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Mungbean yield and nutrient uptake performance in response of NPK and lime levels under acid soil in Vindhyan region, India

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Abstract: A field experiment was conducted to understanding the management of soil acidity with NPK and lime levels for sustainable mungbean productivity, Crop was sown during kharif season of 2014at Agronomy farm of Rajiv Gandhi South Campus Banaras Hindu University, Barkachha, Mirzapur, Uttar Pradesh. Results of the study demonstrated that significant improvement in seed (524 kg /ha), straw (1426 kg /ha), biological yield (1949 kg/ha) and total NPK uptake (96.68 kg/ha) were recorded in 100% RDF. Similar results were observed with application of 200 kg lime/ha in mungbean. Interaction effect was also recorded at P=0.05 level of significance between fertility and lime levels on mungbean seed (622 kg/ha) and biological (2145kg/ha) yield with 100 % RDF + 200 kg lime/ha which were observed highest than all other treatments. Moreover, highest B:C ratio was observed with the application of 200 kg lime/ha. The present study revealed that soil acidity problems affecting pulses productivity, can be overcome with applications of 100% RDF and 200 kg lime/ha in Vindhyan region, India.

Keywords: Acid soil, Fertility Levels, Lime, Mungbean, Yield

INTRODUCTION

India grows nearly 24 million ha of pulses with the annual production of 18.50 million tonnes and productivity is 730 kg/ha, whereas USA and Canada's productivity is as high as 1900Kg/hectare.(GOI, 2015). Mungbean [*Vigna radiate* (L.) Wilczek] is widely used in India and is consumed as dehusked green gram split (dhal) in the form of cooked dhal and deep fat fried snack item. The composition of mungbean split (per 100 g) is as follows: protein 21-24 g, fat 1.31 g, minerals 3.48 g, fiber 4.11 g, carbohydrates 56.72 g, energy 334 kcal, calcium 124 mg, phosphorous 326 mg and iron 4.42 mg (Gopalan *et al.,* 2002; Dhakal *et al*., 2015). Acid soils make up approximately 30% of the world's total land area and more than 50% of the world's potentially arable lands, particularly in the tropics and subtropics (Kochian *et al.,* 2004; Meena and Yadav, 2014). Soil acidity is a major factor affects root growth and nutrient availability to the plants. Acidic soils cause's significant losses in mungbean production and where the choice of crops is restricted to acid tolerant species and varieties, profitable market opportunities may be reduced. The associated chemical changes in the soil can restrict the availability of essential plant nutrients specially; macro nutrients are i.e. nitrogen, phosphorus and potassium. Essential plant nutrients can also be leached below the rooting zone in acid soil. Biological processes favorable to plant growth may be affected adversely by acidity (Lambridge and Godwin, 2007). Soil acidity have a major impact on mungbean productivity for sustainable farming systems, and acidification can also extend into subsoil layers posing serious problems for plant root development and remedial action.Application of finely crushed limestone, and other liming material, is the only practical way to neutralize the soil acidity (Alleoni *et al.,* 2010). The most commonly used liming material is agricultural limestone, the most economical and relatively easy to manage source. The limestone is not very water-soluble, making it easy to handle. Hence, the present field study was carried out to find out appropriate soil acidity management with lime to increase mungbean productivity with NPK application in acid soil of vindhyan region, India.

MATERIALS AND METHODS

A field experiment was conducted during kharif season of 2014-15 at Agronomy farm of Rajiv Gandhi South Campus Banaras Hindu University, Barkachha, Mirzapur, Uttar Pradesh (Fig. 1). This is situated in Vindhyan region of district Mirzapur (25^0 10' latitude, 82^0 37' longitude and altitude of 89 meters above mean sea level. This region comes under agro-climatic zone III A (Semi-Arid Eastern Plain Zone) and the region is mostly rainfed. Crop was sown in agro-horti based system between rows of custard appletree spacing of 7 X 7 meter, custard appletrees were 8 year old planted in august 2008. The soil of the experimental site was sandy loam and having 186 kg/ha alkaline permanganate oxidizable N (Subbiah and Asija, 1956), 20.98kg/ha available P (Olsen *et al*., 1954). Available K 243.48 kg/ha analyze with flame photometer method (Stanford and English, 1949) and 0.37% organic carbon (Walkely and Black, 1947). The pH of soil was 5.81 analyzed with glass electrode pH meter (Jackson, 1973). The experiment was laid out in factorial randomize block design with three replications assigning 16 treatments combinations consisting four levels of fertility @ Recommended dose of fertilizers i.e. (Control, 75% RDF, 100% RDF, 125% RDF) and lime (Control, 100 kg/ha, 200 kg/ha, 300 kg/ha). RDF was 20:40:20 kg /ha (N_2:P_2O_5:K_2O). Mungbean variety HUM 12 was sown at a spacing of 30 cm x 10 cm on 15 August in 2013. Application of RDF (Recommended dose of fertilizers) were applied as per treatment through Urea, DAP and MOP basally in the furrows just before sowing at depth of 8-10 cm. Lime was used for surface application before sowing at a depth of 15 cm. All the data obtained were statistically analyzed using the F-test (Gomez and Gomez, 1984). Critical difference (CD) values at P=0.05 were used for determine the significance of differences between mean values of treatments.

RESULTS AND DISCUSSION

Crop and weather: The climate of experimental Agricultural Research Farm is typically semi-arid to sub-humid, characterized by extremes of temperature both in summer and winter with low rainfall and moderate humidity. Maximum temperature in summer is as high as 45 ^{0}C and minimum temperature in winter falls below 10 ^{0}C. The rainfall was received 564.14 mm during the experiment conducted on mungbean,out of the total rainfall more than 56.57 per cent received between 34 to 35 Standard Meteorological Weeks (SMW). Maximum and minimum temperature fluctuated between 35.95ºC and 24.16 ºC and relative humidity between 97.47 and 91.11 are presented in Fig.1 [Source: Observatory, KrishiVigyan Kendra, R.G.S.C, BHU, Mirzapur (UP), India].

Effect of fertility levels: Results were concluded that to understanding the management of fertility levels on mungbean.The data parented (Table1and2) show that amongst RDF of fertility levels, maximum improvement at P=0.05 level of significancein seed, straw, biologicalyields and NPKuptake were re-

Table 1. Effect of fertility and lime levels on yields and harvest index of mungbean.

Treatment	Yield (kg /ha)			Economics
	Seed	**Straw**	**Biological**	**B:C ratio**
Fertility levels (% RDF)				
Control	346	1207	1554	2.04
75	429	1.29	757	2.08
100	524	1425	1949	2.18
125	526	1426	1952	2.08
SEm±	0.03	0.06	0.08	-
CD (P = 0.05)	0.09	0.18	0.24	-
Lime levels (kg/ha)				
Control	355	1216	1572	2.08
100	426	1327	1752	2.13
200	520	1419	1938	2.23
300	524	1424	1949	2.14
SEm±	0.03	0.06	0.08	-
CD (P = 0.05)	0.09	0.18	0.24	-

RDF= Recommended dose of fertilizer.

Table 2. Interaction effect of fertility and lime levels on yield (kg/ha) of mungbean.

Fertility/Lime levels (kg/ha)	Control	75 % RDF	100 % RDF	125 % RDF	Mean
Seed yield					
Control	297	363	373	387	355
100	322	426	459	497	426
200	393	466	622	597	520
300	373	459	638	621	524
Mean	346	429	524	526	456
CD (P = 0.05)	019	SEm±	06		
Biological yield					
Control	1339	1626	1647	1675	1572
100	1547	1751	1817	1894	1752
200	1682	1833	2145	2094	1938
300	1647	1818	2186	2144	1949
Mean	1554	1757	1949	1952	1803
CD (P = 0.05)	48	SEm±	17		

RDF= Recommended dose of fertilizer.

Table 3. Effect of fertility and lime levels on total nutrient NPK uptake by mungbean.

Treatments	Nutrient uptake (kg /ha)			Total NPK uptake (kg /ha)
	Nitrogen	Phosphorus	Potassium	
Fertility levels (% RDF)				
Control	22.20	3.18	26.37	51.75
75	31.60	4.59	35.07	71.26
100	43.08	6.35	47.25	96.68
125	43.25	6.36	47.43	97.04
SEm±	0.47	0.07	0.38	0.77
CD (P=0.05)	1.35	0.19	1.09	2.24
Lime levels (kg/ha)				
Control	23.20	3.34	27.32	53.85
100	31.78	4.63	35.01	71.43
200	42.12	6.19	46.38	94.69
300	43.03	6.32	47.41	96.76
SEm±	0.47	0.07	0.38	0.77
CD (P=0.05)	1.35	0.19	1.09	2.24

RDF= Recommended dose of fertilizer.

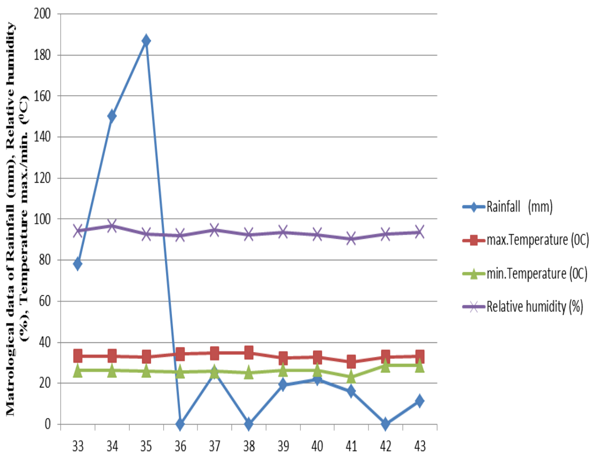

Fig. 1. *Mean week-wise meteorological data during crop season kharif 2013.*

corded in 100% RDF.Macro nutrientsNPK were more responsive for vegetative growth, and play important role for crop growth and development (Meena *et al.,* 2013; Meena *et al,.* 2015a). Nitrogen is a component of chlorophyll and is required for several enzyme reactions for better plant growth. The right amount of phosphorus can help crops yield more pods and create healthier stocks and root systems (Meena *et al.,* 2015b). Both nutrients are playskey role in mungbean seed formationand are responsible for keeping the system operating smoothly of mungbean plants, overall an increase in seed, straw, biological yield and nutrient contentwere mainly attributed to greater number of growth and yield parameters of mungbean. Potassium is important for a plant's ability to withstand in extreme conditions (Sheldrick *et al.,* 2011; Meena and Yadav, 2015). In general, NPK were responsible for increased plant height, nodulation pattern, growth and yield parameters or ultimately yields and quality of mungbean. The present results are also in agreement with the findings on legume crops work has been done by several workers Browne *et al.* 2008; Awomi*et al.* 2012; Meena, 2013; Meena*et al.,* 2015b.

Effect of lime levels: Amongst lime levels, similarly results parented (Table1and2) that amongst lime levels, maximum improvement were recordedat *P*=0.05 level of significancein seed, straw, biological yields and NPK uptake in mungbean (Table 2) were recorded in lime application 200 kg/ha. Lime is usually added to acid soils to increase soil pH. Soil acidity management with lime is increase crop production due to increase nutrient availability in soil; primarily by improve root growth due to increase NPK and other nutrients availability for plant (Brady and Weil,2002).Moreover, acidic soils are poor in their basic cautions and some micronutrients which are as essential to crop growth and productivity. This was further substantiated by several reports that application of lime on acid soils is beneficial in situation where nutrients in the soil are made unavailable due to very low pH or high acidity (Wang *et al.,* 2006).

Interaction effect: Interaction effect was recorded at *P*=0.05 level of significance between fertility and lime levels on seed and biological yield of mungbean with 100 % RDF + 200 kg lime/ha which were observed highest than all other treatments (Table 3). Liming is a common practice used to improve soil properties. It has both direct and indirect positive effect on soil acidity, mobilization of plant nutrients, soil aggregates and structure, biological activities of soils (Tyler and Olsson, 2001; Bolan *et al.,* 2003; Meena *et al.,* 2015).

Conclusion

The present study concluded that soil acidity problems are commonly affect pulses productivity, it can be overcome with applications of 100% RDF and 200 kg lime/ha in Vindhyan region, India. Results of the study demonstrated that significant improvement in seed (524 kg /ha), straw (1426 kg /ha), biological yield (1949 kg/ha) and total NPK uptake (96.68 kg/ha) were recorded in 100% RDF. Similar results were observed with application of 200 kg lime/ha in mungbean. Interaction effect was also recorded at *P*=0.05 level of significance between fertility and lime levels on mungbean seed (622 kg/ha) and biological (2145kg/ha) yield with 100 % RDF + 200 kg lime/ha which were observed highest than all other treatments. Soil acidity have a major impact on mungbean productivity for sustainable farming systems, and acidification can also extend into subsoil layers posing serious problems for plant root development and remedial action. On the basis of conducted field experiment recommended that limestone and other liming material, is the only practical way to neutralize the soil acidity and increase productivity of mungbean.

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