

Original Research Article

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Residual Effect of Manure and Fertilizer on Growth, Yield of Chickpea and Soil Nutrient Status under Maize-Chickpea Cropping System

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ABSTRACT

A field experiment was conducted at the Agronomy Farm, B. A. College of Agriculture, Anand Agricultural University, Anand during two consecutive *Kharif* and *rabi* seasons of the year 2015-16 and 2016-17 with a view to study the “Direct and residual effect of organic manures and inorganic fertilizers on maize (*Zea mays* L.)– chickpea (*Cicer arietinum* L.) cropping sequence”. The experiment comprised of four levels of organic manures viz., Control(M₁), FYM(M₂), castor cake(M₃), vermicompost (M₄); and two levels of Recommended dose of fertilizers (100% (F₁) and 75% (F₂) of RDF) and two levels of sulphur (0(S₁) and 20(S₂) kg S/ha). The experimental plots were laid out in Randomized Block design with four replications. The *kharif* maize was fertilized as per different treatment combinations and its residual effect was study on *rabi* chickpea. The results revealed that growth, yield attributes, seed and stover yields of chickpea and available N and P₂O₅ status were significantly increased due to different organic manurial treatments (M₂, M₃ and M₄) over control (M₁) and highest seed yield was recorded by residual effect of FYM @ 10 t/ha (M₂) and being at par with vermicompost(M₃), castor cake(M₄). The residual effects of 100% RDF was significantly affected on seed & stover yields and available N over 75% RDF while in case of sulphur treatments, non-significant results were observed in all cases except weight of nodules/plant. Hence, in maize-chickpea cropping sequence, application of 100% RDF (120-60-0 kg NPK/ha) and FYM @ 10t/ha to maize crop gave better residual effect on crop yields of succeeding crop chickpea.

Keywords

Agronomy farm,
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Introduction

Pulses are considered as an important food crop occupying a unique position in agriculture and also an important component of food grain crops because of their high nutritive value. Pulses also have inherent capacity to fix atmospheric nitrogen and adaptability to a wide range of agro-

ecological, cropping system and management ability. Amongst the grain legumes, chickpea occupies third position in crop productivity.

Maize-Chickpea is one of the most prevalent cropping system in some part of Gujarat. In continuous cropping, use of imbalanced nutrients (NP or N alone) through inorganic fertilizers without organic manure cannot

sustain the desired level of crop production. Indian soils are poor in organic carbon due to less buildup of organic carbon in tropical climate. Sulphur is considered as fourth major nutrient in crop growth and development and reports indicated that more than 30 per cent soils of Gujarat and India deficient in available sulphur. Integration of inorganic fertilizer with organic manures will sustain the crop production and also effective in improving soil health and enhancing the nutrient use efficiency. Looking to the importance of role of organic manure along with chemical fertilizers in crop production and maintaining soil health, the investigation planned on prominent cropping sequence like maize-chickpea with certain objectives.

Materials and Methods

The field experiment entitled, “Direct and residual effect of organic manures and inorganic fertilizers on maize (*Zea mays* L.) – chickpea (*Cicer arietinum* L.) cropping sequence” was carried out during *kharif* and *rabi* seasons of the years 2015-16 and 2016-17 at College Farm, Department of Agronomy, B.A. College of Agriculture, Anand Agricultural University, Anand. The texture of the soil is loamy sand. The soil is very deep and fairly moisture retentive. It is suitable for variety of crops of tropical and sub-tropical regions. The soil of experimental site had low organic carbon (0.45%), low available N (250.88 kg/ha), medium available P₂O₅ (48.54 kg/ha) and SO₄-S (15.24 mg/kg); and high available K₂O (315.84 kg/ha). There were total four levels of organic manure like (M₁: no manure, M₂: FYM 10 t/ha, M₃: castor cake 1.0 t/ha and M₄: vermicompost 2.5 t/ha); two levels of inorganic fertilizer (F₁:75% RDF and F₂: 100 % RDF) and two sulphur levels (S₁: 0 kg S/ha and S₂: 20 kg S/ha). The experimental design was Randomized Block Design (Factorial) with four replications. Recommended dose of fertilizer (120-60-0

kg/ha) was applied by urea and DAP chemical fertilizer and sulphur was applied in form of Gypsum to maize crop and residual effect was study on chickpea crop var. GG 2 (Gujarat Gram 2). All agronomical practices and plant protection measure was followed for better and successful crop production. The chickpea seeds were treated bio-fertilizer (*Rhizobium thiogangnaticum*) before sowing. The observation on growth and yield attributes were recorded by randomly selected five plants from net plot area and tagged all plants for further observations. The data of various parameters were statistically analyzed using analysis of variance (ANOVA) technique and the treatments were compared at 5% levels of significance (Cochran and Cox, 1967).

Results and Discussion

Effect of organic manures

Organic fertilizers are natural materials of either plant or animal source, including livestock manure, green manures, crop residues, household waste, compost, and works directly as a source of plant nutrients and indirectly influences the physical, chemical and biological properties of soil. Microorganisms from the soil decay the organic fertilizers to make its nutrients available for utilize by plants which added into the soil and have the characteristic nature of the slow release of nutrients

Data presented in Table 1 indicated that plant population at 20 DAS was non-significantly affected by residual effect of organic manures and almost uniform plant population was observed in all experimental plots. The number of nodules/plant (21.8) and nodules weight (225.20 mg/plant) was observed significantly highest under previously applied of FYM@10 t/ha (M₂) to maize crop over control (M₁) and castor cake (M₃) but being at par with vermicompost (M₄). The increased in

the nodules/plant and nodule weight/plant due to residual effect of organic manure treatment over control might be attributed to the built up of residual soil fertility and increase in the microbial population in root zone after addition of organic manures for continuous two seasons. Sindhi *et al.*, (2016) also reported the similar findings.

The seed index, seed and stover yields of chickpea were significantly increased due to residual effect of 10t FYM/ha (M₂) over control (M₁) whereas being at par with castorcake (M₃) and vermicompost (M₄). The treatment M₂ recorded significantly highest seed index (26.1 g), seed yield (1199 kg/ha) and stover yield (1794 kg/ha).

The increased in seed yield of chickpea due to residual effect of FYM, castor cake and vermicompost manures over control was to the tune of 28.0, 20.2 and 24.0 percent, respectively. It might be ascertained to the increased in availability of nutrients, release of CO₂ increasing fertilizer use efficiency, accumulation of organic carbon and improvement of soil physical properties also.

The residual effect of organic manure increased in chickpea seed yield might be due to improvement in soil physical, chemical and biological properties and also serves as a source of energy for soil microflora which resulted in better root nodulation and nitrogen fixation (De Datta and Hundal, 1984).

The persistent material in organic manures requires more time for its decomposition, hence, about 25 to 33% of nitrogen and small fraction of phosphorus and potassium in organic manure may be available to immediate crop *i.e.* maize and rest to subsequent crops (Inoko, 1984) which sustain the productivity. Utilization of inexhaustible atmospheric nitrogen through biological nitrogen fixation can help a great deal in maintaining soil productivity. These results

are in confirmation with those reported by Gawai and Pawar (2006). The protein content in chickpea was significantly influenced by residual effect of organic manure treatments applied to preceding maize and especially the treatment M₂ which recorded significantly highest protein content (21.3 %) (Table 1).

The improvement in protein content in seed might be due to increase in nitrogen content in seed. Application of organic manures helped in more efficient translocation of N from vegetative parts to develop seed as well as in the synthesis of protein from the reduced nitrogen compounds within seeds as coenzyme pyridoxyl phosphate or pyridoxamine phosphate involved in the transmission reaction and activation of amino acids for protein synthesis in the presence of enzyme and ATP. These results are in accordance with those of Shahid *et al.*, (2017).

The available N, P₂O₅ and S were significantly improved by residual effect of organic manures treatments over control whereas available K₂O was non-significantly altered in soil after harvest of chickpea. The significantly highest available N (291.5 kg/ha), P₂O₅ (63.8 kg/ha) and S (18.0 mg/kg) was recorded with the treatment M₄ (Vermicompost 2.5t/ha) and being at par with FYM (M₂) and castorcake (M₃).

This might be due to long last residual effect of vermicompost and their complementary effects and also due to addition of organic matter in to the soil through organic manures helped in modifying the soil environment which enhance the availability of nutrients and resulted in improvement of the soil fertility. Hiremath *et al.*, (2016) and Srinivasanarao *et al.*, (2010) reported similar improvements in soil fertility with the use of organic manure.

Table.1 Residual effect of organic manures and inorganic fertilizer treatment on chickpea growth and yield attributes and soil nutrient status (pooled of two year)

Treatment	Plant population at 20 DAS	Number of nodules/plant at 50 DAS	Nodules weight (mg/plant)	Seed index (g)	Seed yield (kg/ha)	Stover yield (kg/ha)	Protein content (%)	Soil nutrient status after harvest			
								N	P ₂ O ₅	K ₂ O	S
								(kg/ha)			(mg/kg)
Organic manure (M)											
M ₁	300.2	13.8	194.1	23.2	937	1425	19.5	224.4	52.2	224.4	15.2
M ₂	310.9	21.8	225.2	26.1	1199	1794	21.3	287.6	60.1	290.9	18.0
M ₃	305.8	18.7	208.2	25.5	1126	1686	20.7	274.5	63.4	239.4	17.1
M ₄	307.7	21.0	216.4	25.9	1162	1888	20.9	291.5	63.8	252.5	18.0
S.Em. \pm	2.96	0.35	3.65	0.45	26.0	40.6	0.3	8.08	0.58	11.90	0.32
C. D. at 5%	NS	1.0	10.3	1.3	73	114	0.9	36.4	1.6	NS	0.9
Inorganic fertilizer (F)											
F ₁	303.4	18.5	208.7	24.9	1059	1627	20.4	255.8	55.6	250.9	16.8
F ₂	308.9	19.1	213.2	25.5	1154	1770	20.8	283.2	64.1	252.7	17.4
S.Em. \pm	2.09	0.25	2.58	0.32	18.4	28.7	0.2	3.35	1.05	2.77	0.23
C. D. at 5%	NS	NS	NS	NS	52	80.6	NS	9.4	NS	NS	NS
Sulphur (S)											
S ₁	306.4	18.8	205.8	25.1	1084	1690	20.5	266.1	59.5	250.7	16.8
S ₂	305.9	18.8	216.2	25.3	1129	1706	20.7	273.0	60.2	252.8	17.4
S.Em. \pm	2.09	0.25	2.58	0.32	18.4	28.7	0.2	3.35	0.41	2.77	0.23
C. D. at 5%	NS	NS	7.2	NS	NS	NS	NS	NS	NS	NS	NS
Interaction	-	-	-	-	-	-	-	-	-	-	-
C. V. %	5.5	10.5	9.8	10.1	13.3	13.5	9.0	10.0	5.5	8.8	10.6

Effect of inorganic fertilizer

Residual effect of 100 % RDF (F₂) was recorded non-significant on plant population at 20 DAS, number of nodules/plant, weight of nodules/plant, seed index, protein content and soil available phosphorus, potash and sulphur over 75 % RDF (F₁) (Table 1). The significantly highest value of seed yield (1154 kg/ha) and stover yield (1770 kg/ha) of chickpea were recorded with the residual effect of treatment F₂ (100% RDF) which was at par with treatment F₁ (75% RDF).

The increased in seed and stover yield of chickpea due to residual effect of 100 % RDF over 75 % RDF was to the tune of 9.0 and 8.8 per cent, respectively. This was largely attributed to better growth of plant, which resulted adequate supply of photosynthates for development of sink. Thus, the overall better growth performance and higher values of the yield attributes reflected into higher seed and stover yields. Similar findings were reported by Kumar *et al.*, (2015) and Hiremath *et al.*, (2016).

Effect of sulphur

Data presented in Table 1 indicated that residual effect of sulphur was found non-significant on chickpea growth and yield attributes, yield as well as after harvest soil nutrient status of soil except nodule weight/plant (Table 1).

Sulphur applied to maize crop and its residual effect on chickpea crop was found significant on nodule weight/plant. Treatment S₂ gave 5.1 per cent higher nodule weight/plant than treatment S₁. This increased might be due to involvement of sulphur in synthesis of sulphur containing amino acid and also chickpea seed treated with rhizobium culture which might helped in increasing the availability of sulphur. The findings

corroborate the observations of Srinivasanarao *et al.*, (2010).

On the basis of experimental results, it could be concluded that residual effect of recommended dose of fertilizer (120-60-00 kg NPK/ ha) along with FYM @ 10 t/ha gave higher seed and stover yields of chickpea in maize – chickpea cropping sequence and also maintain soil health.

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