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Response of mungbean to fertility and lime levels under soil acidity in an alley cropping system of Vindhyan Region, India

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Abstract
A field experiment was conducted to find out the management strategy with fertility and lime levels in an acidic soil, and its response to mungbean production. The experiment was laid out in factorial randomized block design with three replications, assigned 16 treatments combinations consisting four levels of recommended dose of fertilizers (RDF) i.e. (0, 75%, 100%, 125% RDF) and lime (0, 100, 200 and 300 kg/ha), the RDF was 20:40:20 kg /ha (N_2: P_2O_5: K_2O). Results were obtained at critical difference (CD) values p=0.05 level. Among the treatments,significant improvement was recorded in 100% RDF on dry matter accumulation (g/plant) of root (9.121), leaf (1.573), stem (8.230), total dry matter/plant (14.37), number of trifoliate (13.03), Soil-Plant Analyses Development (SPAD) value (nmol/mg) of chlorophyll (49.09), yields kg/ha of grain (524), straw (1425) and biological (1949). Similarly, the application of 200 kg lime/ha was significantly increase in dry matter accumulation (g/plant) of root (9.041), leaf (1.559), stem (8.158), total dry matter/plant (14.25), number of trifoliate (12.41), SPAD value of chlorophyll (48.59), yields kg/ha of grain (520), straw (1419) and biological (1930). Hence, on the basis of conducted field experiment recommended @ 100% RDF and 200 kg lime/ha for better mungbean crop productivity in the vindhyan region, India.

Keywords: fertility levels, lime, mungbean, soil acidity, yield

Introduction

Mungbean is one of the important source of protein, carbohydrates, calcium, iron, thiamine, riboflavin, dietic fibres, zinc, copper, manganese, folic acid, thiamine, vitamin C, lysine, tryptophan, thrionine, methionine, cysteine, phosphorus, potassium, lipids, and fatty acids (Meena *et al.* 2015a) [15]. Soil acidity itself is not responsible for restricting plant growth and crop productivity; while the associated chemical changes in the soil can restrict the availability of essential plant nutrients especially nitrogen, phosphorus and potassium. The essential plant nutrients can also be leached below the rooting zone in acid soil. The biological processes such as photosynthesis, respiration, plant nutrition, plant hormone functions, tropisms, nastic movements, photoperiodism, photomorphogenesis, are favorable to plant growth may be affected adversely by acidity (Lambridge and Godwin, 2007; Meena *et al.* 2013a) [12, 14]. Without treatment, soil acidification has 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. The soil acidity can be corrected easily by liming or adding basic materials to neutralize the acid present in soil (Alleoni*et al.,* 2010). The most commonly used liming material is agricultural limestone, not only a good water-soluble source but also the most economical and relatively easy to manage. Hence, the present field study objective was to find out appropriate soil acidity management with lime to increase mungbean productivity and evaluate the application of RDF in the vindhyan region, India.

Materials and Methods

A field study was conducted during *Kharif* (summer) season, 2014 at Agronomy farm of Rajiv Gandhi South Campus, Banaras Hindu University, India, located at 25º 10' N latitude 82 º 37' E longitudes and an altitude of 427 meters above the mean Arabian Sea level. The crop was sown in an alley cropping system between the rows of 9-year old custard apple (*Annona squamosa*), tree spacing was 7 X 7 meter.

The mungbean variety HUM 12 was sown at a spacing of 30 x 10 cm on 15 August, 2014. The soil of the experimental site was sandy loam, and having alkaline permanganate oxidizable available N 187.05 kg/ha (Subbiah and Asija, 1956), 20.98 kg/ha available P(Olsen *et al.*, 1954) [17], available K 243.39 kg/ha, analyzed with flame photometer method (Stanford and English, 1949) [18] and 0.34% organic carbon as per chromic acid rapid titration method (Walkey and Black, 1934). The pH of soil was 5.6 analyzed with a glass electrode pH meter.The experiment was laid out in factorial randomize block design with three replications assigned 16 treatment combinations consisting four levels of fertility @ RDF i.e. (0, 75%, 100% , 125% RDF) and lime (0, 100, 200 and 300 kg/ha). The RDF was 20:40:20 kg /ha (N_2: P_2O_5: K_2O), RDF were applied as per treatment through urea, ammonium phosphate (DAP) and muriatic of potash (MOP) as the basal dose in the furrows just before sowing at a depth of 8-10 cm. Lime was applied before 15 days of sowing at a depth of 15 cm. All the data obtained were statistically analyzed using the *F*-test (Gomez and Gomez, 1984) [7]. The CD values at p=0. 05 were used for determining the significance of differences between mean values of treatments.

Results and Discussion

The data presented (Table1and 2) show that amongst RDF levels and lime levels observed significant higher than control plots on all growth and yields parameters. Results were obtained at critical difference (CD) values p=0. 05 level of significance, improvement of dry matter accumulation (g/plant) in root (9.121), leaf (1.573), stem (8.230), total dry matter/plant (14.37), number of trifoliate (13.03), SPAD value of chlorophyll (49.09), yields kg/ha of grain (524), straw (1425) and biological (1949) were recorded in 100% RDF. Similarly, application of 200 kg lime/ha gave improvement of dry matter accumulation (g/plant) in root (9.041), leaf (1.559), stem (8.158), total dry matter/plant (14.25), number of trifoliate (12.41), SPAD value of chlorophyll (48.59), yields kg/ha of grain (520), straw (1419) and biological (1930) were recorded maximum. However, dry matter accumulation was not influenced on early stage at 15 and 30 DAS.

According to Meena (2013) [14], NPK nutrients play an important role in vegetative growth and development of mungbean. Nitrogen is one of the major components of chlorophyll and essentially required for several enzyme activities in a plant system (Awomi *et al.*, 2012,) [2]. Likewise, the role of NPK in the mung bean plant to maintains cell division, carbohydrate production, stress management, protein synthesis, grain feeling (Meena *et al.*, 2015b) [15]. Moreover, similar results in agreement to improve the NPK avialblity to the mungbean crop better growth and productivity with the findings of Brown *et al*. 2008 [5]; Awomi *et al.* 2012 [2]; Jangir *et al.* 2016 [8].

The application of lime in an acidic soil increase nutrient availability, improving root growth and development of mungbean due to increased NPK nutrient availability (Brady and Weil, 2002) [4]. The application of lime in an acid soil not only replaces hydrogen ions, raises soil pH and makes NPK in more available from but also thereby increasing plant growth and development of legume crops (Zhao *et al.*, 2007) [21]. The application of lime in an acid soils is beneficial to mineralization of nutrient (NPK) availability, and create a better environment in the rhizospheric zone of the soybean plant under low soil pH or high acidity (Brown *et al.*, 2008; Bekere, 2013; Kebeney *et al.*, 2014; Kumar *et al.* 2017) [5, 3, 9, 11]. Similar results were observed in anexperiment on mung bean by Cifu *et al.* (2004) [6]. The experimenat was conducted on Sesamum, mungbean and cowpea in an acid soil with the application of lime @ 0.5, 1.0, 1.5, and 2.0 ton/ha, respectively. The highest rate of lime application was in favor to the decline the soil acidity, and increase NPK availability, neutralize soil pH and increase yield (Kumar *et al.* 2017a) [3].

Table 1: Effect of fertility and lime levels on dry matter patterning in mungbean

Treatment	Dry matter of roots /plant (g)				Dry matter of leaves /plant (g)				Dry matter of stem /plant (g)				Total dry matter /plant (g)			
	15 DAS	30 DAS	45 DAS	At harvest	15 DAS	30 DAS	45 DAS	At harvest	15 DAS	30 DAS	45 DAS	At harvest	15 DAS	30 DAS	45 DAS	At harvest
Fertility levels (%RDF)																
0	0.092	0.677	1.940	6.028	0.376	0.489	1.628	1.039	0.122	0.638	2.044	5.439	0.212	1.51	5.53	9.67
75	0.120	0.685	2.400	7.457	0.517	0.524	2.014	1.286	0.171	0.645	2.528	6.728	0.218	1.64	6.73	11.77
100	0.157	0.684	2.936	9.121	0.734	0.884	2.464	1.573	0.201	0.789	3.093	8.230	0.223	1.80	8.21	14.37
125	0.158	0.938	2.945	9.150	0.736	0.983	2.472	1.578	0.210	0.876	3.103	8.256	0.227	1.84	8.26	14.51
SEm±	0.006	0.097	0.018	0.056	0.032	0.175	0.015	0.010	0.007	0.123	0.019	0.051	0.02	0.01	0.06	0.13
CD (p 0.05)	NS	NS	0.052	0.162	NS	NS	0.044	0.028	NS	NS	0.055	0.147	NS	0.04	0.18	0.37
Lime levels (kg/ha)																
0	0.097	0.631	1.990	6.182	0.347	0.448	1.670	1.066	0.125	0.650	2.096	5.578	0.216	1.58	5.65	9.94
100	0.128	0.736	2.384	7.408	0.596	0.703	2.001	1.277	0.162	0.647	2.512	6.685	0.218	1.62	6.70	11.73
200	0.148	0.849	2.910	9.041	0.727	0.843	2.442	1.559	0.208	0.778	3.066	8.158	0.219	1.78	8.14	14.25
300	0.155	0.768	2.937	9.125	0.693	0.886	2.465	1.573	0.210	0.873	3.094	8.233	0.226	1.81	8.23	14.41
SEm±	0.006	0.097	0.018	0.056	0.032	0.175	0.015	0.010	0.007	0.123	0.019	0.051	0.004	0.01	0.06	0.13
CD (p 0.05)	NS	NS	0.052	0.162	NS	NS	0.044	0.028	NS	NS	0.055	0.147	NS	0.04	0.18	0.37

RDF: Recommended dose of fertilizer, DAS:Days after sowing, NS:Non significant

Table 2: Effect of fertility and lime levels on leaf, Chlorophyll contain and yields of mungbean.

Treatment	No. of trifoliate leaves at 45 DAS	Chlorophyll contain at 45 DAS (SPAD value)	Yield (kg /ha)		
			Seed	Straw	Biological
Fertility levels (%RDF)					
0	8.77	33.14	346	1207	1554
75	10.67	40.15	429	1329	1757
100	13.03	49.09	524	1425	1949
125	13.09	48.95	526	1426	1952
SEm±	0.10	0.35	003	006	008
CD (p 0.05)	0.29	1.02	009	018	024
Lime levels (kg/ha)					
0	8.96	33.96	355	1216	1572
100	10.63	40.07	426	1327	1752
200	12.91	48.59	520	1419	1938
300	13.06	48.72	524	1424	1949
SEm±	0.10	0.35	003	006	008
CD (p 0.05)	0.29	1.02	009	018	024

RDF: Recommended dose of fertilizer

Conclusion

The present study concluded that soil acidity problems affected mung bean yield in an custard apple based alley cropping. The maximum improvement in the mung bean yields *viz*. seed (524 kg /ha), straw (1426 kg /ha), and biological yield (1949 kg/ha) were recorded for the application of 100% RDF. Soil acidity had a major impact on food grain production, and acidification can also extend into subsoil layers posing serious problems for crop growth and development. As per the experimental results, it was recommended that @ 100% RDF and 200 kg lime/ha, is the only practical way to neutralize the soil acidity and increase pulses productivity in Vindhyan region of India.

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