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VS Ranpariya
Department of Agricultural Chemistry and Soil Science Junagadh Agricultural University, Junagadh, Gujarat, India

KB Polara
Department of Agricultural Chemistry and Soil Science Junagadh Agricultural University, Junagadh, Gujarat, India

DV Hirpara
Department of Agricultural Chemistry and Soil Science Junagadh Agricultural University, Junagadh, Gujarat, India

KH Bodar
Department of Agricultural Chemistry and Soil Science Junagadh Agricultural University, Junagadh, Gujarat, India

Correspondence
VS Ranpariya
Department of Agricultural Chemistry and Soil Science Junagadh Agricultural University, Junagadh, Gujarat, India

Effect of potassium, zinc and FYM on content and uptake of nutrients in seed of summer green gram (*Vigna radiata* L.) and post harvest soil fertility under medium black calcareous soil

VS Ranpariya, KB Polara, DV Hirpara and KH Bodar

Abstract
An field experiment was conducted at Instructional Farm, College of Agriculture, Junagadh Agricultural University, Junagadh during *summer* season of 2016 to evaluate soil application of potassium, zinc and FYM and effect on nutrient content and uptake of green gram (*Vigna radiata* L.) under south Saurashtra region of Gujarat. The experiment comprising of Three levels of potassium *viz.*, 0, 40, and 60 kg K_2O ha^{-1}, zinc sulphate *viz.*, 0 and 10 kg $ZnSO_4$ ha^{-1} and FYM *viz.*, 0 and 5 t ha^{-1} and experiment was laid out in Factorial Randomized Block Design and replicated thrice. The results revealed that the content and uptake of nutrients by seed were significantly influenced by the various levels of potassium, zinc and FYM. The application of potassium 40 and 60 kg K_2O ha^{-1}, zinc sulphate 10 kg $ZnSO_4$ ha^{-1} and 5 t ha^{-1} FYM significantly increased the N, P, K, S and Zn content and uptake of all nutrients. Potassium, zinc and FYM also increased all nutrient availability in soil after harvest of crop.

Keywords: *Vigna radiata*, Potassium, Zinc sulphate.

Introduction
India is one of the major pulses growing country of the world, accounting roughly for one third of total world area under pulse cultivation and one fourth of total world production. Pulses occupy a key position in Indian diet and meet about 30 per cent of the daily protein requirement. Green gram commonly known as “mung” or “mung bean” is the most important crop of the South-East Asia and particularly the Indian sub-continent. This popular and ancient crop is specially recognized as an excellent source of protein. It also plays an important role in maintaining and improving the fertility of soil through its ability to fix atmospheric nitrogen in the soil by root nodules.

Potassium is one of the essential nutrient for plant growth and vital for sustaining modern high yield agriculture. Plant needs large quantities of potassium which not only improves the crop yield, but crop quality also. Hence potassium fertilization results in higher value product and therefore in a greater return to farmers. It is a prime factor for deciding the market price of green gram grown, which improve the income of farmers just by improving the quality of produce (Krishna, 1995) [7].

Among the micronutrients, zinc plays vital role in plant growth and development. Zinc also catalyses the biosynthesis of indol acetic acid, acting as metal activator of the enzyme, there by ultimately increasing crop yield. Moreover, it controls the equilibrium between CO2, water and carbonic acid in plant metabolism and helps in synthesis of nucleic acids, proteins and stimulates seed formation. Its deficiency retards photosynthesis and nitrogen metabolism. The end result is lower yield; poor produce quality and sub optimal nutrient use efficiency. Mungbean also respond to zinc application.

Organic manures like farm yard manures and compost have been traditionally used as input for improving soil physical, chemical and biological properties as well as maintain soil fertility which has resulted in yield stability. Guar *et al*. (1990) [5] reported that organic nitrogen is slowly mineralized and about 30 percentage N, 60 to 70 percentage P2O5 and 75 percentages K2O is likely become available to the first crop and rest of the nutrients to succeeding crops. Therefore, an experiment planned to know the effect of potassium and zinc with FYM on yield and quality of green gram.

Materials and Methods

The experiment was conducted at Instructional Farm, College of Agriculture, Junagadh Agricultural University, Junagadh during *Summer* season of 2015-16. The soil of the experimental field was clayey in texture and alkaline in reaction (pH of 8.0 and EC of 0.56 dS m^{-1}). The soil was low in available nitrogen (225 kg ha^{-1}), medium in available phosphorus (36 kg ha^{-1}), medium in available potassium (185 kg ha^{-1}), medium in available sulphur (15.64 ppm), medium in iron (5.26 ppm), high in zinc (0.50 ppm), high in manganese (16.77 ppm) and high in copper (2.07 ppm). The experiment comprised of total twelve treatment combinations in which three levels of potassium (0, 40 and 60 K_2O kg ha^{-1}), two levels of zinc (0 and 10 $ZnSO_4$ kg ha^{-1}) and two levels of FYM (0 and 5 t ha^{-1}) were laid out in Randomized Block Design having factorial concept with three replications. The fertilizer application was done with fixed doses of nitrogen at 20 kg ha^{-1} and phosphorus at 40 kg ha^{-1}. Potassium, zinc and FYM application was done according to the treatments. The nutrients of N, P, K and Zn were applied by using sources of Urea, DAP, MOP and zinc sulphate (WG 35% Zn), respectively. The Green gram variety "Gujarat Mung - 4" was planted in third week of January with spacing of 30 m × 10 m and seed rate of 25 kg ha^{-1}. The crop was raised with all the standard package of practices and protection measures also timely carried out as they required. The experimental data recorded for growth parameters, yield attributes and yield parameters were statistically analyzed for level of significance.

Results and Discussion

Effect of potassium

Nutrient content and uptake by seed

The concentration of potassium recorded significantly higher in seed with the values of 0.7 % at potassium applied @ 60 kg K_2O ha^{-1} at harvest. The concentration of nitrogen, phosphorus, and zinc recorded significantly higher in seeds with values of 3.51%, 0.47% and 51.6 mg kg^{-1} at potassium applied @ 60 kg K_2O ha^{-1}at harvest. The concentration of sulphur and micro-nutrient in seed did not influenced by potassium application. The increase in N, P, K and Zn content might be due to favourable effect of availability of N, P, K and Zn at the higher level of potash. These finding are close agreement with those obtained by Anwar (2012) [1] in green gram.

The uptake of nitrogen, phosphorus, potassium, sulphur and micro-nutrient by seeds of green gram was increased with increasing potassium rate at harvest. The application of potassium @ 60 kg K_2O ha^{-1} showed significantly higher value of nitrogen (45.81 kg ha^{-1}) and phosphorus (6.26 kg ha^{-1}) uptake by seed. Similar trend was observed for the uptake of potassium (9.2 kg ha^{-1}) and (3.85 kg ha^{-1}) sulphur by seed. Similar trend was observed for the uptake of micro-nutrient like iron (774 g ha^{-1}), manganese (78.83 g ha^{-1}), zinc (66.99 g ha^{-1}) and copper (70.09 g ha^{-1}) uptake by seed with the application of 60 kg K_2O ha^{-1}. Abbasi *et al.* (2012), Ingle (2010), Sarker *et al.* (2012), Singh *et al.* (1993) [16] and Baldha (2009) [2] were also observed the same trend of results in green gram.

Post harvest soil fertility

The available potassium in soil significantly influenced by potassium application at various levels. The available potassium was recorded significantly higher with the application of 60 kg K_2O ha^{-1} with respective value of 216 kg ha^{-1}over that of control while, the availability of N, P_2O_5, S and pH, O.C and EC did not influenced by potassium application. Same trend for available K in soil was observed by Bhuma and Selvakumari (2015) [3] after harvest of crop.

Effect of zinc

Nutrient content and uptake by seed

The concentration of zinc recorded significantly highest in seed with the values of 50.96 mg kg^{-1} at zinc applied @ 10 kg $ZnSO_4$ ha^{-1} respectively. The concentration of N and S recorded significantly highest in seed with values of 3.63% and 0.81% at zinc applied @ 10 kg $ZnSO_4$ ha^{-1} at harvest. The concentration of P, K and micro nutrients did not influenced by zinc application. Zinc exerts beneficial effect on N-assimilation via its influence on nitrate reductase activity. Thus N content in seeds are significantly increased following uptake by application of zinc. Chaudhary *et al.* (2014) [4] were also observed the same trend of results in green gram.

The uptake of nitrogen, phosphorus, potassium, sulphur and micro-nutrient by seed were increased with application of zinc. The application of zinc @ 10 kg $ZnSO_4$ ha^{-1} showed significantly higher value of nitrogen (45.66 kg ha^{-1}) and phosphorus (5.88 kg ha^{-1}) uptake by seeds. Similar trend was also observed for the uptake of potassium (8.74 kg ha^{-1}) and sulphur (3.55 kg ha^{-1}) by seed. Similar trend was observed for the uptake of micro-nutrient like iron (740 g ha^{-1}), manganese (74.02 g ha^{-1}), zinc (63.38 g ha^{-1}) and copper (63.65 g ha^{-1}) uptake by seed with the application of 10 kg $ZnSO_4$ ha^{-1}. Comparable results were also obtained by Sesode (2008) [15], Mathukia (2004) [9], Manivasagaperumal *et al.* (2012) [8], Roy *et al.* (2013) [12] and Sitaram *et al.* (2013) [17] in green gram.

Post harvest soil fertility

The available zinc in soil after harvest of crop significantly influenced by zinc application. The available zinc and sulphur were recorded significantly higher under the application of 10 kg $ZnSO_4$ $ha^{-1}$with respective value of 0.63 mg $kg^{-1}$and 17.94 kg ha^{-1}over that of control while, the availability of N, P_2O_5, K_2O and pH, O.C. & EC did not influenced significantly by zinc application. Same trend was observed by Singh and Bhatt (2014) [4] with green gram.

Effect of FYM

The concentration of zinc recorded significantly highest in seed with the values of 50.26 mg kg^{-1} at FYM applied @ 5 t ha^{-1} at harvest. The concentration of P and K recorded significantly highest in seed with values of 0.46% and 0.70% at FYM applied @ 5t ha^{-1}at harvest. The concentration of N, K and micronutrients did not influenced by zinc application.

The uptake of nitrogen, phosphorus, potassium, sulphur and micro-nutrient by seed were increased with FYM application. The application of FYM @ 5 t ha^{-1}showed significantly higher value of nitrogen (43.95 kg ha^{-1}), phosphorus (6.07 kg ha^{-1}), potassium (8.92 kg ha^{-1}) and sulphur (3.69 kg ha^{-1}) uptake by seed. Similar trend was observed for the uptake of micro-nutrient like iron (749 g ha^{-1}), manganese (74.35 g ha^{-1}), zinc (64.26 g ha^{-1}) and copper (64.98 g ha^{-1}) uptake by seed with the application of FYM @ 5 t ha^{-1}. Application of FYM provides half of the N, third part of P and full of K availability and further increase microbial population that assimilates N from atmosphere thus N uptake along with other nutrients are significantly increase in seeds of green gram. Saravanan *et al.* (2013) [13], Meena (2013) [10], Ram *et al.* (2012) [11] and Sulbha (2015) [18] also observed the same trend of results in green gram.

Post harvest soil fertility

The available macro and micro nutrient in soil were significantly influenced by FYM application after harvest of crop. The available N, P, K, and S was significantly higher recorded under the application of FYM @ 5 t ha^{-1} with respective value of 255, 43.08, 203 kg ha^{-1} and 17.87 mg kg^{-1}over that of control, while similar trend was observed for the available soil micronutrient like iron (5.5 mg kg^{-1}), manganese (20.17 mg kg^{-1}), zinc (0.55 mg kg^{-1}) and copper (2.87 mg kg^{-1}) with the application of FYM @ 5 t ha^{-1}. Soil pH (7.58) was significantly decreased with the application of FYM @ 5 t ha^{-1}. Application of FYM produced organic acid which reduced soil pH at great extent. Same trend was observed by Hemalatha *et al.* (2013) [6]. Soil O.C. (0.58%) was significantly increased with the application of FYM @ 5 t ha^{-1} over control. The application of organic manure are converted the organically bound N to inorganic. Organic chelats are reduces the P fixation in calcareous soil aling with Fe and Zn.

Table 1: Effect of Potassium, Zinc and FYM on content and uptake of macro nutrients by seed of green gram.

Treatment	Seed content (%)				Seed uptake (kg ha^{-1})			
	N	P	K	S	N	P	K	S
Potassium levels (kg K_2O ha^{-1})								
K_0 – 0	3.22	0.39	0.64	0.70	35.77	4.32	6.96	2.74
K_{40} – 40	3.37	0.47	0.68	0.80	42.67	5.99	8.7	3.50
K_{60} – 60	3.51	0.47	0.70	0.80	45.81	6.26	9.2	3.85
S.Em±	0.07	0.01	0.01	0.03	1.09	0.21	0.26	0.15
C.D. at 5%	0.21	0.04	0.03	NS	3.20	0.63	0.77	0.45
Zinc Sulphate levels (kg $ZnSO_4$ ha^{-1})								
Z_0 – 0	3.10	0.42	0.67	0.72	37.17	5.16	7.85	3.18
Z_{10} – 10	3.63	0.46	0.69	0.81	45.66	5.88	8.74	3.55
S.Em±	0.05	0.01	0.01	0.02	0.89	0.17	0.21	0.12
C.D. at 5%	0.17	NS	NS	0.07	2.61	0.52	0.63	0.36
FYM levels (t ha^{-1})								
F_0 – 0	3.33	0.42	0.66	0.75	38.89	4.97	7.67	3.04
F_5 – 5	3.40	0.46	0.70	0.78	43.95	6.07	8.92	3.69
S.Em±	0.05	0.01	0.01	0.02	0.89	0.17	0.21	0.12
C.D. at 5%	NS	0.03	0.03	NS	2.61	0.52	0.63	0.36
C.V. %	7.54	11.80	6.33	14.54	9.14	13.66	11.03	15.82

Table 2: Effect of Potassium, Zinc and FYM on content and uptake of micro nutrients by seed of green gram.

Treatment	Seed content (ppm)				Seed uptake (g ha^{-1})			
	Fe	Mn	Zn	Cu	Fe	Mn	Zn	Cu
Potassium levels (kg K_2O ha^{-1})								
K_0 – 0	552	54.18	46.08	44.40	596	58.74	49.84	47.65
K_{40} – 40	570	58.43	48.92	49.21	726	74.34	62.35	62.74
K_{60} – 60	592	59.68	51.60	50.90	774	78.83	66.99	70.09
S.Em±	12.11	1.56	1.13	1.93	22.26	2.38	1.84	1.91
C.D. at 5%	NS	NS	3.34	NS	65.31	6.98	5.41	5.60
Zinc Sulphate levels (kg $ZnSO_4$ ha^{-1})								
Z_0 – 0	558	56.29	47.47	46.91	657	67.25	56.07	56.68
Z_{10} – 10	585	58.57	50.26	49.28	740	74.02	63.38	63.65
S.Em±	9.89	1.28	0.92	1.58	18.18	1.94	1.50	1.55
C.D. at 5%	NS	NS	2.72	NS	53.32	5.69	4.41	4.57
FYM levels (t ha^{-1})								
F_0 – 0	557	56.91	47.28	46.74	649	66.92	55.19	55.35
F_5 – 5	585	57.95	50.26	49.45	749	74.35	64.26	64.98
S.Em±	9.89	1.28	0.92	1.58	18.18	1.94	1.50	1.55
C.D. at 5%	NS	NS	2.72	NS	53.32	5.69	4.41	4.57
C.V. %	7.34	9.46	8.07	13.95	11.03	11.67	10.69	10.99

Table 3: Effect of potassium, zinc and FYM on post harvest soil fertility.

Treatments	Soil pH2.5	Soil EC2.5 (dSm^{-1})	Soil O.C. (g kg^{-1})	N (kg ha^{-1})	P_2O_5 (kg ha^{-1})	K_2O (kg ha^{-1})	S (mg kg^{-1})	Fe (mg kg^{-1})	Mn (mg kg^{-1})	Zn (mg kg^{-1})	Cu (mg kg^{-1})
Potassium levels (kg K_2O ha^{-1})											
K_0 – 0	7.73	0.52	4.4	235	36.69	156	16.27	4.88	17.44	0.51	2.66
K_{40} – 40	7.57	0.56	4.8	239	38.70	196	16.61	5.39	19.57	0.50	2.70
K_{60} – 60	7.77	0.56	4.4	243	40.12	216	17.20	5.29	19.28	0.54	2.68
S. Em ±	0.18	0.01	0.12	4.49	1.90	5.93	0.88	0.15	0.96	0.02	0.13
C.D. at 5%	NS	NS	NS	NS	NS	17.39	NS	NS	NS	NS	NS
Zinc sulphate levels (kg $ZnSO_4$ ha^{-1})											
Z_0 – 0	7.70	0.54	4.4	246	38.91	188	15.44	5.00	19.58	0.41	2.81
Z_{10} – 10	7.68	0.55	4.7	247	40.41	191	17.94	5.1	17.95	0.63	2.56
S. Em ±	0.15	0.009	0.09	3.67	1.55	4.84	0.72	0.12	0.78	0.01	0.10
C.D. at 5%	NS	NS	NS	NS	NS	NS	2.12	NS	NS	0.05	NS

FYM levels (t ha^{-1})											
F_0 – 0	8.00	0.58	3.3	238	36.23	176	15.52	4.87	17.36	0.49	2.49
F_5 – 5	7.58	0.58	5.8	255	43.08	203	17.87	5.50	20.17	0.55	2.87
S. Em ±	0.15	0.009	0.09	3.67	1.55	4.84	0.72	0.12	0.78	0.01	0.10
C.D. at 5%	0.44	NS	0.27	10.77	4.57	14.20	2.12	0.37	2.30	0.05	0.31
C.V. %	8.30	7.48	20.17	6.31	16.67	10.81	18.37	10.44	17.73	15.61	16.97

Conclusion

It can be concluded that application of potassium @ 40 kg ha^{-1}, zinc sulphate @ 10 kg ha^{-1} along with 5 t ha^{-1} FYM significantly increase the nutrient content and uptake in seed of green gram and increase the availability of nutrient in medium black calcareous soils of South Saurashtra region of Gujarat.

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