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Enhancing Mungbean Productivity and Profitability through Zinc and Iron Application in Western Rajasthan

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Abstract

A field experiment was conducted during *kharif* season (July to September), 2018 at Agricultural Research Station, Mandor, Agriculture University, Jodhpur (Rajasthan), India to examine the performance of mungbean with soil application and foliar spray of zinc and iron. The experiment was laid out in a randomized block design with three replication. Highest plant height (43.51 cm), dry matter accumulation (19.98 g plant^{-1}), number of branches (7.80 plant^{-1}), number of pods (38.82 plant^{-1}), number of grains (10.98 pod^{-1}), 1000 grains weight (43.95 g) were recorded at harvest stage of the crop by the treatment (T_{10}) soil application of zinc sulphate and ferrous sulphate each @ 25 kg ha^{-1}+foliar application of ferrous sulphate @ 0.5% at 35 DAS. Soil application of zinc sulphate and iron sulphate each @ 25 kg ha^{-1} enhanced grain (1357 kg ha^{-1}) and straw yield (2492 kg ha^{-1}) of mungbean by 37.3% and 34.6% over control (988 kg ha^{-1} and 1852 kg ha^{-1}), respectively. B:C ratio was highest with treatment T_8 (4.52) followed by treatment T_{10} (4.51) soil application of zinc sulphate and ferrous sulphate each @ 25 kg ha^{-1}+foliar application of ferrous sulphate @ 0.5% at 35 DAS. Therefore, it can be concluded that mungbean growth parameters and yield can be increased substantially due to soil application of zinc sulphate and iron sulphate each @ 25 kg ha^{-1} in western Rajasthan conditions.

Keywords: Mungbean, productivity, zinc sulphate, ferrous sulphate, soil application

1. Introduction

Pulses are the main source of protein and contribute about 14% of the total protein of an Indian average diet. Every 100 g of edible portion of mungbean seed contains 4.5 mg phosphorus, 75 mg calcium, 24.5 g protein and 348 K Cal energy (Meena et al., 2013). Mungbean [*Vigna radiata* (L.) Wilczek] accounts for 1.92 mha area with the production of 1.24 million tonnes in Rajasthan out of 4.25 mha area with 2.41 mt production in India (Anonymous, 2019). It is cultivated over a wide range of climatic conditions in various states like Maharashtra, Andhra Pradesh, Rajasthan, Uttar Pradesh, Karnataka, Odisha and Bihar in India. Rajasthan is one of the major mungbean growing states of the country. In Rajasthan it is mainly cultivated in arid and semi-arid districts of the state including Nagaur, Jaipur, Jodhpur, Sikar, Pali, Jhunjhunu and Ajmer. Although Rajasthan contributes about 45% of total mungbean area in India, the average productivity in the state is not quite better. There is a

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wide gap between the potential yield and average yield being harvested at farmers' fields.

There may be several possible reasons for low yield harvested by the farmers of state. Lack of optimum mineral nutrition particularly micronutrients management may be one of them, limiting higher productivity of pulses in general and mungbean crop in particular. Besides vagaries of monsoon, most soils of Rajasthan are desertic, calcareous, coarse textured with high pH and very low in organic carbon. Crop grown under such soil conditions would suffer multi-nutrient deficiency including iron and zinc which are becoming a major limiting factor for getting higher yield of different crops (Sahu et al., 2007; Prasad, 2010; Shivay et al., 2014). Hence, optimum mineral nutrient management including micronutrient (zinc and iron) is a basic requirement to realize potential yield of major crops and mungbean as well. The effect of zinc nutrition on physiological and metabolic processes of plants, role in more absorption of essential elements due to increased cation exchange capacity of roots and thereby bearing more yield contributing characters are possible basis of more yield (Yashona et al., 2018). Zinc also has significant role in primordia initiation, indole acetic acid synthesis and partitioning of food material from leaves to reproductive parts which ultimately results in good fruiting (Kalyanaraman and Sivagurunath, 1993; Quah et al., 1996). The role of iron and zinc has been very crucial in plant system because both micronutrients be involved in the various courses of plant growth and development (Kim and Rees, 1992; Bybordi and Mamedov, 2010). The beneficial effects of micronutrients (Zn and Fe) application on growth attributes and productivity of many crops in different soil and agro-climatic conditions had been reported by many workers (Salam et al., 2004; Kumawat et al., 2006; Singh et al., 2013; Mirzapour and Khoshgoftarmanesh, 2013; Nikhil and Salakinkop, 2018). In view of this, an attempt was made to enhance productivity of mungbean through zinc and iron application in conditions of western Rajasthan.

2. Materials and Methods

The experiment was conducted at Agricultural Research Station-Mandor (26° 15' to 26° 45' N latitude and 73° 00' to 73° 29' E longitude), Agriculture University, Jodhpur, Rajasthan, India during *kharif* season (July to September), 2018. Ten core soil samples were collected randomly from 0-15 cm depth on the site using Spade, mixed thoroughly, bulked, air dried and sieved to pass through a 2 mm sieve for chemical analysis. The soil of experimental field was sandy loam in texture having low available nitrogen, phosphorus, zinc, iron and medium in potassium with neutral in nature pH 7.8 (1:2.5 soil: water ratio). All these parameters were estimated following the standard procedures (Jackson, 1967). The mean daily maximum and minimum temperature fluctuated between 31.6 to 39.7 ^{0}C and 23.9 to 29.5 ^{0}C, respectively during the crop growing season. There was total 227.2 mm of rainfall received in 15 rainy days during the *kharif* season (26th MW, 2018 to 38th MW, 2018). The experiment was laid out in Randomized Block Design with ten treatments replicated three times. The random allocation of treatments was done using statistical table prepared by Fisher and Yates (1963). The treatments comprised of T_1- RDF, T_2- RDF+zinc sulphate @ 25 kg ha^{-1}, T_3- RDF+zinc sulphate spray @ 0.5% at 35 DAS, T_4- RDF+zinc sulphate @ 25 kg ha^{-1}+zinc sulphate spray @ 0.5% at 35 DAS, T_5- RDF+ferrous sulphate @ 25 kg ha^{-1}, T_6- RDF+ferrous sulphate spray @ 0.5% at 35 DAS, T_7- RDF+ferrous sulphate @ 25 kg ha^{-1}+ferrous sulphate spray @ 0.5% at 35 DAS, T_8- RDF+zinc sulphate and ferrous sulphate each @ 25 kg ha^{-1}, T_9- RDF+zinc sulphate and ferrous sulphate each @ 25 kg ha^{-1}+zinc sulphate spray @ 0.5% at 35 DAS and T_{10}- RDF+zinc sulphate and ferrous sulphate each @ 25 kg ha^{-1}+ferrous sulphate spray @ 0.5% at 35 DAS. A basal dose of 15 kg nitrogen and 30 kg phosphorus ha^{-1} (RDF) were applied through urea and diammonium phosphate in all plots. Zinc and iron were applied through zinc sulphate heptahydrate and iron sulphate heptahydrate, respectively in individual plots as per treatments through broadcasting at the time of sowing and mixed thoroughly in the soil. Foliar application of zinc sulphate and iron sulphate was given at 35 DAS @ 5 g l^{-1} of water after cleaning the weeds from crop at 30 DAS. Crop variety GM 4 was sown on 5th July, 2018. One irrigation was applied at pre-flowering (25 DAS) for proper growth and development of crop during the growing season. The observations of yield and yield attributes were recorded at harvest but growth parameters such as plant height and dry matter accumulation were recorded at 30, 60 DAS and at harvest stages. Experimental data recorded in various observations were statistically analyzed in accordance with the 'Analysis of Variance' technique as described by (Fisher, 1950). The critical difference (CD) for the treatment comparisons were worked out where ever the variance ratio (F test) was found significant at 5% level of probability.

3. Results and Discussion

3.1. Growth attributes

Mungbean growth in terms of plant height, dry matter accumulation and number of branches were significantly increased over control (Table 1) with soil application of zinc sulphate and iron sulphate (T_8). These parameters were further increased when T_8 was combined with foliar application of zinc sulphate @ 0.5% at 35 DAS (T_9) and foliar application of iron sulphate @ 0.5% at 35 DAS (T_{10}), but these were statistically at par with each other The maximum plant height (43.5 cm), dry matter accumulation (19.98 g plant^{-1}) and number of branches (7.80 plant^{-1}) were recorded by the application of RDF+zinc sulphate and ferrous sulphate each @ 25 kg ha^{-1}+foliar spray of ferrous sulphate @ 0.5% at 35 DAS (T_{10}). Foliar applications combined with soil application significantly increased the plant height, number of branches per plant and dry matter accumulation to the tune of 30.5%, 36.4% and 36.1%, respectively due to T_9 (soil application of zinc sulphate @ 25 kg ha^{-1}+iron sulphate @ 25 kg ha^{-1}+foliar

Table 1: Effect of zinc and iron application on growth, yield attributes, yield and economics of mungbean

Treatments	Plant height (cm)			Dry matter accumulation (g plant^{-1})			No. of branches plant^{-1}	No. of pods plant^{-1}	No. of grains pod^{-1}	1000 grains weight (g)	Grain yield (kg ha^{-1})	Stover yield (kg ha^{-1})
	30 DAS	60 DAS	At harvest	30 DAS	60 DAS	At harvest	At harvest					
T_1	7.83	30.05	32.85	1.71	12.03	14.61	5.52	27.88	8.04	39.66	988	1852
T_2	9.23	35.90	38.80	2.03	15.86	17.66	6.75	33.89	9.83	42.50	1224	2277
T_3	7.84	30.18	32.92	1.71	12.10	14.72	5.62	28.27	8.13	40.06	1028	1927
T_4	9.24	36.10	38.90	2.02	15.94	17.78	6.88	34.08	9.95	42.82	1262	2326
T_5	8.35	31.82	33.62	1.82	12.83	14.98	5.75	29.06	8.33	40.13	1060	1977
T_6	7.83	34.40	36.00	1.71	13.61	16.42	6.03	30.17	8.47	40.29	1070	1985
T_7	8.36	34.64	36.64	1.83	14.09	16.73	6.33	31.50	8.65	40.63	1114	2068
T_8	10.18	40.62	42.49	2.23	16.91	19.83	7.45	36.97	10.41	43.43	1323	2418
T_9	10.19	40.73	42.87	2.22	16.96	19.89	7.53	37.45	10.53	43.86	1333	2441
T_{10}	10.19	41.48	43.51	2.23	17.01	19.98	7.80	38.82	10.98	43.95	1357	2492
SEm±	0.49	1.89	1.93	0.11	0.82	0.95	0.36	1.75	0.55	0.66	64.94	117.07
CD (p=0.05)	1.45	5.63	5.73	0.33	2.45	2.83	1.08	5.20	1.64	1.98	192.95	347.85

Table 1: Continue...

Treatments	Cost of cultivation (₹ ha^{-1})	Gross return (₹ ha^{-1})	Net return (₹ ha^{-1})	B:C ratio
T_1	21262	80006	58744	3.76
T_2	22205	99018	76813	4.46
T_3	21889	83247	61358	3.80
T_4	22831	101977	79146	4.47
T_5	22694	85785	63091	3.78
T_6	21947	86574	64627	3.94
T_7	23379	90122	66743	3.85
T_8	23636	106764	83128	4.52
T_9	24263	107647	83384	4.44
T_{10}	24321	109621	85300	4.51
SEm±				
CD (p=0.05)				

T_1: control (RDF); T_2: RDF+zinc sulphate @ 25 kg ha^{-1}; T_3: RDF+zinc sulphate spray @ 0.5% at 35 DAS; T_4: RDF+zinc sulphate @ 25 kg ha^{-1}+zinc sulphate spray @ 0.5% at 35 DAS; T_5: RDF+ferrous sulphate @ 25 kg ha^{-1}; T_6: RDF+ferrous sulphate spray @ 0.5% at 35 DAS; T_7: RDF+ferrous sulphate @ 25 kg ha^{-1}+ferrous sulphate spray @ 0.5% at 35 DAS; T_8: RDF+zinc sulphate and ferrous sulphate each @ 25 kg ha^{-1}; T_9: RDF+zinc sulphate and ferrous sulphate each @ 25 kg ha^{-1}+zinc sulphate spray @ 0.5% at 35 DAS; T_{10}: RDF+zinc sulphate and ferrous sulphate each @ 25 kg ha^{-1}+ferrous sulphate spray @ 0.5% at 35 DAS; 1 US$=₹ 71.47 at the time of harvest.

application of 0.5% zinc sulphate) and 43.5%, 41.3% and 36.8%, respectively due to T_{10} (soil application of zinc sulphate @ 25 kg ha^{-1}+iron sulphate @ 25 kg ha^{-1}+foliar application of 0.5% iron sulphate). The response of the treatment in growth attributes could be depicted as T_{10}>T_9>T_8, which were at par. Foliar application of iron sulphate when supplemented with soil application of zinc+iron resulted in maximum increment in growth parameters of mungbean. This might be due to positive response of both zinc and iron improved over all nutritional environments of plant, which improved the growth and development of plant. The favourable influence of zinc and iron on photosynthetic and enzymatic activities would in turn increase vegetative growth of plants (Thalooth et al., 2006). Growth parameters of mungbean increased due to application of zinc and iron was also reported by Singh et al., 2013.

3.2. *Yield attributes and Yield*

The significant improvement in yield attributes and yield of mungbean (Table 1) were observed with soil application of RDF+zinc sulphate and ferrous sulphate each @ 25 kg ha^{-1}+foliar spray of ferrous sulphate @ 0.5% at 35 DAS over control. The maximum pods (38.82 plant^{-1}), grains (10.98 pod^{-1}) and test weight (43.95 g) were observed by the application of RDF+zinc sulphate and ferrous sulphate each @ 25 kg ha^{-1}+foliar spray of ferrous sulphate @ 0.5% at 35 DAS. The significant grain (1357 kg ha^{-1}) and straw yield (2492 kg ha^{-1}) of munbean were recorded by the application of RDF + zinc sulphate and ferrous sulphate each @ 25 kg ha^{-1}+foliar spray of ferrous sulphate @ 0.5% at 35 DAS over control. The combined effect of zinc and iron provided sufficient nutrition to the plant and thereby more yield attributes and yield was recorded. Zinc is an essential element, which stimulates seed formation ultimately resulting into better development of the crop plants (Quah et al., 1996; Khorgami and Farnia, 2006; Habib, 2012). The similar results of increased grain and straw yield and biological yield in mungbean with soil application of both zinc sulphate and iron sulphate were found by Jamal *et al.* (2018) and Singh *et al*. (2013) in respect of application of iron sulphate in soil+foliar spray in mungbean. The soil application of zinc and iron has synergistic effect (Gaffar et al., 2011) leading to higher availability of native nutrients and thereby results in higher crop growth, yields and quality (Meena et al., 2006; Niyigaba et al., 2019).

3.3. Economic

The lowest cost of cultivation was noted in control (₹ 21262 ha^{-1}) and highest of (₹ 24321 ha^{-1}) in T_{10}: RDF + zinc sulphate and ferrous sulphate each @ 25 kg ha^{-1}+foliar spray of ferrous sulphate @ 0.5% at 35 DAS. In the present experimentation, though other economic parameters like gross and net return were increased when both soil as well as foliar treatments were applied together (Table 1). Gross return (₹ 109610 ha^{-1}) and net returns (₹ 85300 ha^{-1}) recorded highest under treatment T_{10}: RDF+zinc sulphate and ferrous sulphate each @ 25 kg ha^{-1}+foliar spray of ferrous sulphate @ 0.5% at 35 DAS. The B:C remained comparatively higher in case of soil application of both zinc sulphate and iron sulphate each @ 25 kg ha^{-1} (T_8). T_8 recorded the maximum increment of 20.2% in benefit cost ratio followed by 19.9% in T_{10}.

4. Conclusion

Mungbean productivity (1323 kg ha^{-1}) and profitability (4.52 B:C ratio) may be increased substantially due to soil application of zinc sulphate and iron sulphate each @ 25 kg ha^{-1} along with recommended dose of fertilizer in western Rajasthan conditions.

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