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Influence of organic and inorganic sources of nutrients on growth, yield and quality of mungbean (*Vigna radiata*)

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Climate change is affecting all four dimensions of food security: food availability, food accessibility, food utilization and food systems stability. It has an impact on human health, livelihood assets, food production and distribution channels, as well as changing purchasing power and market flows (Ashoka *et al.* 2017; Meena *et al.* 2020). Food insecurity is a major issue for many people and households in poor and developing countries. It is estimated that ~79 million people are undernourished in the world (FAO 2018). Pulses can help contribute to food security in a number of ways, and constitute an essential part of the Indian diet for nutritional security, soil and environmental sustainability under changing climate (Brown and Funk 2008).

Mungbean (*Vigna radiata* (L.) Wilczek) is one of the important food legume in Asian region, where 90 % of global production currently occurs. The total area covered under pulses in India was ~23 Mha with a total production of 25.23 Mt and 694 kg/ha productivity. In India, the area of mungbean is 2.93 Mha in 2017-18 with production of 2.01 Mt (DASE 2018). Its average productivity is very low around 436 kg/ha (Meena and Yadav 2015; Meena *et al.* 2020a). The inbuilt mechanism of biological nitrogen fixation (BNF) enable pulse crops to meet 80-90% of their nitrogen (N) requirements, hence a starter dose of 15-25 kg N/ha is sufficient to meet out the requirement to most of the pulse crops. In the recent years micro-nutrients such as zinc (Zn) and iron (Fe) have improved productivity of pulse crops considerably in many pockets (Thiyagarajan *et al.* 2003 ; Meena and Lal 2015). A wide range of the soils have spread deficiency of Zn and Fe is a one of the reason to response the pulses productivity, and particularly in the light textured soils, having low organic carbon (OC) and alkaline reaction. In many parts of the country, Zn as a plant nutrient now stands third in importance next to N and phosphorus (P) (Takkar and Randhawa 1978 ; Meena *et al.* 2018). While ferro-sulfur proteins play an important role in N-fixation and electron movement in photosynthesis (Saini and Singh 2017). Organic manure application preserves the soil ecosystem through optimum soil biological activity, which sustains the soil fertility (Meena *et al*. 2017). Large-scale application of manure plays an important role to improve the soil fertility and productivity of soils through its positive effects on soil physical, chemical and biological properties, and balanced plant nutrition (Kumari *et al*. 2012). Research information on the conjunctive application of organic manures and fertilizers to increase the yield of mungbean and improves soil fertility in rice-wheat system of the Indo-Gangetic Plain Zone (IGPZ). The aim of this study was to evaluate the response of organic manures and fertilizers on short-term effects on mungbean growth, yield, quality, and treatment response to the soil fertility. Therefore, looking on yield levels and increasing of alternative strategy to nutrient application to the mungbean in the rice-wheat system of India.

A field experiment was carried out during summer 2017 at the Agricultural Research Farm, Institute of Agricultural Sciences (IAS), Banaras Hindu University (BHU), Varanasi, Uttar Pradesh (India) situated under North East Plain Zone of the country. Agricultural Research Farm is situated at a distance of about 10 km from the Varanasi Railway Station in the South-East direction and lies in the North Gangetic alluvial plain, on the left side of river Ganges. It is located at 25.20 N latitude and 83.00 E longitudes and at an altitude of 75.7 m above the mean sea level (MSL). The homogeneous composite soil samples were collected to appropriate analysis. The top soil layer contains available N (236.4 kg/ha), P (22.6 kg/ha), potassium (K) (280.6 kg/ha), organic carbon (0.36%), pH (7.32) and electrical

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conductivity (EC) 0.29 dS/m at 25^{0}C. Recommended dose of fertilizer (RDF) was applied @ 20, 40 and 20 kg N, P and K/ha. The amount of NPK were given through urea, diammonium phosphate (DAP), muriate of potash (MOP), Zn through $ZnSO_4.7H_2O$ @25 kg/ha and Fe through $FeSO_4.7H_2O$ @ 50 kg/ha. Vermicompost, biochar, pressmud and FYM were applied as per treatment (3 t/ha each), 15 days before sowing and thoroughly incorporated in soil with the help of spade as per treatment. The seed rate 15 kg/ha of mungbean variety HUM-16 (Maliviya Jankalyani) was used for the experimentation. Critical difference (CD) values at p= 0.05 were used to determine the significance of differences between mean values of treatments (Draper and Smith 1998).

The perusal of the data presented in the Table 1, the treatment organic sources were significantly influenced the growth parameters of mungbean. Results indicated that the application of the pressmud @3 t/ha recorded a significant response to the plant height (51.74 cm) and dry matter accumulation (DMA) (15.32 g/plant) at harvest, leaf area index (LAI) (3.76), number of trifoliate leaves (12.32) and chlorophyll content (44.41 SPAD value) at 45 DAS, which were significantly at par with the application of vermicompost @ 3 t/ha. However, the minimum value of these parameters were recorded with the application of biochar @ 3 t/ha. This may be obtained due to the beneficial effect of pressmud to enhance the macro and micronutrients availability in soil during the period of crop. It might have attributed to higher manufacture of food and its subsequent partitioning in sink. As a result almost all growth attribute of crop resulted into significant improvement due to application of pressmud, the results confirmed with the work done by Singh and Pareek (2003). It is an established fact that vermincompost improves the physical and biological properties of soil. Vermicompost increases the supply of all essential plant nutrients for the growth and development of plants. These results are in agreement with Tak (2003) and Meena *et al*. (2016). It is also indicated from the Table 1 that the application of 125% RDF +Zn +Fe produced significantly highest plant height (51.76 cm) and DMA (15.32 g/plant) at harvest, LAI (3.76), number of trifoliate leaves (12.33) and chlorophyll content (44.42 SPAD value) at 45 DAS, while, it was statistically at par with the application of 100% RDF +Zn +Fe. Singh *et al*. (2010) reported that N application at the vegetative, flowering or pod filing stages can potentially increase the proportion of plant N derived from N fixation. To the establishment and vigorous growth of legumes ensure good development of nodules and thus resulting in the high N fixation. P has a specific role in nodule formation and microbial activities in the soil, the adequate supply of this nutrient might have increased growth attributes (Kumawat *et al*. 2010a). Zn plays a regulatory role in the intake and efficient use of water by plants. It acts as an activator of several enzymes in plants and is directly involved in the biosynthesis of growth substances (Meena and Lal 2018; Meena *et al*. 2018). It enhances photosynthesis at early growth of plants, and improves growth parameters of mungbean plants. Iron is an essential component of many enzymes. It also enters into oxidation processes that release energy from sugars and starches and reactions that convert

Table 1 Effect of organic and inorganic sources of nutrients on growth parameters of mungbean

Treatment	Plant height (cm)		DMA (g/plant)				LAI				No. of trifoliate leaves (45 DAS)	Chlorophyll contain (SPAD value) (45 DAS)
	20 DAS	At harvest	15 DAS	30 DAS	45 DAS	At harvest	15 DAS	30 DAS	45 DAS	At harvest		
Organic sources (3 t/ha)												
Biochar	23.92	40.67	0.518	3.72	8.40	12.04	0.206	0.540	2.96	2.55	9.73	34.19
FYM	25.00	44.30	0.539	4.08	8.98	13.11	0.213	0.602	3.22	2.76	10.58	37.54
Vermicompost	25.68	48.16	0.552	4.44	9.60	14.26	0.219	0.668	3.50	2.98	11.48	41.10
Pressmud	26.11	51.74	0.559	4.78	10.17	15.32	0.214	0.729	3.76	3.19	12.32	44.41
SEm±	0.65	1.01	0.019	0.10	0.16	0.30	0.008	0.017	0.07	0.06	0.24	0.93
CD (P=0.05)	NS	3.48	NS	0.35	0.56	1.03	NS	0.059	0.25	0.20	0.81	3.21
Inorganic sources												
Control	23.79	36.25	0.515	3.32	6.89	10.73	0.205	0.464	2.65	2.29	8.70	30.11
50% RDF+ Zn+ Fe	24.97	41.56	0.538	3.82	8.74	12.30	0.213	0.555	3.03	2.61	9.94	35.01
75% RDF +Zn+ Fe	25.33	47.36	0.546	4.37	9.67	14.02	0.209	0.654	3.44	2.93	11.30	40.36
100% RDF+ Zn+ Fe	25.74	51.76	0.551	4.78	10.37	15.32	0.215	0.729	3.76	3.20	12.33	44.42
125% RDF+ Zn+ Fe	26.05	54.17	0.560	4.99	10.76	16.04	0.224	0.771	3.93	3.31	12.89	46.65
SEm±	0.69	0.96	0.015	0.09	0.15	0.29	0.007	0.017	0.07	0.05	0.23	0.89
CD (P=0.05)	NS	2.78	NS	0.26	0.44	0.82	NS	0.048	0.20	0.15	0.65	2.56

FYM: Farmyard Manure; RDF: Recommended Dose of Fertilizers; Zn: Zinc; Fe: Iron; DMA: Dry Matter Accumulation; LAI; Leaf Area Index

Table 2 Effect of organic and inorganic sources of nutrients on yield attributes, yield, quality and economics of mungbean

Treatment	Pod length (cm)	No. of pods/ plant	No. of seeds/ pod	Test weight (g)	Grain yield (kg ha)	Straw yield (kg/ha)	Biological yield (kg/ha)	Harvest index (%)	Protein content (%)	Protein yield (kg/ha)	Net eturn (₹/ha)	B:C ratio
Organic sources (3 t/ha)												
Biochar	7.01	23.81	9.84	4.56	795	2000	2795	28.30	19.14	156	27094	1.28
FYM	7.58	26.04	10.67	5.02	895	2194	3089	28.65	20.62	191	31720	1.41
Vermicompost	8.18	28.41	11.54	5.48	1000	2332	3299	29.69	22.18	229	34095	1.30
Pressmud	8.74	30.62	12.35	5.94	1098	2527	3584	30.03	23.64	266	39905	1.53
SEm±	0.16	0.62	0.23	0.13	28	36	57	0.81	0.41	10	1507	0.06
CD (P=0.05)	0.55	2.14	0.79	0.44	95	125	198	NS	1.41	34	5216	0.21
Inorganic sources												
Control	6.31	21.08	8.84	4.02	675	1853	2511	26.63	17.37	119	19557	0.91
50% RDF+ Zn+ Fe	7.14	24.35	10.04	4.69	820	2162	2965	27.38	19.50	163	26578	1.15
75% RDF +Zn+ Fe	8.06	27.92	11.36	5.39	978	2293	3254	29.72	21.86	218	34831	1.45
100% RDF+ Zn+ Fe	8.75	30.63	12.36	5.93	1098	2458	3539	30.82	23.64	263	41012	1.67
125% RDF+ Zn+ Fe	9.12	32.12	12.90	6.21	1164	2550	3689	31.29	24.62	290	44040	1.72
SEm±	0.15	0.59	0.22	0.12	26	36	56	0.15	0.39	10	1484	0.06
CD (P=0.05)	0.44	1.71	0.63	0.35	76	102	161	0.45	1.13	28	4276	0.18

nitrate to ammonium in the plant (Meena *et al*. 2018a).

The perusal of data from Table 2 indicated that the maximum pod length (8.74 cm), number of pods (30.62), number of seeds/pod (12.35), test weight (5.94 g), grain yield (1098 kg/ha), straw yield (2527 kg/ha), biological yield (3584 kg /ha), harvest index (30.03), protein content (23.64%) and protein yield (266 kg/ha) were recorded in the application of pressmud @ 3 t/ha, which remains at par with vermicompost @ 3 t/ha. Moreover, lowest parameters were recorded in the biochar @3 t/ha treated plots. It may be due to slow mineralization/decomposition of the biochar in the early years. Such increase may be due to release of macro and micronutrients during the course of microbial decomposition. Organic matter also function as a source of energy for soil microflora which bring about the transformations of inorganic nutrients held in soil or applied in the form of fertilizers in a form that is readily utilized by growing plants (Singh and Pareek 2003). This indicates that application of vermicompost increases the efficiency of inorganic phosphorus. Organic fertilizers help to increase the organic matter contents of soil, thus reducing the bulk density and decreasing compaction. Hence, plants get a suitable growing environment which promotes better growth and development (Saini and Singh 2017; Meena *et al.* 2020b). Vermicompost alone or in combination with fertilizer improve the fertility status of soil. Increased nutrient availability might have increased the synthesis of protein in grain (Anjum *et al.* 2006). Data pertaining (Table 2) on the yield parameters indicated that application of 125% RDF +Zn +Fe produced highest pod length (8.75 cm), number of pods (30.63), number of seeds (12.36), test weight (5.94 g), grain yield (1098 kg/ha), straw yield (2458kg/ha), biological yield (3539kg/ha), harvest index (30.82), protein content (23.64%) and protein yield (263 kg/ha) however, it was statistically at par with the application of 100% RDF +Zn +Fe. The enhancement in mungbean yield with P might be due to increase in P availability that lead to better translocation of photosynthates towards sink with consequent improvement in yield attributes (Kumawat *et al*. 2010b; Meena *et al.* 2017). Application of Zn helps to improved growth attributes over control, which was mainly due to their direct and indirect role in many physiological activities in plant (Nair *et al*. 2013). The increased vegetative growth and the balanced C:N ratio might have increased the synthesis of carbohydrates, which ultimately promoted yield (Dadhich and Meena 2014). Crude protein content in mungbean seeds significantly increased with an increase in the availability of N. This was mainly due to the structural role of N in building up amino acids (Singh *et al*. 2010).

The perusal of the data (Table 2) indicated that the maximum net return (39905 ₹/ha) was recorded in the application of pressmud @ 3 t/ha and followed by vermicompost @ 3 t/ha (34095 ₹/ha). The maximum BC ratio (1.53) was recorded in the application of pressmud @ 3 t/ha and followed by FYM @ 3 t/ha(1.41). Furthermore, the results indicated that with the application of 125% RDF +Zn +Fe produced highest net return (41012 ₹/ha), BC ratio (1.67), while, it was statistically at par with the application of 100% RDF +Zn +Fe in net return (44040 ₹/ha) and B: C ratio (1.72).

SUMMARY

The study concluded that response of organic manures and fertilizers application of 125% RDF+ Zn+ Fe+ pressmud improved the growth parameters, yield attributes, yields and quality of seed found best treatment combination, and also in terms of net return and B: C ratio. It is concluded that the application of better combination of the organic and inorganic sources of the nutrients helps to the farmers, to get the economically better mungbean yield and enhance the soil fertility in the rice-wheat cropping system belt of India. Demand of the country to sustain the rice-wheat cropping system and food security can be achieved through the application of organic manures and fertilizer with diversification of crop with pulse based cropping system.

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