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Effect of Organic Manures and Inorganic Phosphorus Fertilizer on Growth and Yield of Chickpea

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ABSTRACT

A field experiment was conducted to study the effect of organic manures and inorganic phosphorus fertilizers on soil health, growth and yield of chickpea' at Agricultural College Farm, Bapatla. The experiment was laid out in Randomized Block Design replicated thrice. The results revealed that application of 100% RDP through biogas digest + microbial consortium (T_{10}) recorded significantly higher drymatter production, seed and haulm yield which was on par with the treatment that supplies 100% RDP through biogas digest (T_9). The lowest drymatter production and seed and haulm yield were recorded in the treatment which did not received any P fertilizer.

Key words: *Biogas digest, Growth and yield, Organic manures, Phosphorus fertilizer.*

Chickpea (*Cicer arietinum* L.) is one of the major *rabi* pulse crop which has high digestible dietary iron, niacin, vitamin C and B. Among the pulse crops, chickpea occupies an important position due to its nutritious value (17-23% protein). According to World Health Organization (WHO), the per capita requirement of pulses is 80 grams per day but per capita net availability of pulses in India is only 43 grams per day. Its requirement in India is projected to be around 10.22 million tonnes by the year 2030 that needs a 4 percent increase in the annual growth rate (IIPR, 2011). The current average global yield of chickpea is 0.9 t ha^{-1}, which is much lower than its estimated potential of 6 t ha^{-1} under the optimum cultivated conditions (FAO, 2012). Area under chickpea cultivation in India is around 8.3 mha and in Andhra Pradesh it is 4.7 lakh ha. All India production is around 7.1 million tonnes and it is 5 lakh tonnes in A.P. Andhra Pradesh occupied 5^{th} position with respect to area under the crop with a productivity of 1.4 t ha^{-1} (Annual report 2016-17, MoAF, GOI).

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 and imbalanced use of plant nutrients 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 in all soil types. The supply of phosphorus is more important than nitrogen because, the later 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 upto 29-45% yield losses in chickpea (Ahlawat *et al*., 2007).

MATERIAL AND METHODS

A field experiment entitled "Effect of organic manures and inorganic phosphorus fertilizers on soil health, growth and yield of chickpea" was conducted at Agricultural College Farm, Bapatla using chickpea variety JG-11 as a test crop. The experimental soil was moderately alkaline (8.3), medium in organic carbon (0.53%), low in available nitrogen (172 kg ha^{-1}), high in available P_2O_5 (26.5 kg ha^{-1}) and K_2O (321 kg ha^{-1}) and sufficient in sulphur (17.2 mg kg^{-1}) and micronutrients. The soil was clayey in texture with a bulk density and water holding capacity of 1.87 Mgm^{-3} and 56.86 per cent, respectively. 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 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 and S were applied

Table 1. Effect of organic manures and inorganic phosphorus fertilizers on drymatter production ($kg\ ha^{-1}$) and yield of chickpea

Treatments	Drymatter			Yield	
	30DAS	60DAS	90DAS	Seed yield ($kg\ ha^{-1}$)	Halum yield ($kg\ ha^{-1}$)
T_{-1} – Control (No P fertilizer)	933	2117	3180	750	1729
T_2 – 100% RDP through inorganic sources	1236	2736	3650	1090	2140
T_3 – 75% RDP through inorganic sources	1053	2330	3440	975	2063
T_4 – 75% RDP (through inorganic) + 25% P through BGD (Biogas digest)	1373	2790	3817	1228	2532
T_5 – 50% RDP (through inorganic) + 50% P through BGD (Biogas digest)	1413	2873	3847	1241	2544
T_6 – 100% RDP (through inorganic) + Microbial Consortium	1310	2747	3736	1113	2156
T_7 – 75% RDP (through inorganic) + Microbial Consortium	1227	2337	3580	989	2112
T_8 – 50% RDP (through inorganic) + Microbial Consortium	1057	2197	3297	793	1988
T_9 – 100% RDP through BGD	1500	3033	4300	1369	2682
T_{10}– 100% RDP through BGD + Microbial Consortium	1510	3200	4767	1583	2744
SEm±	74.07	182.90	232.20	91.88	94.97
CD (0.05)	220.10	543.60	689.90	273.18	282.20
CV (%)	10.10	12.00	10.60	14.30	7.20

through inorganic sources. N in the form of urea for inorganic treatments applied in two splits whereas complete P and S was applied as basal dose. Microbial consortium in the respective plots includes *Rhizobium*, PSB and KSB. *Rhizobium* was given as seed treatment @ 5-6 ml per kg of chickpea seed. PSB and KSB were applied in the plots by mixing with the soil from same plot and evenly distributing it in the same plot.

Five successive plants were sampled at vegetative, reproductive and at harvest and these samples were dried in shade first and then dried in hot-air oven at 65^0C till to attain constant weight. Sample dry weights were summed up to arrive at mean drymatter per plant in individual treatment. The mean dry weight was multiplied by number of plants m^{-2} and expressed in $t\ ha^{-1}$. The crop harvested from each net plot was bundled up separately and allowed for drying in sun and threshed individual plot wise. Cleaning of the seed was done after threshing and then dried in sun to a constant weight to record the final yield. Seed yield from the labeled plants were added to the corresponding plot yields before expressing the final seed yield in $t\ ha^{-1}$ during the study.

RESULTS AND DISCUSSION

Drymatter production

The data revealed a significant effect of organics, inorganics and combination of organics and inorganics on (Table 1.) dry matter production of chickpea. The results indicated significant differences among the treatments on dry matter production at vegetative, reproductive and harvest stages and had shown an increasing trend with the advancement in the age of the crop.

At vegetative stage, the significantly higher dry matter production (1510 kg ha^{-1}) was recorded in treatment T_{10} which received 100% RDP through BGD + Microbial consortium and this was on par with T_9 treatment (1500 kg ha^{-1}) which received 100% RDP through BGD, T_4 treatment(1373 kg ha^{-1}) which received 75% RDP through inorganic + 25% P through BGD, T_5 treatment (1413 kg ha^{-1}) which received 50% RDP through inorganic + 50% P through BGD and T_6 treatment (1310 kg ha^{-1}) which received 100% RDP through inorganic + Microbial consortium. However, the lowest dry matter production (933 kg ha^{-1}) was recorded in T_1 treatment with no P fertilizer application. Similar trend was observed at reproductive stage. At harvesting stage, among the different treatments the highest dry matter (4767 kg ha^{-1}) was recorded in treatment T_{10} which received 100% RDP through BGD + Microbial consortium and this was on par with T_9 treatment (4300 kg ha^{-1}) which received 100% RDP through BGD, while lowest dry matter production (933 kg ha^{-1}) was recorded in T_1 treatment. The treatment T_9 was on par with T_4 (75% RDP through inorganic + 25% P through BGD), T_5 (50% RDP through inorganic + 50% P through BGD) & T_6 (100% RDP through inorganic + Microbial consortium) with dry matter production of 3817, 3847 & 3736 kg ha^{-1}, respectively.

Among completely inorganic treatments (T_2 and T_3) T_2 treatment which received 100% RDP through inorganic sources recorded higher dry matter production (1236, 2736 & 3650 kg ha^{-1}) compared to T_3 treatment which received 75% RDP through inorganic sources (1053, 2330 & 3440 kg ha^{-1}) at vegetative, reproductive and harvest stages respectively. The percent increase in dry matter production over control at vegetative stage were 61.8, 60.7, 51.4 & 32.4 in T_{10} (100% RDP through BGD + Microbial Consortium), T_9 (100% RDP through BGD), T_5 (50% RDP through inorganic + 50% P through BGD) & T_2 (100% RDP through inorganic sources) respectively. An increase of 51.5 % in T_{10}, 40.4% in T_9, 35.7% in T_5 & 29.2% in T_2 over control were recorded at reproductive stage and this increase was 50% in T_{10}, 35.2% in T_9, 20.9% in T_5 and 14.7% in T_2 over control at harvest stage.

High dry matter production was recorded in treatment which were supplied with organics which include BGD and microbial consortium. This might be due to high mobilization of nutrients in soil by microbial consortium to make them available for plant absorption and also BGD effect on soil chemical processes to make unavailable forms of nutrients into available forms. The high drymatter production obtained with organic manure treated plots might be due to more moisture conservation and additional availability of nutrients (Yadav *et al.*, 2004, Bodamwad and Rajput, 2006).

Comparison of BGD and inorganic treatments clearly indicated that higher dry matter production in chickpea was recorded in plots where most or all of the P requirement is met through BGD. Comparing the drymatter values at vegetative, reproductive and harvest sages provide us with the fact that microbial consortium had positive effect on drymatter production of chickpea. Drymatter production is considered to be the reliable index of crop growth. The highest dry matter production due to applied BGD might be attributed to its supply of almost all nutrients in adequate amount and timely supply of nutrients to the crop which helped in the synthesis of carbohydrates, required for the formation of protoplasm, resulting in higher cell division and cell elongation (Haile and Ayalew, 2018).

Seed yield

Significantly higher seed yield (1583 kg ha^{-1}) was recorded in T_{10} treatment which received 100% RDP through BGD + Microbial consortium and this was on par with T_9 treatment which received 100% RDP through BGD (1369 kg ha^{-1}) while control treatment (T_1) with no P fertilizer was significantly recorded the lowest seed yield of 750 kg ha^{-1}(Table 1). The treatment T_9 (100% RDP through BGD) was on par with T_4 (75% RDP through inorganic + 25% P through BGD), T_5 (50% RDP through inorganic + 50% P through BGD) and T_6 (100% RDP through inorganic + Microbial consortium) with 1228, 1241 & 1113 kg ha^{-1} seed yields respectively. Among completely inorganic treatments, T_2 which received 100% RDP recorded higher seed yield (1090 kg ha^{-1}) as compared to T_3 which received 75% RDP (975 kg ha^{-1}). An increase in seed yield of 111% in T_{10} treatment, 82.5% in T_9 treatment, 65.4% in T_5 treatment and 45.3% in T_2 treatments were recorded over control

The highest seed yield in treatments which received P through organic sources and this higher seed yield in organics applied plots might be due to higher and easier availability of all nutrients required for plant growth in organics applied plots. This could be possible due to faster rate of mineralization, availability and utilization by the plants in these treatments (Sridhar and Adeoye, 2003 and Akkani *et al.*, 2011). Higher yield response of crop to organics application could also be due to improved soil physical and biological properties resulting in better supply of nutrients to plants. Inoculation with microbial consortium secretes both organic and inorganic acids which solubilize insoluble form of phosphorus into available form of phosphorus thereby increase the growth of crop (Prabhu *et al.*, 2003).

Haulm yield

Significantly higher haulm yield (2744 kg ha^{-1}) was recorded in treatment T_{10} (100% RDP through BGD + Microbial Consortium) (Table 1) and it was on par with T_9 treatment which received 100% RDP through BGD (2682 kg ha^{-1}), T_5 treatment which received 50% RDP through inorganic + 50% P through BGD (2544 kg ha^{-1}) and T_4 treatment which received 75% RDP through inorganic + 25% P through BGD (2532 kg ha^{-1}). The percent increase in haulm yield in T_{10} (100% RDP through BGD + Microbial Consortium), T_9 (100% RDP through BGD), T_5 (50%

RDP through inorganic + 50% P through BGD) and T_2 (100% RDP through inorganic sources) over control were 58.7, 55.1, 47.1 & 23.7 respectively. High haulm yield was recorded from treatments which were supplied with organics and this might be attributed to improved vegetative growth due to better availability of nutrients at peak growth period and greater synthesis of carbohydrates and their translocation (Ghosh and Joseph., 2008).

CONCLUSION

It can be concluded that the highest dry matter production, seed yield and haulm yield of chickpea can be obtained with the application of 100% RDP through BGD + microbial consortium and it was on par with the treatment which received 100% RDP through BGD.

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