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Effect of Biogas Digest and Inorganic Sources of Nutrients on Nutrient Uptake of Chickpea (*Cicer arietinum* L.)

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ABSTRACT

A field experiment was conducted during *Rabi*, 2018 in clayey soil, at Agricultural College Farm, Bapatla to study the Effect of biogas digest and inorganic nutrient sources on nutrient uptake of chickpea. The experiment was laid out in randomized block design replicated thrice. The results of the experiment revealed that application of 100% RDP through BGD + microbial consortium(T_{10}) recorded highest N, P, K, S, Fe, Mn, Zn and Cu uptake at vegetative and harvest stages. The protein content and uptake of other nutrients were recorded highest with the application of 100% RDP through BGD + microbial consortium (T_{10}).

Keywords: *Biogas Digest (BGD), Chickpea, Nutrient uptake and Recommended Dose of Phosphorus (RDP),*

Chickpea (*Cicer arietinum* L.) is one of the major *rabi* pulse crop which has high digestible dietary iron, Among the pulse crops, chickpea occupies an important position due to its nutritious value (17-23% protein). According to World Health Organization (WHO, 2013), the per capita requirement of pulses is 80 g/day but per capita net availability of pulses in India is only 43 g/day. Its requirement in India is projected to be around 10.22 million tonnes by the year 2030 that needs a 4% increase in the annual growth rate (IIPR, 2011).

Plant nutrients are the main sources for improving the quality and quantity of chickpea production. The non-availability of nutrients is one of the major constraints of crop productivity and soil fertility with imbalanced use of plant nutrients that markedly affect the crop growth and yield (Siddiqui *et al*., 2015). Phosphorus deficiency is usually the most important single factor which is responsible for poor yield of chickpea on all soil types. The supply of phosphorus is more important than nitrogen because, the latter is being fixed by *Rhizobium* bacteria through symbiosis if smaller initial quantities of nitrogen are applied at earlier stages of crop. Phosphorus stimulates nodulation, early root development, plant growth, yield and quality of grains. It is known to improve the crop quality. Phosphorus is one of the critical nutrient deficiency in Indian soils and may cause yield losses of up to 29-45% in chickpea (Ahlawat *et al*., 2007).

MATERIAL AND METHODS

A field experiment entitled Effect of biogas digest on and inorganic nutrient sources on nutrient uptake of chickpea was conducted at Agricultural College Farm, Bapatla using chickpea variety JG-11 as a test crop. The experiment comprises of 10 treatments viz., T_{-1} – Control (No P fertilizer); T_2 – 100% RDP through inorganic sources; T_3 – 75% RDP through inorganic sources; T_4 – 75% RDP (through inorganic) + 25% P through BGD (Biogas digest); T_5

– 50% RDP (through inorganic) + 50% P through BGD (Biogas digest); T_6 – 100% RDP (through inorganic) + Microbial Consortium; T_7 – 75% RDP (through inorganic) + Microbial Consortium; T_8 – 50% RDP (through inorganic) + Microbial Consortium; T_9 – 100% RDP through BGD; T_{10} – 100% RDP through BGD + Microbial Consortium laid out in randomized block design (RBD) and were replicated thrice.

Biogas Digest (BGD) was applied to plots depending on phosphorus content of BGD and recommendation to crop. Nitrogen and Sulphur contributed by BGD was deducted and the remaining N & S were applied through inorganic sources. N in the form of urea for inorganic treatments applied in two splits whereas complete P & S was applied as basal dose. Microbial Consortium was applied in the respective plots. Rhizobium was given as seed treatment @ 5-6 ml per kg of chickpea seed. Phosphorus Solubilizing Bacteria (PSB) and Potassium solubilizing Bacteria (KSB) were applied in the plots by mixing with the soil from same plot and evenly distributed it in the same plot.

The plant samples collected at vegetative and harvest stages were washed with dilute HCl and then with distilled water. The samples were shade dried initially and then oven dried at 60^0c temperature and powdered in willey mill. The nitrogen content in chickpea plants was estimated by micro Kjeldahl distillation method (Piper, 1966). Phosphorus in the diacid extract of plant samples was estimated by Vanadomolybdo phosphoric yellow colour method using spectrophotometer at 420nm wavelength as described by Jackson (1973). Potassium in the diacid extract of plant samples was determined using flame photometer as per the method described by Jackson (1973). Sulphur in the diacid extract of plant samples was determined by turbidimetric method using spectrophotometer at a wavelength of 420 nm (Vogel, 1979). Zinc, Copper, Manganese and Iron in the diacid extract were determined using atomic absorption spectrophotometer as per the specifications mentioned by Lindsay and Norvell (1978).

RESULTS AND DISCUSSION

Macro and Micro nutrient uptake

At vegetative stage (Table 1&2.), among different treatments T_{10} treatment *i.e.*100% RDP through biogas digest(BGD) + Microbial consortium had recorded higher uptake of N (61.91 kg ha^{-1}), K (52.25 kg ha^{-1}) S (11.63 kg ha^{-1}) , Fe (333.7 g ha^{-1}), Mn (127.6 g ha^{-1}), Zn (67.3 g ha^{-1}) and Cu (19.81 g ha^{-1}). which was on par with T_9 *i.e.* 100% RDP through BGD i.e., N (57.00 kg ha^{-1}), P (6.30 kg ha^{-1}), K (51.30 kg ha^{-1}), S (11.10 kg ha^{-1}) but significantly superior over other treatments.

At harvest Chickpea grain (Table 1.) recorded highest uptake of N (54.61 kg ha^{-1}), P (8.86 kg ha^{-1}), K(25.64 kg ha^{-1}) and S(7.28 kg ha^{-1}) while haulm recorded N (25.28 kg ha^{-1}), P (5.76 kg ha^{-1}), K (64.21 kg ha^{-1}) and S (10.98 kg ha^{-1}) uptake with T_{10}. The N and P uptake of grain is superior over haulm in all the treatments. The uptake of P (7.4 kg ha^{-1}) at vegetative stage and at harvest stages with the application of 100% RDP through biogas digest (BGD) + Microbial consortium (T_{10}) was significantly superior over all other treatments.

The uptake of Fe (136.1 g ha^{-1}), Mn (97.5 g ha^{-1}), Zn (38.5 g ha^{-1}) & Cu (22.64 g ha^{-1}) by grain (Table 2) with the application of 100% RDP through biogas digest along with microbial consortium (T_{10}) is significantly superior over all other treatments. The highest uptake of micronutrients viz., Fe (540.6 g ha^{-1}), Mn (143.5 g ha^{-1}), Zn (91.9 g ha^{-1}) & Cu (33.2 g ha^{-1}) is observed in treatment T_{10} which is on par with the application of 100% RDP through biogas digest (T_9). The higher uptake of nutrients was observed in treatments which received organics compared to inorganics and combined application of organics and

Table 1. Effect of organic manures and inorganic phosphorus fertilizer on nitrogen, phosphorus, Potassium and sulphur uptake (kg ha^{-1})

Treatments	Vegetative Stage				Harvest stage							
					Haulm				Grain			
	N	P	K	S	N	P	K	S	N	P	K	S
T_{-1} – Control (No P fertilizer)	25.20	1.59	26.23	2.89	12.11	1.38	35.11	3.29	19.79	1.73	11.17	2.10
T_2 – 100% RDP through inorganic sources	40.79	2.97	38.58	6.31	16.69	2.82	47.94	5.56	33.88	3.59	16.67	3.82
T_3 – 75% RDP through inorganic sources	31.60	2.11	30.97	4.11	15.47	2.27	44.76	4.34	27.44	2.93	14.73	3.12
T_4 – 75% RDP (through inorganic) + 25% P through BGD (Biogas digest)	48.07	3.98	46.14	8.27	21.23	4.50	57.97	7.85	39.13	5.16	19.16	4.67
T_5 – 50% RDP (through inorganic) + 50% P through BGD (Biogas digest)	50.91	4.52	48.03	9.02	21.84	4.58	58.50	8.40	39.84	5.34	19.47	4.82
T_6 – 100% RDP (through inorganic) + Microbial Consortium	43.23	3.41	43.35	7.21	17.52	3.23	48.95	5.82	34.84	4.31	17.03	3.91
T_7 – 75% RDP (through inorganic) + Microbial Consortium	38.03	2.58	37.54	6.01	16.47	2.32	46.67	4.86	29.46	3.07	15.03	3.26
T_8 – 50% RDP (through inorganic) + Microbial Consortium	29.58	2.11	30.01	3.70	14.71	1.59	42.77	3.98	21.89	2.22	11.82	2.38
T_9 – 100% RDP through BGD	57.00	6.30	51.30	11.10	24.17	5.10	61.95	9.92	45.44	6.98	21.80	5.89
T_{10}– 100% RDP through BGD + Microbial Consortium	61.91	7.40	52.25	11.63	25.28	5.76	64.21	10.98	54.61	8.86	25.64	7.28
SEm±	2.26	0.20	2.27	0.42	1.02	0.18	2.82	0.38	1.93	0.22	0.94	0.22
CD(0.05)	6.73	0.61	6.77	1.27	3.04	0.55	8.40	1.14	5.76	0.68	2.80	0.67
CV(%)	9.20	9.63	9.76	10.56	9.56	9.56	9.63	10.23	9.70	9.01	9.46	9.45

Table 2. Effect of organic manures and inorganic phosphorus fertilizer on Fe, Mn, Zn & Cu uptake (g ha^{-1})

Treatment	Vegetative				Harvest Stage								
					Haulm				Grain				
	Fe	Mn	Zn	Cu	Fe	Mn	Zn	Cu	Fe	Mn	Zn	Cu	Protein Content(%)
T_1 – Control (No P fertilizer)	178.30	72.70	35.60	10.16	309.60	81.80	51.90	18.35	55.10	41.30	15.10	8.25	16.50
T_2 – 100% RDP through inorganic sources	222.60	100.60	40.10	14.79	363.80	108.10	58.60	23.45	71.40	64.60	20.40	13.19	19.40
T_3 – 75% RDP through inorganic sources	194.90	84.80	35.60	11.90	356.80	101.50	58.20	22.49	67.40	57.20	18.80	11.18	17.60
T_4 – 75% RDP (through inorganic) + 25% P through BGD (Biogas digest)	289.80	112.80	57.50	17.35	483.50	129.60	80.70	28.35	100.10	74.30	26.80	15.96	19.90
T_5 – 50% RDP (through inorganic) + 50% P through BGD (Biogas digest)	301.30	116.70	61.10	17.99	486.00	130.80	82.90	29.01	102.30	75.60	28.80	16.50	20.10
T_6 – 100% RDP (through inorganic) + Microbial Consortium	258.10	106.90	51.00	16.00	390.30	109.50	65.60	23.72	83.50	66.60	22.70	13.92	19.60
T_7 – 75% RDP (through inorganic) + Microbial Consortium	250.60	99.20	48.80	14.17	388.90	105.20	65.20	23.06	78.60	58.00	20.50	11.67	18.60
T_8 – 50% RDP (through inorganic) + Microbial Consortium	217.60	83.10	43.00	11.73	373.80	95.90	61.60	21.65	63.70	45.50	17.00	8.89	17.20
T_9 – 100% RDP through BGD	327.00	124.80	65.70	19.62	523.00	138.40	88.80	31.65	114.80	83.70	31.80	19.03	20.70
T_{10}– 100% RDP through BGD + Microbial Consortium	333.70	127.60	67.30	19.81	540.60	143.50	91.90	33.20	136.10	97.50	38.50	22.64	21.60
SEm±	14.59	5.48	2.90	0.86	23.35	6.03	3.96	1.39	4.93	3.51	1.35	0.78	0.93
CD(0.05)	43.38	16.30	8.63	2.57	69.38	17.92	11.77	4.16	14.65	10.46	4.02	2.34	2.77
CV(%)	9.83	9.23	9.95	9.78	9.59	9.13	9.73	9.50	9.78	9.18	9.76	9.64	8.43

inorganics. This might be due to the added organics are better source of available nutrients in soil which might attribute to more availability and its subsequent uptake by the crop (Chavan *et al*., 1997).

Higher nutrient uptake in organics applied plots might be the result of addition *Rhizobium* and PSB that helped in the release of more organic acids which acted on unavailable forms making them to be available for plant uptake accompanied with increased biological nitrogen fixation activities. Similar results of nutrient uptake with organics application in black gram crop was also observed by Gajendrasingh *et al*. (2016) and Senthilvalavan and Ravichandran (2016).

The ability of a plant to take up phosphorus is largely due to its root distribution relative to phosphorus as P is relatively immobile in the soil. The favourable soil conditions under organic manures which acts as store house of energy for microorganisms are responsible for nutrient transformation besides providing better soil physico-chemical environment (decrease in bulk density and increase in saturated hydraulic conductivity and CEC) which helps in the mineralization of nutrients.

The organic manure besides being the direct source of nutrients also solubilize the insoluble P and K in soil through release of various organic acids (Dakshinamoorthy *et al.*, 2000). Application of organic manures might have improved the soil environment which encouraged proliferous root system resulting in better absorption of water and nutrients from lower layers and thus resulting in higher yield and nutrient uptake as mentioned by Pathak *et al.* (2015).

Protein Content(%)

The treatment T_{10} (100% RDP through BGD + Microbial Consortium) also recorded significantly higher protein content (21.6%) in seed (Table 2) and it was on par with T_9 treatment (100% RDP through BGD) with 20.7%, T_5 (50% RDP through inorganic + 50% P through BGD) with 20.1, T_4 (75% RDP through inorganic + 25% P through BGD) with 19.9 & T_6 (100% RDP through inorganic + Microbial Consortium) with 19.6 while lowest (16.5) was recorded in T_1 *i.e.*, control plot with no P fertilizer.

It was observed from the data that highest protein content was recorded in treatment which received organics compared to inorganics and combination of organics and inorganics. This might be due to the fact that BGD application to the chickpea crop resulted in higher availability of nitrogen in soil and thereby greater uptake by the plant. Nitrogen, being the principle constituent of protein might have substantially increased the protein content of seed due to increased uptake of nitrogen under higher nutrients. Sulphur may also play a greater role in protein content of chickpea. Adequate and timely supply of S by BGD improved the mineralization which might have resulted in high protein content of chickpea. Similar findings were made of Malav *et al*. (2015).

CONCLUSION

The present study revealed that application of biogas digest along with microbial consortia and recommended level of Phosphorus through inorganic sources increased the nutrient uptake of crop during vegetative and harvest stages. Application of 100 per cent Recommended dose of Phosphorus through biogas digest along with microbial consortium increased the uptake of macro and micro nutrients by chickpea plants and also the protein content of grain.

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