VEGETOS

Vol. 26 (1) : 183-187 (2013)

DOI:10.5958/j.2229-4473.26.1.026

Effect of Bio-Organics and Chemical Fertilizers on Growth and Yield of Chickpea (*Cicer arietinum* L.) Under Middle Gujarat Conditions

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A field experiment was carried to study the performance of chickpea (*Cicer arietinum* L.) as influenced by FYM, Biofertilizers castor cake and levels of nitrogen and phosphorus during 2008-09. Chickpea plants exhibited significant responses to various bio-organics with respect to growth, yield and yield attributes. Application of FYM + castor cake and FYM + *Rhizobium* + *Azotobacter* + PSB gave the maximum values. Application of 100% RDF gave significantly the highest values for all the growth and yield attributes. Treatment combination B_3F_3 was at par with B_4F_3 produced significantly higher number of pods plant^{-1}. Significantly maximum grain yield was recorded under B_4F_3 which failed to statistically superior over B_4F_1, B_4F_2, B_4F_0 and B_3F_3.

Keywords: Bio-Organics, Chemical Fertilizer, chickpea, growth, yield

Received:17.09.2012 **Revised:** 30.2.2013 **Accepted:** 17.5.2013

INTRODUCTION

Chickpea (*Cicer arietinum* L.) is an important pulse crop with synonym Bengal gram, garbanzo (Spanish), chana (Hindi) and chanaka (Sanskrit). Chickpea (*Cicer arietinum* L.) is the largest produced food legume in South Asia and the third largest produced food legume globally, after the common bean (*Phaseolus vulgaris* L.) and field pea (*Pisum sativum* L.). India is the largest chickpea producing country accounting for 64% of the global chickpea production. The other major chickpea producing countries include Pakistan, Turkey, Iran, Myanmar, Australia, Ethiopia, Canada, Mexico and Iraq. It is grown in an about 30% of the national pulse acrage which contributes to about 38% of national pulse production in India. The total production of this crop has increased from 3.65 million tones in 1950-51 to 5.77 million tones in 2003-04 registering a quite low growth rate of 0.58% annually in the area under cultivation (a decline from 7.57 to 7.29 million hectares) with an increased productivity from 482 to 792 kg/ha (Masood and Shiv 2005). During the triennium 2004-2007, the global chickpea area was about 11.0 m ha with a production of 8.8 m tons and average yield of nearly 800 kg ha^{-1}. (Gaur *et al.* 2010). Pulses occupy a very important place in Indian diet because they constitute the major source of protein to the predominantly vegetarian population. Nutritionally, Chickpea is relatively free from various antinutritional factors, has a high protein digestibility, and is richer in phosphorus and calcium than other pulses. Because of its higher fat content and better fiber digestibility, chickpea holds good promise as a protein and calorie source for animal feed. Chickpea straw also has a forage value. Because of these diversified uses of the crop and its abil-

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ity to grow better with low inputs under harsh edaphic factors, it is an important component of the cropping system of subsistence farmers in the Indian subcontinent.

Keeping in view the foresaid beneficial effects of symbiotic and free-living nitrogen fixing microbes, an attempt has been made to evaluate the associative effect of *Rhizobium* and *Azotobacter* on chickpea (*Cicer arietinum* L.). Besides these bacteria, phosphate solubilising microbes of different genus/species were also included in order to assess their effect on plant growth and yield under organic farming. The extensive use of chemical fertilizers in agriculture is currently under debate due to environmental concern and fear for consumer health. Consequently, there has recently been a growing level of interest among the people to develop and adopt eco-friendly sustainable agricultural practices. In this context, increasing and extending the role of bioinoculants (biofertilizers) may reduce the need of chemical fertilizers and thereby decrease adverse environmental effects (O'Connell 1992). Based on the above perspectives, the present investigation was undertaken to find out the effects of the bio-organics and chemical fertilizers on the performance of chickpea.

MATERIAL AND METHODS

A field experiment was conducted during winter (*rabi*) season of 2008-09 at College Agronomy Farm, Anand Agricultural University, Anand, situated at 22^0-35' N latitude, 72^0-55' E longitude and an altitude of about 45.1 meters above the MSL. The soil was loamy sand in texture, neutral in reaction (pH 7.5), low in organic carbon (0.23%) and available nitrogen (198 kg ha^{-1}), medium in available phosphorus (24.20 kg ha^{-1}) and high in available potassium (358.86 kg ha^{-1}). The total rainfall recorded during 2008 was 961 mm. The treatment comprised of four levels of bio-organics (B_1: *Rhizobium* + *Azotobacter* + PSB, B_2: FYM @ 5 tonnes ha^{-1}, B_3: FYM @ 5 tonnes ha^{-1} + *Rhizobium* + *Azotobacte*r + PSB, B_4**:** FYM @ 2 tonnes ha^{-1}+ castor cake @ 0.5 tonnes ha^{-1}) and four levels of chemical fertilizers (F_0: No fertilizers, F_1: 50% of RDF, F_2: 75% of RDF, F_3: 100% RDF). Recommended dose was 25 Kg N and 50 Kg P_20_5 ha^{-1} which was applied through urea and di-ammonium phosphate. The treatments were evaluated in randomized block design with factorial concept in three replications. Treatment wise dose of fertilizers like nitrogen and phosphorus; FYM, castor cake and biofertilizers like *Rhizobium*, *Azotobactor*, and PSB were placed in about 5 to 6 cm deep, prior to sowing in the furrows. Chickpea (Gujarat Gram-1) was sown manually using a seed rate of 60 kg ha^{-1} with 30 cm row spacing. Crop was grown in irrigated conditions and it was not much affected by the incidence of pest and diseases. The economics was calculated by considering the sale price of chickpea and cost of cultivation during 2009. Data collected on various parameters of crop were subjected to statistical analysis to draw valid conclusion.

RESULTS AND DISCUSSION

Chickpea plants exhibited significant responses to various bio-organics and chemical fertilizers in respect of growth, yield and yield attributes (Table 1). Application of bio-organics were found significantly superior in improving the growth parameters like plant height, fresh and dry weight of nodules plant^{-1}, days to 50% flowering and number of branches plant^{-1}. Application of FYM + castor cake (B_4) and FYM + *Rhizobium* + *Azotobacter* + PSB (B_3) gave the maximum values. Among the yield attributes, number of pods plant^{-1}, the grain yield plant^{-1} grain and straw yields (kg ha^{-1}), seed index and harvest index, maximum values was obtained in plots nourished through the FYM + castor cake (B_4) followed by FYM + *Rhizobium* + *Azotobacter* + PSB (B_3) except straw yield which was the maximum under B_3. Bio-organics did not manifest their significant variation in protein content of grain. All the bio-organics significantly improved the organic carbon, available nitrogen and phosphorus in the soil over initial levels. Significantly higher results were obtained under application of FYM + *Rhizobium* + *Azotobacter* + PSB (B_3). The reason might be due to high rate of mineralization of organic nitrogen due to lowering the

Table 1. Effect of bio-organics and chemical fertilizers on growth parameters, yield and yield attributes quality, post harvest soil nutrient status and economics of chickpea.

Treatment	Plant height			Fresh weight (mg) of nodules plant^{-1}	Dry weight (mg) of nodules	Days to 50% flowering	Number of branches plant^{-1}	Number of pods plant^{-1}	Grain yield plant^{-1}	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Seed index (g)	Harvest index (%)	Protein content in grain (%)	Post harvest available soil nutrients (kg ha^{-1})			Net realization (Rs. ha^{-1})
	30 DAS	60 DAS	90 DAS												OC (%)	N	P_2O_5	
Bio-organics																		
Rhizobium + *Azotobacter* + PSB (B_1)	13.68	35.48	48.94	269.45	157.51	44.66	9.70	59.45	13.33	1446	2239	20.42	39.49	18.14	0.24	219.91	28.45	40699
FYM @ 5 tonnes ha^{-1} (B_2)	14.16	35.61	52.65	197.04	113.84	45.41	11.15	80.10	15.53	1802	2650	21.79	40.19	19.05	0.26	233.11	25.93	52053
FYM @ 5 tonnes ha^{-1} + *Rhizobium* + *Azotobacter* + PSB (B_3)	14.49	37.41	53.56	281.80	169.05	47.66	11.96	103.55	19.45	2322	2834	22.33	44.98	19.40	0.29	258.40	31.46	69775
FYM @ 2 tonnes ha^{-1}+ Castor cake @ 0.5 tonnes ha^{-1}(B_4)	14.86	38.88	54.36	240.45	140.38	44.41	12.70	110.94	23.35	2761	2751	23.60	50.09	19.48	0.27	237.17	30.48	84814
C.D. (P=0.05)	0.78	0.79	1.16	8.98	6.24	2.25	0.55	3.70	1.40	138.94	178.92	0.67	2.97	NS	0.02	18.04	1.69	-
Chemical Fertilizers																		
No fertilizers (F_0)	13.68	35.48	48.94	233.83	135.20	45.83	10.96	81.88	16.83	1851	2441	21.23	42.33	17.95	0.24	218.47	27.79	55659
50% of RDF (F_1)	14.16	35.61	52.65	242.82	143.16	44.75	11.25	85.43	17.66	2045	2570	21.90	43.79	18.74	0.26	233.11	28.05	61895
75% of RDF (F_2)	14.49	37.41	53.56	249.44	146.35	45.25	11.62	89.14	18.24	2162	2618	22.48	44.76	18.99	0.27	243.01	29.50	65695
100% RDF (F_3)	14.86	38.88	54.36	262.65	156.07	46.33	11.68	97.60	18.94	2272	2844	22.54	43.88	20.39	0.28	254.00	30.99	69348
C.D. (P=0.05)	0.78	0.79	1.16	8.98	6.24	NS	0.55	3.70	1.40	138.94	178.92	0.67	NS	1.49	0.02	18.04	1.69	-
Initial	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.23	198	24.2	-

C:N ratio by adding castor cake and more availability of organic carbon for multiplication of microorganisms and this helped in improving the nutrient availability in soil by increased microbial activities. The results are in close conformity with those of Rajput and Kushwah (2005) and Karande *et al.* (2007).

All the growth, quality and yield attributing characters of chickpea increased significantly with increasing rates of nitrogen and phosphorus. Application of 100% RDF (F_3) gave the maximum values for all the growth attributes *viz.* plant height at 60 DAS, fresh and dry weight of nodules plant^{-1} and number of branch plant^{-1}. Plant height at 30 and 90 DAS and days to 50% flowering were not significantly influenced by application of chemical fertilizers. Application of 75% of RDF (F_2) gave almost comparable results to F_3. Significantly the highest value for yield attributes (number of pods plant^{-1}, the grain yield plant^{-1} grain and straw yields kg ha^{-1} and seed index) were recorded under application of 100% RDF over no fertilizers. Not much variation was found with respect to harvest index, all four levels were at par with each other. Application of 100% and 75% of RDF significantly increased the protein content in seed over F_1 and F_0. In case of post harvest nutrient status organic carbon, available nitrogen and phosphorus in the soil were found significantly improved under application of 100% and 75% of RDF over no fertilizers. The increase in yield due to N and P may be attributed to improvement in vegetative growth due to better availability of nutrients at vital growth period and greater synthesis of carbohydrate and their translocation (Datt *et al.* 2003). The results are confirmed by the findings of Chaudhari *et al.* (1998).

The interaction between bio-organics and chemical fertilizers exhibited significant effect on number of pods plant^{-1} and grain yield kg ha^{-1}. Treatment combination B_3F_3 produced a significantly the higher number of pods plant^{-1} and it remained at par with B_4F_3 followed by B_4F_2 which was comparable with B_4F_1 and B_4F_0. All the combinations of FYM + castor cake produce profitable yield. Significantly maximum grain yield was recorded under B_4F_3 which failed to statistically superior over B_4F_1, B_4F_2, B_4F_0 and B_3F_3.

In terms of economics, B_4 (FYM + castor cake) recorded the highest net return of Rs. 84814 ha^{-1} with BCR of 7.42 followed by B_3 (FYM + *Rhizobium* + *Azotobacter* + PSB) with net return of Rs. 69775 ha^{-1} and BCR of 6.40. Among the various fertilizer levels, F_3 (100% RDF) recorded the highest net return of Rs. 69348 ha^{-1} with BCR of 6.98 followed by F_2 (Rs. 65695 ha^{-1}) with BCR of 6.82. Treatment combination B_4F_0 and B_4F_1 was found most economic with net profit of Rs. 82606 ha^{-1} and Rs. 83988 ha^{-1} respectively with BCR of 7.25 and 7.07 over B_4F_3 whose net profit was highest Rs. 86575 ha^{-1} but it was not economical because of lower BCR of 6.99 so we can use bio-organics only and avoid the use of chemical fertilizers.

Conclusion

The study found the response of chickpea to four levels of bio-organics and four levels of chemical fertilizers under middle Gujarat conditions. Application of FYM + castor cake significantly improved grain yield (2761 kg ha^{-1}), straw yield and post harvest soil nutrient status probably due to better balanced nutrient supply due to organics that resulted in better crop growth and yield attributes. Among the chemical fertilizers application of 100% RDF gave highest grain yield, protein content and post harvest nutrient status at par with 75% RDF. Straw yield also maximizes under this treatment. Maximum net return and benefit cost ratio were observed with the application of FYM + castor cake and 100% RDF. Interaction effect turned out to be significant and indicated that adding only FYM + castor cake in the soil proved beneficial for boosting seed yield and was most profitable due to higher net return and maximum B: C ratio.

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