International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2020; 8(1): 1228-1231
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Received: 07-11-2019
Accepted: 09-12-2019

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Response of greengram to soil and foliar application of micronutrients mixture in southern dry zone of Karnataka

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DOI: https://doi.org/10.22271/chemi.2020.v8.i1q.8418

Abstract
The productivity of pulses are declining year by year due to many reasons. The major one is as they are grown in rainfed areas with low moisture availability combined with low fertile soils and another important physiological constraint which limit the productivity is flower drop. Experiment was laid out in RCBD with fourteen treatments including control, RDF + FYM, foliar application of MM at 20 DAS (MMF1 and MMF2), 40 DAS (MMF1 and MMF2) along with RDF+FYM, Foliar spray at 20 and 40 DAS along with FYM+RDF and soil application of MMS1, MMS2, MMS3 and MMS4 along with RDF+FYM. These treatments were replicated thrice. Micronutreints mixture comprising Fe (20.10 g), Mn (18.20 g), Zn (160 g), Cu (12.73 g), with B (43.70 g)/without B, Mo(2.33 g) was prepared using appropriate micronutrients salts for foliar application per acre and Fe (80.4g), Mn(72.8g), Zn (640 g), Cu (50.92 g), with B (174.8 g)/without B, Mo (9.32 g) for MMS1 and two, three and four times that of MMS1 for other mixture (MMS2, MMS3 and MMS4, respectively) per acre for soil application. Results revealed that foliar application of MMF1 at 20 days after sowing and MMF2 at 40 days after sowing along + RDF+FYM recorded significantly higher plant height (28.35 cm), number of leaves per plant (6.87) number of branches per plant (4.13), number of pods per plant (26.42), number of seeds per pod (13.15) and seed yield (1030.70 kg ha^{-1}) and dry matter (15.61 g $plant^{-1}$)) of blackgram. While higher haulm yield (1873.75 kg ha^{-1}) and was observed with MMS2 + RDF+FYM.

Keywords: Greengram, soil, foliar application, micronutrients mixture

Introduction
Agriculture still remains the backbone of Indian economy in spite of various technological advancements and industrial development with 70 % of people dependent on agriculture and 25 % of country's Gross Domestic Product coming from agricultural sector. Among the various inputs in agriculture, fertilizer is a vital input since it replenishes the nutrients removed from the soil by crops and also boosts the yield of crops. Pulses play an important role in Indian agriculture. In India, pulses are being cultivated over an area of 23.6 million hectares with an annual production of 17.2 million tonnes and productivity of 728 kg per hectare. Greengram [*Vigna radiata* (L.) Wilczek] also known as mungbean is an important pulse crop of India. It is also considered as "Golden Bean" because of its nutritional value (Its seed contains 24.2% protein, 1.3% fat and 60.4% carbohydrate) and suitability for increasing the soil fertility by way of addition of nitrogen (30 kg ha-1 annum-1). Among all pulses grown in India, greengram ranks third after chickpea and pigeon pea, with a production of 1.49 mt. from 3.53 m ha area (Anon., 2012) [1]. Foliar feeding of nutrients has become an established procedure in crop production to increase yield and quality of crop products and it also minimizes environmental pollution and improves nutrient utilization through reducing the amounts of fertilizers added to the soil.

Material and methods
Field experiment was conducted during early *Kharif* 2017 on sandy loam soil at College of Agriculture, V.C. Farm, Mandya, University of Agricultural Sciences, Bengaluru, Karnataka to study the effect of micronutrients mixture application on growth and yield of greengram in Southern Dry Zone (Zone 6) of Karnataka.

The experiment was laid out in RCBD with fourteen treatments including control, RDF + FYM, foliar application of MMF1 and MMF2 at 20 DAS, MMF1 and MMF2 at 40 DAS along with RDF+FYM and their combinations and soil application of MMS1, MMS2, MMS3 and MMS4 along with RDF+FYM. Initial soil properties of the experimental site during 2017 was presented in the Table 1.

Table 1: Initial Physico-chemical properties of the soil

Sl. No	Parameter	Site 1 (2017)
I. Physical properties		
	Coarse sand (%)	55.70
	Fine sand (%)	25.87
	Silt (%)	14.9
	Clay (%)	3.53
	Textural Class	Sandy loam
II. Chemical properties		
1	pH (1:2.5)	7.39
2	EC (dS m^{-1})	0.13
3	Organic carbon (g kg^{-1})	1.53
4	Available N (kg ha^{-1})	252.97
5	Avail. P_2O_5 (kg ha^{-1})	45.8
6	Avail. K_2O (kg ha^{-1})	345.96
7	Exch. Ca (cmol ha^{-1})	3.24
8	Exch.Mg (cmol ha^{-1})	1.89
9	Available S (mg kg^{-1})	15.67
10	DTPA Fe (mg kg^{-1})	17.82
11	DTPA Zn (mg kg^{-1})	0.52
12	DTPA Mn (mg kg^{-1})	8.78
13	DTPA Cu (mg kg^{-1})	0.53
14	Hot water soluble Boron (mg kg^{-1})	0.46

Table 2: Micronutrient carrier and content of micronutrient in the mixture used in different crops

Micronutrients salts used	Form	MMF1 (g ha^{-1})	MMF2 (g ha^{-1})	MMS1 (g ha^{-1})	MMS2 (g ha^{-1})	MMS3 (g ha^{-1})	MMS4 (g ha^{-1})
$Fe_2SO_4.7H_2O$	Fe	50.25	50.25	100.5	201	100.5	201
$MnSO_4.5H_2O$	Mn	45.5	45.5	91	182	91	182
$ZnSO_4.7H_2O$	Zn	400	400	800	1600	800	1600
$CuSO_4.7H_2O$	Cu	31.82	31.82	63.64	127.28	63.64	127.28
Sodium molybdate	Mo	5.82	5.82	11.64	23.28	11.64	23.28
Boric acid	B	-	109.25	218.5	437	-	-

*MMS-micronutrients mixture for soil application, MMF-micronutrients mixture for foliar application

Recommended dose of NPK (25:50:50 kg ha^{-1}) for greengram was supplied with urea, single super phosphate and murate of potash, respectively and micronutrient mixture (MMS1 and MMS2) comprising Fe, Mn, Zn, Cu, B and Mo (Table 2) was applied at the time of sowing in the form of iron sulphate, manganese sulphate, zinc sulphate, copper sulphate, borax and sodium molybdate, respectively. Micronutrient mixture containing the amount as indicated in Table 2 for foliar spray was prepared by dissolving the appropriate quantity of all the micronutrient salts in distilled water. Then the pH of the solution was adjusted to 6.5 using 1% KOH solution. This solution was used for foliar spraying (@ 500 l/ha) at 20 and 40 DAS as per the treatment plan. Crop was harvested at proper maturity. Periodical and quantitative observations were taken in order to assess the effect of micronutrients mixture on growth, yield and yield parameters. Mature pods were harvested manually by hand picking. The seed was separated by manual threshing. Seed and haulm yield was recorded separately treatment wise.

Results and Discussion

Table 3: Effect of micronutrients mixture application on growth parameters of greengram

Treatments	Plant height (cm)	Number of leaves per plant	Number of branches per plant	Dry matter production per plant (g $plant^{-1}$)
T_1	18.20	4.80	2.47	14.03
T_2	25.07	5.65	2.87	15.03
T_3	25.40	5.73	2.93	15.90
T_4	24.41	5.33	3.20	15.46
T_5	21.23	5.35	3.46	13.68
T_6	25.89	5.40	3.58	15.66
T_7	28.35	6.87	4.13	15.61
T_8	22.46	5.73	3.07	14.99
T_9	25.44	6.51	2.99	14.78
T_{10}	24.73	6.20	3.28	16.34
T_{11}	21.13	5.27	3.08	14.61
T_{12}	24.67	6.53	3.67	16.21
T_{13}	22.84	6.53	3.24	14.69

T_{14}	22.76	5.60	3.04	15.33
SEm±	1.10	0.25	0.16	0.64
CD (p=0.05)	3.20	0.72	0.47	1.88

Effect of application of micronutrients mixture on growth and yield of greengram was significant (Table 3). Significantly higher plant height was noticed in T_7 (28.35 cm) with the application of RDF + FYM + MMF1 at 20 DAS+ MMF2 at 40 DAS and it was on par with T_6 and T_9 and significantly differed from other treatments. Highest number of leaves (6.87) and branches (4.13) per plant recorded with the application of RDF + FYM + MMF1 at 20 DAS+ MMF2 at 40 DAS and these treatments were on par with T_{12} (6.53 and 3.67 respectively) with RDF + FYM + MMS2 and lowest was recorded in control (4.80 and 2.47 respectively).Significantly higher dry matter production per plant (16.21 g) was observed with RDF + FYM + MMS2 application.

The growth parameters and dry matter production in both greengram and blackgram recorded with the application of micronutrients mixture along with FYM + RDF were significantly higher than that recorded with only FYM+RDF. Micronutrients play an important role as these are involved in metabolic functions, translocation, enzyme activation, cell multiplication, photosynthesis etc., thus application of micronutrients mixture either through soil or foliage enhanced the growth parameters and dry matter production in greengram. The similar beneficial effect of multi micronutrients mixture application have been reported by Kannan *et al.*, (2014) [4] and Poongothai and Chitdeshwari (2003) [5] in blackgram, by Hemn (2013) [3] in cowpea, by Valenciano *et al.* (2010) [8] in chickpea and by Quddus *et al.* (2011) [6] in mungbean.

Table 4: Effect of micronutrients mixture application on yield and yield attributes of greengram

Treatments	Pod length (cm)	Number of pods per plant	Number of seeds per pod	Test weight (g)	Seed yield (kg ha^{-1})	Haulm yield (kg ha^{-1})
T_1	6.31	17.61	9.87	4.01	680.43	765.93
T_2	7.53	21.49	11.26	4.17	895.75	1271.07
T_3	7.60	20.97	11.55	4.17	846.52	1609.34
T_4	7.32	20.88	11.87	4.10	920.15	1581.09
T_5	7.35	19.42	10.73	4.14	921.04	1592.13
T_6	7.39	24.11	12.87	4.15	1015.36	1643.11
T_7	7.99	26.42	13.15	4.26	1030.70	1656.47
T_8	7.66	24.05	12.17	4.10	921.65	1347.83
T_9	7.73	20.66	12.21	4.11	939.33	1510.44
T_{10}	7.21	20.14	10.96	4.08	983.16	1518.51
T_{11}	7.68	22.23	11.67	4.11	809.69	1559.96
T_{12}	7.88	21.09	11.69	4.07	927.49	1873.75
T_{13}	6.74	21.72	11.68	4.25	912.04	1631.78
T_{14}	7.28	20.88	11.91	4.04	902.99	1486.38
SEm±	0.36	1.02	0.55	0.06	42.74	74.47
CD (p=0.05)	1.06	2.98	1.60	0.18	124.25	216.49

The data on the effect of application of FYM + RDF and micronutrients mixture on yield attributes and yield of greengram are presented in Table 4.Yield and yield attributes were differed significantly with the application of micronutrients mixture along with RDF + FYM. Significantly higher pod length (7.99cm), number of pods per plant (26.42), number of seeds per pod (13.15), Test weight (4.26 g) were recorded with the application of RDF + FYM + MMF1 at 20 DAS + MMF2 at 40 DAS and lowest was observed with control, RDF + FYM. Superior yield of 1030.70 kg ha^{-1} was observed in T_7 significantly and it was on par with other treatments except T_1, T_2, T_3, T_{11} and T_{14}. Significantly higher haulm yield was observed in T_{12} (1873.75 kg ha^{-1}) compare to all other treatments.

Foliar application of micronutrients (Fe, Mn, Zn, Mo, Cu, with/without B) resulted in effective absorption of the nutrients during critical stages of growth and in turn contributed to increased pod length. This result was in accordance with the earlier findings of Sarkar and Malik (2001) [7]. Foliar application of nutrients enhanced the number of floral buds, prevented the floral shedding by maintaining optimum bio - physiological conditions and also these micronutrients such as Fe, Zn and Mn have a structural role in chlorophyll. Consequently supply of these micronutrients enhances the chlorophyll content ultimately photosynthesis. This in turn, leads to an increase in yield attributes in the treatment that received micronutrients mixture (Farag *et al.*, 2014) [2] and B in the mixture might have improved flower retention, pollination and sugar transportation. Thus the total effect of application micronutrients mixture resulted in higher yield attributes and yield in greengram.

Conclusion

The results indicated that soil or foliar application of micronutrients mixture along with RDF+FYM can significantly enhance the growth, yield and nutrient content of greengram. Application of micronutrients mixture ensures the balanced supply of nutrients which in turn helps in improving the nutritional quality of crops.

Acknowledgement

Department of science and Technology, Ministry of Science and Technology Government of India for awarding INSPIRE fellowship to carry out the research as part of Doctoral Degree program of corresponding author.

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