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Effect of Farmyard Manure, Vermicompost and Chemical Nutrients on Growth and Yield of Chickpea (*Cicer arietinum* L.)

Guriqbal Singh, H.S. Sekhon and Harpreet Kaur
Department of Plant Breeding and Genetics, Punjab Agricultural University, Ludhiana 141004, India

Corresponding Author: Guriqbal Singh, Department of Plant Breeding and Genetics, Punjab Agricultural University, Ludhiana 141004, India Tel: +91 161 2401960/413, +9109417452596 Fax: +91 161 2400945

ABSTRACT

Adequate and balanced nutrition is essential for obtaining high grain yields. The aim of the study was to find out proper nutrient management in chickpea using different sources of nutrients. Two field experiments were conducted to study the effects of Farmyard manure (FYM), phosphorus, zinc sulphate, vermicompost and nitrogen+phosphorus application on the growth and yield of chickpea. On the basis of three-year mean, as compared to no application of nutrients, the application of 5 t FYM ha^{-1} improved chickpea grain yield by 14.89%, 30 and 60 kg P_2O_5 ha^{-1} by 14.81 and 21.85% and 25 kg $ZnSO_4$ ha^{-1} by 5.18%. Chickpea grain yield increased with successive increase in dose of vermicompost from 0 to 3 and 2 t ha^{-1} seemed to be the optimum dose. Applications of 10 kg N + 20 kg P_2O_5 ha^{-1} and 20 kg N + 40 kg P_2O_5 ha^{-1} increased the grain yield by 18.97 and 24.20%, respectively over no application of nitrogen and phosphorus. Increase in grain yield with the application of various nutrients was due to improvement in plant growth and yield attributes. The study highlights the importance of using nutrients through various sources for realizing high productivity of chickpea.

Key words: Nitrogen, phosphorus, zinc sulphate, yield attributes, *Cicer arietinum*

INTRODUCTION

Chickpea (*Cicer arietinum* L.) is an important grain legume crop in the world which was globally grown on 11.55 million ha area with total production of 10.46 million tonnes during 2009 (http://faostat.fao.org). India, Pakistan, Turkey, Australia, Myanmar and Ethiopia are the major chickpea producing countries. Chickpea, almost in all regions, is grown on marginal soils and the good soils are used for growing other more favoured crops. With the result, the productivity of chickpea is very low. Chickpea productivity is influenced by many factors including sowing time (Valimohammadi *et al.*, 2007), *Rhizobium* inoculation (Parveen *et al.*, 1999; Yadav *et al.*, 2011), plant population (Ali *et al.*, 1999), moisture stress (Khamssi, 2011), seed priming (Ghassemi-Golezani *et al.*, 2008), etc. For obtaining high grain yields proper management of the crop is a must and proper nutrient management is one of the important factors contributing towards high productivity. Though chickpea, being a grain legume, is capable of fixing atmospheric nitrogen, a starter dose of nitrogen is essential for proper growth and development of the plant. Chickpea grain yields are known to improve with the application of nitrogen (Namvar *et al.*, 2011; Yagmur and Kaydan, 2011). Phosphorus plays an important role in nodulation, nitrogen fixation, growth and yield of chickpea (Meena *et al.*, 2002, 2005; Jat and Ahlawat, 2006; Singh *et al.*, 2010).

Application of 20 kg N+20 kg P_2O_5 ha^{-1} or 20 kg N + 40 kg P_2O_5 ha^{-1} (Devi and Singh, 2005) improve chickpea yields considerably.

In some soils deficiency of many micronutrients is becoming an alarming problem for sustainable agriculture. In case only the major nutrients, such as nitrogen and phosphorus, are supplied to the crop through straight or complex chemical fertilizers only, the deficiency of some other major, secondary and micronutrients is bound to appear in various crops. Therefore, those sources of nutrients should be used which supply the plants various nutrients. This will help not only in obtaining high crop yields but also maintain soil fertility over a long run. Such sources of nutrients could be farmyard manure and vermicompost, as both these organic manures contain fairly good amount of various nutrients essential for proper growth and development of the plant. Both organic and inorganic sources of nutrients can be used in chickpea (Tolanur and Badanur, 2003; Karande *et al*., 2006; Gawai and Pawar, 2006).

There was, therefore, a need to study the effect of nutrient application through various sources on the productivity of chickpea. The present study was undertaken to investigate the effect of application of farmyard manure, vermicompost and chemical fertilizers in chickpea.

MATERIALS AND METHODS

Site characterization: Two field experiments were conducted during rabi (winter) of 1999-2000, 2000-01 and 2001-02 at the research farm of the Punjab Agricultural University Ludhiana (30° 56'N, 75° 52'E, altitude 247 m), India under irrigated conditions. The soil of the experimental field was loamy sand, having pH 8.2, organic carbon 0.30%, P 15.1 kg ha^{-1} and K 275 kg ha^{-1}. Meteorological data pertaining to the crop growing season are presented in Table 1.

Treatments and experimental design: Experiment 1 comprised of 12 treatments i.e., all combinations of two levels of farmyard manure (0 and 5 t ha^{-1}), three levels of phosphorus (0, 30 and 60 kg P_2O_5 ha^{-1}) and two levels of zinc sulphate (0 and 25 kg $ZnSO_4$ ha^{-1}). The experiment was conducted in a factorial randomized block design with three replications. Phosphorus was supplied through single super phosphate (16% P_2O_5). All treatments received uniform dose of nitrogen and sulphur. All nutrient sources were applied at the time of sowing.

Experiment 2 comprised of 3/4 levels of vermicompost (1, 2 and 3 t ha^{-1} in 1999-2000 and 0, 1, 2 and 3 t ha^{-1} in 2000-01 and 2001-02) and three levels of nutrients (0 kg N+0 kg P_2O_5 ha^{-1}, 10 kg N+20 kg P_2O_5 ha^{-1} and 20 kg N+40 kg P_2O_5 ha^{-1}). All treatment combinations were

Table 1: Monthly meteorological data during Rabi 1999-2000 to 2001-02

	1999-2000				2000-01				2001-02			
Month	Max temp. (°C)	Min temp. (°C)	Total rainfall (mm)	No. of rainy days	Max temp. (°C)	Min temp. (°C)	Total rainfall (mm)	No. of rainy days	Max temp. (°C)	Min temp. (°C)	Total rainfall (mm)	No. of rainy days
October	33.1	17.5	0.0	0	33.8	18.6	0.0	0	32.9	18.3	0.0	0
November	27.8	11.6	0.0	0	27.4	12.2	0.0	0	28.1	11.3	0.0	0
December	21.7	5.7	0.0	0	22.4	6.2	19.4	1	20.4	7.8	7.2	2
January	17.2	7.0	49.7	5	16.8	4.6	4.4	1	18.9	5.7	6.0	1
February	19.7	7.0	39.7	6	21.9	7.5	0.0	0	21.9	7.9	14.0	1
March	26.9	11.1	20.6	2	28.7	12.6	3.0	1	28.7	13.2	9.4	2
April	37.3	17.7	1.4	2	36.6	18.0	59.0	3	36.6	18.9	15.4	1

allocated in a factorial randomized block design with three replications. Nitrogen and phosphorus were supplied through urea (46% N) and single super phosphate (16% P_2O_5). All treatments received uniform dose of sulphur.

Crop husbandry: Pre-sowing irrigation was applied and at proper moisture conditions seedbed was prepared by cultivating the field two times followed by planking. Sowing was done during the first week of November in 1999, 2000 and 2001 using 45 kg seed rate ha^{-1}. Variety PBG 1 was sown in rows 30 cm apart. Weeds were controlled by two hand weedings performed about 30 and 60 days after sowing. Irrigation was applied as per the need. Recommended fungicides and insecticides were sprayed against diseases and insect pests. The crop was harvested and threshed manually.

Observations recorded: In both the experiments, at maturity, data on plant height, branches $plant^{-1}$ and pods $plant^{-1}$ were recorded from five randomly selected plants. From the total produce of each plot, 100 seeds were counted to record data on 100-seed weight. Grain yield data were recorded whole plot basis.

Statistical analysis: All data were subjected to analysis of variance as per the standard procedure and least significant difference values were calculated at 5% significance level whenever the F-ratio was found to be significant.

RESULTS AND DISCUSSION

In Experiment 1, the application of 5 t FYM ha^{-1} improved the plant growth and yield attributes (Table 2) either numerically or significantly and increased grain yield significantly (Table 3) over no application of FYM. On three-year mean basis, application of 5 t FYM ha^{-1} improved chickpea grain yield by 14.89% over no application of FYM (Table 3). Other researchers (Devi and Singh, 2005; Prasad *et al.*, 2005; Singh *et al.*, 2010) also reported beneficial effect of FYM on chickpea

Table 2: Plant growth and yield attributes of chickpea as influenced by the application of farmyard manure, phosphorus and zinc sulphate

	Plant height (cm)			Branches $plant^{-1}$			Pods $plant^{-1}$			100-seed weight (g)		
Treatment	1999-2000	2000-2001	2001-2002	1999-2000	2000-2001	2001-2002	1999-2000	2000-2001	2001-2002	1999-2000	2000-2001	2001-2002
FYM (t ha^{-1})												
0	58.1	57.7	49.3	6.65	8.32	6.97	56.3	62.1	35.7	12.8	13.4	13.4
5	59.9	59.2	54.1	7.06	8.66	7.92	60.4	68.4	48.2	12.9	13.5	13.5
LSD (p = 0.05)	NS	NS	2.3	0.38	NS	0.68	NS	NS	2.4	NS	NS	NS
P_2O_5 (kg ha^{-1})												
0	57.9	56.9	51.7	6.58	8.08	7.15	55.2	61.6	39.0	12.6	13.2	13.2
30	59.2	58.6	51.0	6.85	8.49	7.53	59.2	65.6	42.6	12.7	13.5	13.5
60	59.7	59.9	52.3	7.55	8.90	7.66	60.7	68.5	44.2	12.8	13.8	13.6
LSD (p = 0.05)	NS	NS	NS	NS	0.59	NS	NS	6.3	3.0	NS	NS	0.1
$ZnSO_4$ (kg ha^{-1})												
0	57.6	57.8	50.3	6.58	8.28	7.07	5.70	62.9	38.7	12.8	13.4	13.5
25	60.2	59.1	53.0	7.14	8.70	7.83	5.93	67.6	45.2	12.9	13.5	13.4
LSD (p = 0.05)	NS	NS	NS	0.38	NS	0.68	NS	NS	2.4	NS	NS	NS

Table 3: Grain yield of chickpea as influenced by the application of farmyard manure, phosphorus and zinc sulphate

Treatment	Grain yield (kg ha^{-1}) 1999-2000	2000-01	2001-02	Mean	Percent increase in grain yield over respective control
FYM (t ha^{-1})					
0	988	1357	1080	1141	-
5	1220	1543	1171	1311	14.89
LSD (p = 0.05)	84	134	63		
P_2O_5 (kg ha^{-1})					
0	915	1242	1084	1080	-
30	1117	1509	1094	1240	14.81
60	1153	1599	1198	1316	21.85
LSD (p = 0.05)	103	164	42		
$ZnSO_4$ (kg ha^{-1})					
0	1055	1408	1122	1195	-
25	1153	1492	1128	1257	5.18
LSD (p = 0.05)	84	NS	NS		

productivity. Similarly, phosphorus application improved all these parameters either numerically or significantly and the values were higher with the use of 60 kg P_2O_5 ha^{-1} than with 30 kg P_2O_5 ha^{-1} which in turn were higher than with 0 kg P_2O_5 ha^{-1} . Application of 30 and 60 kg P_2O_5 ha^{-1} increased the grain yield by 14.81 and 21.85% over no application of phosphorus. Other researchers (Meena *et al*., 2005; Jat and Ahlawat, 2006; Singh *et al*., 2010) also highlighted the role of phosphorus in improving the grain yield of chickpea, whereas Kayan and Adak (2006) did not find beneficial effect of phosphorus application in chickpea. Dry matter yield of chickpea is improved with phosphorus fertilization (Islam *et al*., 2001). The application of 25 kg $ZnSO_4$ ha^{-1} increased grain yield significantly over no application of zinc sulphate in one out of three years of experimentation only (Table 3). Other researchers (Akay, 2011) also reported non-significant increase in chickpea grain yield with zinc application.

In Experiment 2, the application of vermicompost improved plant growth and yield attributes (Table 4) and grain yield (Table 5) significantly or numerically. In general, these parameters tended to increase with the increase in the dose of vermicompost. As the dose of vermicompost increased, grain yield of chickpea also improved. However, vermicompost @ 2 t ha^{-1} seemed to be the optimum. Other researchers (Devi and Singh, 2005; Jat and Ahlawat, 2006; Sinha *et al*., 2010) also reported beneficial effect of vermicompost on the growth and yield of chickpea. Nitrogen and phosphorus applications influenced plant growth, yield attributes and grain yield of chickpea, which were higher with higher dose of nutrients. On mean basis, application of 10 kg N+20 kg P_2O_5 ha^{-1} and 20 kg N+40 kg P_2O_5 ha^{-1} increased grain yield of chickpea by 18.97 and 24.20%, respectively over no application of nitrogen and phosphorus. Application of 20 kg N+20 kg P_2O_5 ha^{-1} or 20 kg N+40 kg P_2O_5 ha^{-1} is known to improve yield in chickpea (Devi and Singh, 2005). Mineral nitrogen increases water use efficiency in chickpea (Bahavar *et al*., 2009) and therefore, apart from supplying nutrition it could benefit the crop indirectly also.

In both the experiments, grain yields of chickpea were higher in 2000-01 than in 1999-2000 or 2001-02 (Table 3 and 5) which could possibly be due to differences in meteorological conditions (Table 1). Adequate moisture helps in improving the plant growth and grain yield not only by providing the required water for normal growth of the plant but also improving the availability and consequently uptake of nutrients by the plant.

Table 4: Effect of vermicompost and chemical nutrients on plant growth and yield attributes of chickpea

	Plant height (cm)			Branches plant^{-1}			Pods plant^{-1}			100-seed weight (g)		
Treatment	1999-2000	2000-2001	2001-2002	1999-2000	2000-2001	2001-2002	1999-2000	2000-2001	2001-2002	1999-2000	2000-2001	2001-2002
Vermicompost (t ha^{-1})												
0 (control)	-	59.0	50.8	-	6.68	6.28	-	61.1	34.4	-	13.2	12.3
1	59.7	61.4	51.3	6.73	7.26	6.18	64.2	65.1	36.2	13.1	13.7	12.2
2	60.2	61.6	52.8	7.20	7.42	7.15	68.6	66.4	39.0	13.5	14.0	12.5
3	62.2	62.0	53.0	7.42	7.66	6.57	67.2	68.9	39.4	13.4	14.3	12.4
LSD (p = 0.05)	3.2	NS	NS	0.48	0.41	0.70	NS	NS	NS	NS	0.6	NS
Nutrient dose (ha^{-1})												
0 kg N+0 kg P_2O_5 (control)	59.5	58.3	49.0	6.11	6.43	6.45	57.6	58.0	35.6	13.4	13.2	12.2
10 kg N+20 kg P_2O_5	62.4	62.4	53.1	7.48	7.45	6.35	73.7	67.7	36.1	13.2	14.1	12.4
20 kg N+40 kg P_2O_5	63.6	62.4	53.7	8.05	7.90	6.85	77.0	70.4	40.0	13.5	14.1	12.4
LSD (p = 0.05)	2.8	3.3	3.0	0.42	0.35	NS	7.1	5.8	3.7	NS	0.5	NS

Table 5: Effect of vermicompost and chemical nutrients on grain yield of chickpea

	Grain yield (kg ha^{-1})			
Treatment	1999-2000	2000-01	2001-02	Mean
Vermicompost (t ha^{-1})				
0 (control)	-	1396	954	-
1	941	1471	1079	1163
2	1042	1529	1185	1252
3	1118	1567	1251	1312
LSD (p = 0.05)	103	NS	69	
Nutrient dose (ha^{-1})				
0 kg N+0 kg P_2O_5 (control)	872	1314	1026	1070
10 kg N+20 kg P_2O_5	1130	1548	1141	1273
20 kg N+40 kg P_2O_5	1190	1611	1186	1329
LSD (p = 0.05)	90	124	83	

Increase in grain yield of chickpea with the application of various nutrients could be due to improvement in plant growth and yield attributes. Some yield attributes such as pods plant^{-1} (Khan and Qureshi, 2001; Mishra *et al*., 2002; Noor *et al*., 2003; Ciftci *et al*., 2004), seeds pod^{-1} (Ciftci *et al*., 2004) and 100-seed weight (Noor *et al*., 2003) are known to have positive direct effect on the grain yield of chickpea. Apart from chemical nutrients, the other sources such as farmyard manure and vermicompost should be used as these have residual beneficial effects on the succeeding crops also (Jamwal, 2006). Balanced nutrition may not only help in maintaining soil fertility but also ensure sustainable agriculture in the long run which is essential in various parts of the world for feeding the ever growing human population.

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