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Effect of ferrous sulfate on yield parameters of moong bean (*Vigna radiata* (L.) in arid resign Rajasthan

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Abstract
Effect of ferrous sulfate on yield parameters of moong bean (*Vigna radiata*. (L.) in arid resign Rajasthan were conducted at Adoptive Trail Center (ATC) abuser, Jhunjhunu and at five different location farmer's field during kharif seasons of 2020. In these experiments different combinations of Fertilizer ferrous sulphate basal as well as foliar spray application were used for comparison. Experiments were laid in randomized block design with ten treatments and three replication at Adoptive Trail Center (ATC) abuser, Jhunjhunu and in strip at farmer's field. IPM 02-3 variety of mung-bean (*Vigna radiata* (L.) for zone IInd A was used. Among all treatment significantly superior over control, but maximum seed yield was recorded with ferrous sulphate @ 0.50% (30 and 45 DAS), while application of Ferrous sulfate @ 0.75% (30 & 45 DAS) ranked second.

Keywords: Mung bean, ferrous sulfate and Yield components

Introduction
Main source of protein for vegetarians are Pulses. It's about 14 per cent of the total protein of an Indian diet. Moong bean (*Vigna radiata* (L.)) or green gram is a kharif season crop require 90-120 days of tropical region. Pulses are contain 14% of the total protein and main protein diet for Indian. 100 g mung bean seed contains 348 K Cal energy, 24.5 g protein, 4.5 mg phosphorus and 75 mg calcium. (Meena *et al*., 2013) [11].

In India Rajasthan is one of the major mung bean growing states. In arid and semi-arid of the state Rajasthan districts Jhunjhunu, Nagaur, Sikar, Pali, Jaipur, Jodhpur and Ajmer are mainly cultivated Mungbean (*Vigna radiata* (L.)). About Rajasthan contributes 45% area total mung bean in India.

Family of green gram is fabaceae. Green gram (Vigna radiate (L.)) is widely produced and consumption in India, high source of protein and 2.5 - 3.0 times higher than the cereals. In Rajasthan Mungbean (*Vigna radiata* (L.) has 1.92 mha area with the production of 1.24 million tonnes an in india out of 4.25 mha area with 2.41 mt production (Anonymous, 2019) [1]. It also widely cultivated over India in various states like Maharashtra, Andhra Pradesh, Rajasthan, Uttar Pradesh, Karnataka, Odisha and Bihar. The average productivity in the Rajasthan is not good. At farmers' fields a wide gap between the potential yield and average yield. There are low yield harvested yield in pulses particularly in mung beans. Micronutrients management is not good. In general farmer applied only major nutrients fertilizer like nitrogenous, potasic and phosphatic fertilizers in their fertilizer schedule but lacking of micronutrients. Now a days micronutrients *viz*. zinc and iron deficiencies and limiting factor for crop growth and optimum yield. Hence, optimum yield potential attain nutrient management including micronutrient (iron) is a basic requirement for major crops and mung bean. Micronutrients like iron is play advanced role for plant growth and development. The soils characteristic of western Rajasthan are coarse textured, calcareous, highly alkaline in reaction, desertic and low in organic matter. Pulses grown in this type of soil conditions deficiency different major and micronutrients like iron. (Sahu *et al*. 2007) [18] Iron chlorosis problem in groundnut found in different location in state clearly indicated.

In desertic soil conditions would suffer micro nutrients deficiency including iron which are being a limiting factor for crop growth and productivity (Sahu *et al*., 2007; Prasad, 2010; Shivay *et al*., 2014) [18, 15, 19]. In calcareous soil foliar spray of FeSO4 with lime is commonly used for control Iron deficiency. But spraying only iron salts has less effective because of precipitation of iron from the spray solution and poor translocation of applied iron within the plant. Macro and micro nutrients become more available improve by higher soil microorganism population (Qin *et al*., 2015; Eo & Park, 2016).

Materials and Methods

The experiment were conducted at Adoptive Trail Center (ATC) and at five different location farmers field during kharif seasons of 2020 abuser, Jhunjhunu IInd A (Transitional Plain of Inland Drainage) which covers the areas of districts Sikar, Jhunjhunu, Nagaur and eastern part of Churu. Climate of this zone II a area mean daily minimum temperature during summers comes down to 27.3°C, mean daily maximum temperature goes up to 48°C.during summers and as low as below freezing point during the winters -4°C. Similarly, The average rainfall (about 300-500 mm) varies from 440 mm in Sikar, 405 mm in Jhunjhunu, 311 mm in Nagpur and 325 mm in Churu district. In this zone south - west winds blow during summer's season. The soil was sandy to sandy loam in texture, low in organic carbon (0.37%), phosphorus (32 kg ha-1), potassium (173 kg ha-1), EC (0.17dSm-1) and pH of 8.4 (Table 1). Irrigation water was pH of 7.5 and EC (1.80 dSm-1) (Table 2). In these experiments different combinations of Fertilizer ferrous sulphate basal as well as foliar spray application were used for comparison. Experiments were laid in randomized block design with ten treatments and three replication at Adoptive Trail Center (ATC) abuser (layout A), Jhunjhunu and in strip at farmer's field (layout B). IPM 02-3 variety of mung-bean (*Vigna radiata* (L.) for zone IInd A was used. Ten treatments were T1 – Ferrous sulfate @ 10 kg/ha (Basal dose), T2 – Ferrous sulfate @ 15 kg/ha (Basal dose), T3 – Ferrous sulfate @ 20 kg/ha (Basal dose), T4 – Ferrous sulfate @ 0.25% (30 DAS), T5 – Ferrous sulfate @ 0.50% (30 DAS), T6 – Ferrous sulfate @ 0.75% (30 DAS), T7 – Ferrous sulfate @ 0.25% (30 & 45 DAS), T8 – Ferrous sulfate @ 0.50% (30 & 45 DAS), T9 – Ferrous sulfate @ 0.75% (30 & 45 DAS) and T10 – Control (no Iron application). Basal application of Ferrous sulfate apply at the time of sowing but spray as per treatments. Moong beans were sown manually in a line on 9th July, 2020 at a depth of 3-4 cm. The size of the plot was 4x4 m with a spacing of 15 cm in between the plants and 45 cm in between the rows. Data collected from five random selected plants of each plot. Observations were recorded plant height, number of branch, Test weight, number of grain per pod, grain yield, straw yield and biological yield. Data were statistically analyzed using the F-test (Gomez and Gomez, 1984) at critical difference 5% level of significance differences between mean values of treatments.

Table 1: Initial soil status

	Properties	Value	Method followed
	Electro-chemical		
1.	Soil pH (1:2.5)	8.40	Glass electrode digital pH meter (Chopra and Kanwar, 1982)
2.	Electrical conductivity (dSm^{-1}) (1:2.5)	0.17	Using EC meter (Sparks, 1996)
3.	Organic Carbon, (%)	0.37	Walkley and Black (1934)
4.	Available P_2O_5 (Kg ha^{-1})	32	Olsen's colorimetric method (Olsen *et al*., 1954)
5.	Available K_2O (Kg ha^{-1})	173	Flame photometric method (Jackson, 1973)
6.	Available S (Kg ha^{-1})	30	Turbiditymetric method (Chesin and Yein, 1952)
7.	Zink (PPM)	0.38	DTPA Extraction method (Lindsay and Norwell, 1978)
8.	Ferrous (PPM)	1.86	DTPA Extraction method (Lindsay and Norwell, 1978)
9.	Copper (PPM)	0.52	DTPA Extraction method (Lindsay and Norwell, 1978)
10	Mn (PPM)	4.50	DTPA Extraction method (Lindsay and Norwell, 1978)
	(Soil testing lab. Jhunjhunu)		

Table 2: Irrigation water status

Properties	Value	Method followed
1. pH	7.5	Glass electrode digital pH meter (Chopra and Kanwar, 1982)
2.Electrical conductivity (dSm^{-1})	1.80	Using EC meter (Sparks, 1996)
(Soil testing lab. Jhunjhunu)		

Results and Discussion

Grain yield (Q/ha)

Data of grain yield is given in Table 3. Statistical analysis of the grain yield data that of mung bean was All treatment significantly superior over control (no Iron application), but maximum seed yield was recorded with Foliar spray of ferrous sulphate @ 0.50% (30 and 45 DAS) which was significantly superior over Ferrous sulfate @ 10 kg/ha (Basal dose), Ferrous sulfate @ 15 kg/ha (Basal dose), Ferrous sulfate @ 0.25% (30 DAS), Ferrous sulfate @ 0.50% (30 DAS), Ferrous sulfate @ 0.75% (30 DAS), Ferrous sulfate @ 0.25% (30 & 45 DAS and Ferrous sulfate @ 0.75% (30 & 45 DAS) but found at par with Ferrous sulfate @ 20 kg/ha (Basal dose). Highest grain yield 12.54 Q/ha was found in treated Foliar spray of ferrous sulphate @ 0.50% (30 and 45 DAS) plots compare to control (no Iron application) 9.17 Q/ha. Similar trend was found at farmer's field of zone IIa.

Micronutrients particular Zn and Fe used as basal and foliar spray for batter development of crop. (Habib, 2012, Khorgami and Farnia, 2006, Quah *et al*., 1996, Singh *et al*. 2013 and Jamal *et al*. 2018) [5, 16, 17, 20, 8]. The Basal application of zinc and iron has synergistic effect (Gaffar *et al*., 2011) [11] higher availability of native charge nutrients and thereby results in higher yields (Meena *et al*., 2006; Niyigaba *et al*., 2019) [12, 13].

Straw yield (Q/ha)

Data of straw yield is given in Table 3. Statistical analysis of the straw yield data that of mung bean was All treatment significantly superior over control (no Iron application), but maximum straw yield was recorded with Foliar spray of ferrous sulphate @ 0.50% (30 and 45 DAS) which was significantly superior over Ferrous sulfate @ 10 kg/ha (Basal dose), Ferrous sulfate @ 15 kg/ha (Basal dose), Ferrous sulfate @ 0.25% (30 DAS), Ferrous sulfate @ 0.50% (30 DAS), Ferrous sulfate @ 0.75% (30 DAS), Ferrous sulfate @ 0.25% (30 & 45 DAS and Ferrous sulfate @ 0.75% (30 & 45 DAS) but found at par with Ferrous sulfate @ 20 kg/ha (Basal dose). Highest straw yield 15.68 Q/ha was found in treated

Foliar spray of ferrous sulphate @ 0.50% (30 and 45 DAS) plots compare to control (no Iron application) 8.65 Q/ha. Similar trend was found at farmer's field of zone IIa.

Table 3: Grain yield and straw yield (Q/ha)

Treatments	Seed yield (q/ha)		Straw yield (q/ha)	B:C ratio
	ATC*	C.Fs**		
T_1 – Ferrous sulfate @ 10 kg/ha (Basal dose)	10.19	9.54	12.74	2.28
T_2 – Ferrous sulfate @ 15 kg/ha (Basal dose)	11.24	10.35	14.05	2.46
T_3 – Ferrous sulfate @ 20 kg/ha (Basal dose)	12.46	11.85	15.58	2.67
T_4 – Ferrous sulfate @ 0.25% (30 DAS)	10.62	9.98	13.27	2.41
T_5 – Ferrous sulfate @ 0.50% (30 DAS)	10.83	10.12	13.54	2.45
T_6 – Ferrous sulfate @ 0.75% (30 DAS)	11.53	10.89	14.42	2.58
T_7 – Ferrous sulfate @ 0.25% (30 & 45 DAS)	11.20	10.40	14.00	2.44
T_8 – Ferrous sulfate @ 0.50% (30 & 45 DAS)	12.54	11.80	15.68	2.71
T_9 – Ferrous sulfate @ 0.75% (30 & 45 DAS)	11.47	10.87	14.33	2.46
T_{10} – Control	9.17	8.65	11.46	--
S.Em+	0.31	--	0.38	--
CD at 5%	0.91	--	1.14	

- * Adoptive Trial Center
- ** Cultivars Fields/ farmers Field

A. Lay-out of experiment field

1.5m		1.5m
T_1	T_2	T_3
1 m		
T_2	T_3	T_4
1 m		
T_3	T_4	T_5
1 m		
T_4	T_5	T_6
1 m		
T_5	T_6	T_7
1 m		
T_6	T_7	T_8
1 m		
T_7	T_8	T_9
1 m		
T_8	T_9	T_{10}
1 m		
T_9	T_{10}	T_1
1 m		
T_{10}	T_1	T_2

A. Lay-out of farmer's field

T1	T2	T3	T4	T5	T6	T7	T8	T9	T10

Fig 1: Field over views

Conclusions and recommendations

In this study concluded that in IPM 02-3 variety of mung-bean (*Vigna radiata* (L.) for zone IInd A was used. Among all treatment ferrous sulphate @ 0.50% (30 and 45 DAS), increases grain yield and straw yield as compare to no application of Iron sulphate. Form this conclusion recommendation for farmer's Foliar spray of ferrous sulphate @ 0.50% (30 and 45 DAS) or Foliar spray of ferrous sulphate @ 0.75% (30 and 45 DAS).

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