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RESEARCH PAPER

Influence of zinc and iron application on growth and yield of mothbean (*Vigna aconitifolia* L.) in northern dry zone of Karnataka

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Abstract: A field experiment was conducted during 2022-23 *kharif* season at RARS, Vijayapura to study the influence of zinc and iron on growth and yield of mothbean. The experiment was laid out in a split plot design with four levels of zinc in main plot (0, 2.5, 5 and 7.5 kg ha^{-1}) and four levels of iron in sub plot (0, 2.5, 5, 7.5 kg $ha^{-1)}$ with one absolute control replicated thrice. Among the zinc sulphate levels, application of zinc sulphate alone ($ZnSO_4$) @ 7.5 kg ha^{-1} while in iron sulphate levels, iron sulphate alone ($FeSO_4$) @ 7.5 kg ha^{-1} recorded maximum plant height, dry matter accumulation, effective nodules, number of pods per plant, pod length, number of seeds per pod, test weight, grain and haulm yield of mothbean. Further, higher gross returns (66640 and 64338 ₹ ha^{-1}, respectively), net returns (38823 and 36521 ₹ ha^{-1}, respectively) and B:C (2.40 and 2.31, respectively) was recorded with the application of $ZnSO_4$and $FeSO_4$alone @ 7.5 kg ha^{-1} each. The combined application of $ZnSO_4$and $FeSO_4$each @ 7.5 kg ha^{-1} recorded no significant difference however, numerically higher values of growth and yield were recorded as compared to treatments that received 0 kg ha^{-1} zinc sulphate and iron sulphate each respectively. All the growth and yield parameters increased with increase in $ZnSO_4$and $FeSO_4$levels.

Key words: Growth, Iron, Mothbean, Yield, Zinc

Introduction

Mothbean, scientifically known as *Vigna aconitifolia* L., belongs to the legume genus *Vigna* and possesses remarkable adaptability to arid and semi-arid regions. Its ability to thrive across diverse eco-geographical zones as well as harsh climatic conditions, particularly in the Indian subcontinent, highlights its significant importance. This legume called by several names, like mat bean, math, mattenbohne, matki, dew bean, Turkish gram, and haricot papillon. Moth bean takes center stage primarily for its protein-rich seeds, sprouts, and edible green pods, which serve as a valuable source of nutrition. Moth bean [*Vigna aconitifolia* (Jacq)], is believed to have originated in the regions of India, Pakistan, Myanmar and Sri Lanka, according to DeCandolle (1986). Mothbean cultivation is particularly concentrated in arid and semi-arid regions, with a majority taking place in the North-Western states of India. Rajasthan, known as the driest state in the country, is a major producer of moth bean, closely followed by states like Maharashtra, Gujarat, Punjab, Haryana, Jammu and Kashmir, Madhya Pradesh, and Uttar Pradesh.(Gupta *et al.,* 2016; Viswanatha *et al.,* 2016)

Micronutrients are those vital elements required by plants in very minimal quantities, and play a pivotal role in overall plant development. Inadequate supplies of these nutrients can result in micronutrient deficiency, which is a severe problem in soil and plants worldwide (Imtiaz *et al.,* 2010). Micronutrients like iron (Fe), zinc (Zn), boron (B), and molybdenum (Mo) exert the most significant influence on pulse crop production. Up until the 1980's, zinc deficiency was the primary micronutrient limitation affecting crop production. However, as high yielding crop varieties were developed, chemical fertilizers gained attention, and cultivation practices became more intensive and deficiencies in other micronutrients started to emerge vaguely. Micronutrient deficiency is a serious problem in calcareous soils of arid and semi-arid regions. Calcareous soils usually suffer from a lack of micronutrients, especially zinc and iron. Abundant $CaCO_3$ content in calcareous soils directly or indirectly affects the chemistry and availability of N, P, Fe, Zn, Mg, Ca, K, and Cu. High pH and low solubility of micronutrients (Zn, Fe, Cu, Mn, and B) lead to deficiencies in plants. Zinc deficiency is most pronounced under high yield intensive cultivation systems. Zinc sulphate and iron sulphate are an effective source and is the most popular form in use. The deficiency of Zn and Fe is most commonly observed in Northern Dry Zone of Karnataka. A single application lasts for several years. Keeping in view the important role of zinc and iron in crop production, current study was carried out with chelated applicationof Zn and Feto overcome the micronutrient deficiencies in soil and help the increase in crop growth and yield.

Material and methods

The field experiment was carried out at Regional Agricultural Research Station (RARS), Vijayapura during *kharif,* 2022, under Northern Dry Zone of Karnataka (Zone 3), located at a latitude $16^0 49^1$ North, longitude $75^0 43^1$ East and an altitude of 593.8 m above mean sea level (MSL).The experiment was carried out by adopting split plot design with four main plots which consisted different levels of zinc sulphate *viz.,* $ZnSO_4$ @ 0 kg ha^{-1}, $ZnSO_4$ @ 2.5 kg ha^{-1}, $ZnSO_4$ @ 5 kg $ha^{-1}$and $ZnSO_4$ @ 7.5 kg ha^{-1} four sub plots which consisted of different levels of iron sulphate *viz.,* $FeSO_4$ @ 0 kg ha^{-1}, $FeSO_4$ @ 2.5 kg ha^{-1}, $FeSO_4$ @ 5 kg ha^{-1}and $FeSO_4$ @ 7.5 kg ha^{-1} replicated thrice and one absolute control. Zinc sulphate and iron sulphate were enriched with vermicompost in 1:1 ratio and applied 15 days before sowing. The observations related to growth and yield parameters were recorded at regular interval of time during the crop growth period and data were subjected to standard statistical analysis. The experimental site consisted of shallow *Inceptisol* having clay texture, with a pH of 8.31, low in available nitrogen (175 kg ha^{-1}), medium in available phosphorus (31.05 kg ha^{-1}) and high in potassium (362.0kg ha^{-1}). The soils were deficient in DTPA extractable micronutrients *viz*., zinc (0.48 mg kg^{-1}) and iron (2.78 mg kg^{-1}).

Results and discussion

The response was noticed with the application of zinc and iron sulphate with increase in levels of application. The results of growth and yield attributes were presented in Table 1. The application of zinc sulphate @ 7.5 kg ha^{-1} alone recorded significantly higher plant height, dry matter accumulation and effective number of nodules at harvest (46.81 cm 19.33 g plant^{-1}, 10.50, respectively). Among the iron sulphate levels, application of iron sulphate @ 7.5 kg ha^{-1} alone recorded significantly higher plant height, dry matter accumulation and effective number of nodules (45.02 cm, 18.79 g plant^{-1} and 10.00, respectively). The yield attributes like number of pods per plant, pod length and test weight were significantly higher with the application of zinc sulphate alone @ 7.5 kg ha^{-1} (24.01, 7.30 cm

Table 1. Influence of different levels of zinc sulphate and iron sulphate on growth and yield attributes of mothbean

Treatments	Plant height (cm)	Dry matter accumulation(g plant^{-1})	Effective number of nodules	Number of pods per plant	Pod length (cm)	Test weight 1000 seeds (g)
Zinc sulphate levels (MP)						
MP_1	32.13	16.49	7.23	18.99	6.22	18.61
MP_2	39.72	17.43	8.93	21.77	6.52	19.84
MP_3	42.64	18.29	9.42	22.86	6.82	20.12
MP_4	46.81	19.33	10.50	24.01	7.30	21.42
S.Em ±	1.15	0.54	0.20	0.62	0.17	0.42
C.D (0.05)	3.99	1.87	0.70	2.15	0.57	1.47
Iron sulphate levels (SP)						
SP_1	34.88	16.87	7.95	20.02	6.28	18.95
SP_2	38.68	17.49	8.69	21.58	6.56	19.52
SP_3	42.72	18.37	9.43	22.65	6.82	20.42
SP_4	45.02	18.79	10.00	23.39	7.20	21.10
S.Em ±	1.10	0.42	0.21	0.48	0.15	0.54
C.D (0.05)	3.22	1.23	0.62	1.39	0.43	1.57
Interactions (MP×SP)						
MP_1SP_1	30.08	16.29	6.80	18.54	6.20	18.13
MP_1SP_2	31.13	16.37	7.00	18.66	6.21	18.27
MP_1SP_3	32.77	16.60	7.60	18.97	6.22	19.00
MP_1SP_4	34.53	16.69	7.50	19.82	6.24	19.03
MP_2SP_1	35.30	16.70	8.12	20.19	6.26	19.03
MP_2SP_2	39.29	17.27	8.87	21.95	6.47	19.46
MP_2SP_3	41.00	17.67	9.27	22.27	6.59	19.85
MP_2SP_4	43.28	18.08	9.45	22.66	6.77	21.02
MP_3SP_1	36.00	17.20	8.32	20.32	6.33	19.20
MP_3SP_2	40.14	17.28	9.00	22.17	6.50	19.41
MP_3SP_3	46.27	19.10	10.09	24.18	7.10	20.42
MP_3SP_4	48.15	19.58	10.28	24.77	7.34	21.44
MP_4SP_1	38.14	17.30	8.56	21.03	6.34	19.43
MP_4SP_2	44.15	19.07	9.89	23.55	7.06	20.92
MP_4SP_3	50.82	20.11	10.76	25.17	7.36	22.41
MP_4SP_4	54.13	20.82	12.78	26.30	8.45	22.91
S.Em ±	2.21	0.84	0.43	0.95	0.29	1.08
C.D (0.05)	NS	NS	1.24	NS	NS	NS
Absolute control	22.4	13.4	5.2	15.7	5.2	17.0
S.Em ±	2.18	0.88	0.41	0.99	0.33	1.01
C.D (0.05)	6.29	2.54	1.18	2.85	0.96	2.90

MP: Zinc sulphate levels | SP: Iron sulphate levels | Control – Absolute control

MP_1: Zinc sulphate @ 0 kg ha^{-1} | SP_1: Iron sulphate @ 0 kg ha^{-1}

MP_2: Zinc sulphate @ 2.5 kg ha^{-1} | SP_2: Iron sulphate @ 2.5 kg ha^{-1}

MP_3: Zinc sulphate @ 5 kg ha^{-1} | SP_3: Iron sulphate @ 5 kg ha^{-1}

MP_4: Zinc sulphate @ 7.5 kg ha^{-1} | SP_4: Iron sulphate @ 7.5 kg ha^{-1}

and 21.42 g, respectively) and iron sulphate alone @ 7.5 kg ha^{-1} (23.39, 7.20 cm and 21.10g, respectively) (Table 1).

The grain yield (721 and 696 kg ha^{-1}, respectively) and haulm yield (2119 and 2063 kg ha^{-1}, respectively) was significantly higher in treatment that received zinc sulphate @ 7.5 kg ha^{-1} alone and iron sulphate alone @ 7.5 kg ha^{-1} with an increment in grain yield of 26 per cent and 16 per cent respectively.The combined application of zinc sulphate and iron sulphate did not show any significant difference, however numerically higher values of growth, yield and yield parameters were recorded with combined application of zinc sulphate and iron sulphate each @ 7.5 kg ha^{-1}. This increment in growth parameters might be attributed to the key role of zinc and iron in various metabolic activities, cellular growth, differentiation, chlorophyll synthesis and maintenance of chlorophyll structure and also the supremacy of chelated zinc sulphate and iron sulphate in balanced supply of zinc and iron to the crop, which might have contributed for the vigorous growth of plants and also helped in developing extensive root system leading to enhanced uptake of nutrients and thus contributing to the increased growth parameters. These results are in conformity with Kumawat and Khangarot (2001), Gidaganti *et al.*(2019). The marked advancement in yield and yield contributing parameters might be due to enhanced growth parameters *viz.,* plant height and dry matter accumulation as zinc and iron has a major role in auxin production as well as a component of carbonic anhydrase and several dehydrogenase enzymes. Boradkar *et al*., (2023) reported that the enhanced performance of various yield attributes, including pod quantity, seeds per pod, pod length, and 1000 seed test weight, can be attributed to the increased transport of photosynthetic products from the source to developing seeds. The results of the present investigation are in conformity with Vinodkumar *et al.* (2020) in green gram, Patel *et al.* (2009) in cowpea and Misal (2018) in greengram.

Significantly higher gross returns, net returns and B: C was recorded with application of zinc sulphate @ 7.5 kg ha^{-1} alone (66640 ₹ ha^{-1}, 38823 ₹ ha^{-1} and 2.40, respectively) and iron sulphate @ 7.5 kg ha^{-1} alone (64338 ₹ ha^{-1}, 36521 ₹ ha^{-1} and B: C 2.31, respectively) as depicted in Fig 1. The application of micronutrients like zinc and iron enhanced the grain yield production and consequently improved the gross returns, net returns and B: C, respectively. Comparable research findings were also reported by Gidaganti *et al.* (2019) and Rajendar *et al.* (2022) in greengram.

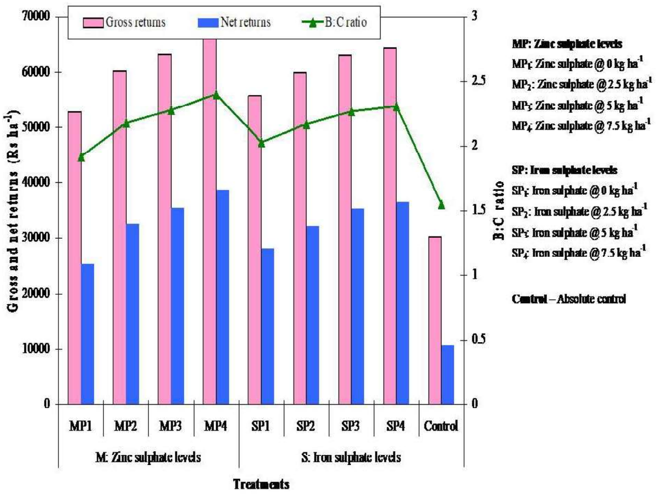

Fig1. Influene of different levels of zinc sulphate and iron sulphate on gross returns, net returns and B:C ratio of mothbean cultivaton

Table 2. Influence of different levels of zinc sulphate and iron sulphate on yield of mothbean

Treatments	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})
Zinc sulphate levels (MP)		
MP_1	571	1764
MP_2	651	1963
MP_3	684	2030
MP_4	721	2119
S.Em±	15.57	48.61
C.D (0.05)	53.87	168.22
Iron sulphate levels (SP)		
SP_1	602	1840
SP_2	648	1947
SP_3	682	2026
SP_4	696	2063
S.Em±	15.72	38.61
C.D (0.05)	45.89	112.70
Interactions (MP×SP)		
MP_1SP_1	562	1737
MP_1SP_2	565	1749
MP_1SP_3	575	1776
MP_1SP_4	583	1792
MP_2SP_1	594	1822
MP_2SP_2	654	1972
MP_2SP_3	670	2004
MP_2SP_4	687	2053
MP_3SP_1	616	1869
MP_3SP_2	661	1985
MP_3SP_3	721	2104
MP_3SP_4	741	2163
MP_4SP_1	637	1930
MP_4SP_2	711	2083
MP_4SP_3	763	2220
MP_4SP_4	774	2243
S.Em±	31.44	77.22
C.D (0.05)	NS	NS
Absolute control	320	1390
S.Em±	30.57	94.34
C.D (0.05)	88.06	271.76

MP: Zinc sulphate levels SP: Iron sulphate levels
Control – Absolute control
MP_1: Zinc sulphate @ 0 kg ha^{-1} SP_1: Iron sulphate @ 0 kg ha^{-1}
MP_2: Zinc sulphate @ 2.5 kg ha^{-1} SP_2: Iron sulphate @ 2.5 kg ha^{-1}
MP_3: Zinc sulphate @ 5 kg ha^{-1} SP_3: Iron sulphate @ 5 kg ha^{-1}
MP_4: Zinc sulphate @ 7.5 kg ha^{-1} SP_4: Iron sulphate @ 7.5 kg ha^{-1}

Conclusion

The present study reveal that application of zinc sulphate @ 7.5 kg ha^{-1} and iron sulphate @ 7.5 kg ha^{-1} alone was found to be optimum for mothbean crop production and also to benefit higher grain yield, gross and net returns in shallow black soils of northern dry zone of Karnataka.

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