sulphate (0.1%) at 20 & 40 DAS	14.28	24.39	35.17	36.85

Foliar spray of Zinc sulphate (0.5%)+ Ferrous sulphate (0.5%) at 20 & 40 DAS	14.53	25.79	36.48	38.14
Foliar spray of Zinc sulphate (0.5%)+ Copper sulphate (0.1%) at 20 & 40DAS	14.41	25.31	36.65	37.94
Foliar application of Ferrous sulphate (0.5%) + Copper sulphate (0.1%) at 20 & 40 DAS	14.48	25.42	36.38	37.79
Foliar application of Zinc sulphate (0.5%) + Ferrous sulphate (0.5%) + Copper sulphate (0.1%) at 20 & 40 DAS	15.20	26.81	38.18	39.48
SEm (±)	**0.54**	**0.77**	**0.30**	**0.29**
C.D. (p=0.05)	**0.18**	**0.25**	**0.92**	**0.89**

Table 2. Effect of micronutrients application on number of branches plant^{-1}at different stages of crop growth.

Treatment	**Number of branches plant^{-1}**			
	25 DAS	**50 DAS**	**75 DAS**	**At harvest**
Control (No spray)	3.34	6.23	7.85	8.05
Foliar spray of water at 20 & 40 DAS	3.47	6.53	7.90	8.35
Foliar spray of Zinc sulphate (0.5%) at 20 & 40 DAS	4.43	7.37	8.81	9.31
Foliar spray of Ferrous sulphate (0.5%) at 20 & 40 DAS	4.03	7.05	8.58	9.12
Foliar spray of Copper sulphate (0.1%) at 20 & 40 DAS	4.01	7.00	8.25	8.77
Foliar spray of Zinc sulphate (0.5%)+ Ferrous sulphate (0.5%) at 20 & 40 DAS	5.25	8.16	9.53	9.78
Foliar spray of Zinc sulphate (0.5%)+ Copper sulphate (0.1%) at 20 & 40DAS	5.17	7.89	9.31	9.25
Foliar application of Ferrous sulphate (0.5%) + Copper sulphate (0.1%) at 20 & 40 DAS	5.09	7.75	9.16	9.14
Foliar application of Zinc sulphate (0.5%) + Ferrous sulphate (0.5%) + Copper sulphate (0.1%) at 20 & 40 DAS	5.97	8.63	9.87	10.23
SEm (±)	**0.13**	**0.15**	**0.09**	**0.12**
C.D. (p=0.05)	**0.41**	**0.46**	**0.27**	**0.36**

Table 3. Effect of micronutrients application on number of trifoliate leaves plant^{-1}at different stages ofcrop growth.

Treatment	**Number of trifoliate leaves plant^{-1}**			
	25 DAS	**50 DAS**	**75 DAS**	**At harvest**
Control (No spray)	2.75	6.00	8.03	5.42
Foliar spray of water at 20 & 40 DAS	2.84	6.62	8.15	6.33
Foliar spray of Zinc sulphate (0.5%) at 20 & 40 DAS	2.99	8.12	9.30	7.80
Foliar spray of Ferrous sulphate (0.5%) at 20 & 40 DAS	2.90	7.85	9.18	7.27
Foliar spray of Copper sulphate (0.1%) at 20 & 40 DAS	2.75	7.72	9.10	7.18
Foliar spray of Zinc sulphate (0.5%)+ Ferrous sulphate (0.5%) at 20 & 40 DAS	3.15	9.52	10.80	9.02
Foliar spray of Zinc sulphate (0.5%)+ Copper sulphate (0.1%) at 20 & 40DAS	3.11	9.00	10.63	8.69
Foliar application of Ferrous sulphate (0.5%) + Copper sulphate (0.1%) at 20 & 40 DAS	3.05	8.88	10.53	8.52
Foliar application of Zinc sulphate (0.5%) + Ferrous sulphate (0.5%) + Copper sulphate (0.1%) at 20 & 40 DAS	3.22	9.87	10.98	9.48
SEm (±)	**0.14**	**0.04**	**0.05**	**0.05**
C.D. (p=0.05)	**NS**	**0.13**	**0.14**	**0.17**

Table 4. Effect of micronutrient application on leaf area indexat different stages of crop growth.

Treatment	Leaf Area Index		
	25 DAS	50 DAS	75 DAS
Control (No spray)	2.0	2.8	2.2
Foliar spray of water at 20 & 40 DAS	2.3	3.1	2.3
Foliar spray of Zinc sulphate (0.5%) at 20 & 40 DAS	2.5	3.6	2.6
Foliar spray of Ferrous sulphate (0.5%) at 20 & 40 DAS	2.4	3.5	2.3
Foliar spray of Copper sulphate (0.1%) at 20 & 40 DAS	2.4	3.4	2.2
Foliar spray of Zinc sulphate (0.5%)+ Ferrous sulphate (0.5%) at 20 & 40 DAS	2.8	3.9	2.9
Foliar spray of Zinc sulphate (0.5%)+ Copper sulphate (0.1%) at 20 & 40DAS	2.7	3.7	2.7
Foliar application of Ferrous sulphate (0.5%) + Copper sulphate (0.1%) at 20 & 40 DAS	2.6	3.5	2.5
Foliar application of Zinc sulphate (0.5%) + Ferrous sulphate (0.5%) + Copper sulphate (0.1%) at 20 & 40 DAS	3.2	4.8	3.7
SEm (±)	**0.09**	**0.12**	**0.11**
C.D. (p=0.05)	**0.3**	**0.4**	**0.4**

Table 5. Effect of micronutrients application on dry matter accumulation (g plant^{-1}) at different stages of crop growth.

Treatment	Dry matter accumulation(g plant^{-1})			
	25 DAS	50 DAS	75 DAS	At harvest
Control (No spray)	2.64	9.24	14.09	14.41
Foliar spray of water at 20 & 40 DAS	2.75	9.61	14.54	15.00
Foliar spray of Zinc sulphate (0.5%) at 20 & 40 DAS	3.85	13.48	18.92	21.02
Foliar spray of Ferrous sulphate (0.5%) at 20 & 40 DAS	3.75	13.12	18.31	20.47
Foliar spray of Copper sulphate (0.1%) at 20 & 40 DAS	3.63	12.71	18.01	19.82
Foliar spray of Zinc sulphate (0.5%)+ Ferrous sulphate (0.5%) at 20 & 40 DAS	4.08	14.69	21.60	22.94
Foliar spray of Zinc sulphate (0.5%)+ Copper sulphate (0.1%) at 20 & 40DAS	3.97	13.89	20.67	21.66
Foliar application of Ferrous sulphate (0.5%) + Copper sulphate (0.1%) at 20 & 40 DAS	3.88	13.59	20.35	21.20
Foliar application of Zinc sulphate (0.5%) + Ferrous sulphate (0.5%) + Copper sulphate (0.1%) at 20 & 40 DAS	4.52	15.83	22.03	24.43
SEm (±)	**0.14**	**0.34**	**0.45**	**0.47**
C.D. (P=0.05)	**0.41**	**1.04**	**1.35**	**1.44**

Table 6. Effect of micronutrients application on yield attributing characters, grain and biological yield of urdbean.

Treatment	Yield attributing characters				Yield (q ha^{-1})			Harvest index (%)
	Pod length (cm)	No. of Pods plant^{-1}	No. of Grains pod^{-1}	1000 grains weight (g)	Grain	Straw	Biological	
Control (No spray)	4.2	18.67	4.4	26.32	6.95	18.42	25.40	27.43
Foliar spray of water at 20 & 40 DAS	4.3	21.00	4.6	27.85	7.48	19.26	26.74	27.97
Foliar spray of Zinc sulphate (0.5%) at 20 & 40 DAS	4.8	26.33	4.8	31.27	8.78	21.70	30.48	28.80
Foliar spray of Ferrous sulphate (0.5%) at 20 & 40 DAS	4.7	25.00	4.7	30.27	8.46	21.50	29.96	28.24
Foliar spray of Copper sulphate (0.1%) at 20 & 40 DAS	4.6	24.33	4.6	29.93	8.04	20.77	28.81	27.90

Foliar spray of Zinc sulphate (0.5%)+ Ferrous sulphate (0.5%) at 20 & 40 DAS	5.3	26.67	5.3	34.53	9.78	23.00	32.78	29.84
Foliar spray of Zinc sulphate (0.5%)+ Copper sulphate (0.1%) at 20 & 40DAS	5.1	25.00	5.2	33.87	9.62	22.89	32.51	29.57
Foliar application of Ferrous sulphate (0.5%) + Copper sulphate (0.1%) at 20 & 40 DAS	5.0	23.67	5.0	33.50	9.48	22.78	32.26	29.37
Foliar application of Zinc sulphate (0.5%) + Ferrous sulphate (0.5%) + Copper sulphate (0.1%) at 20 & 40 DAS	5.5	28.33	5.6	35.50	10.62	24.22	34.84	30.47
SEm (±)	**0.04**	**0.49**	**0.07**	**0.28**	**0.18**	**0.29**	**0.42**	**0.23**
C.D. (P=0.05)	**0.1**	**1.50**	**0.2**	**0.83**	**0.55**	**0.89**	**1.28**	**0.71**

CONCLUSION

On perusal of the findings, results revealed that growth parameters and yield attributing characters of urd bean *viz*., plant height, branches/plant, trifoliate leaves/plant, dry matter accumulation/plant, pods/plant, grains/pod, and test weight were significantly higher underfoliar application of zinc sulphate (0.5%) + ferrous sulphate (0.5%) + copper sulphate (0.1%) at 20 & 40 DAS over rest of the treatments. Similarly, grain yield, straw yield, biological yield and harvest index were also found maximum with the foliar application of zinc sulphate (0.5%) + ferrous sulphate (0.5%) + copper sulphate (0.1%) at 20 & 40 DAS treatment which was significantly higher than rest of the treatments.

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