Annals of Plant and Soil Research 25(3): 506-508 (2023)
https://doi.org/10.47815/apsr.2023.10299
Short communication

Productivity and profitability of chickpea (*Cicer Arietinum*) genotypes improved by different plant densities and fertility levels

GURINDER SINGH[1*] AND MOHINDER LAL[2]

[1]Department of Agronomy, Punjab Agricultural University, Ludhiana, Punjab, India-141004
[2]Department of Agriculture, G.S.S.D.G.S. Khalsa College, Patiala, Punjab, India-147001

Received: January, 2023: Revised accepted: May, 2023

A prominent pulse crop of the semi-arid tropics, chickpea (*Cicer arietinum* L.) is grown on the Indian subcontinent (Gupta *et al* 2018). Nutritionally, it is an important source of protein (16-20%) in vegetarian diet and has become more important to mitigate the problem of protein energy malnutrition (Singh and Singh 2018). With a projected global demand for chickpea of 18.3 million tonnes compared to the current production of 11.23 million tonnes and developing nations with low incomes are expected to encounter the largest supply-demand gap (Sah *et al* 2019). Application of nitrogen fertilization improves the grain yield, protein content and amino acids. Phosphorus fertilization contributes directly to yield of the chickpea and also plays an important role in utilization of sugar and starch, photosynthesis, protein metabolism, energy storage and energy transfer. However, potassium behaves as a catalyst in activating several enzymes as incorporation of amino acids in protein, synthesis of peptide bonds etc. Potassium enhances the resistance in plants against different abiotic factors like drought, heat, frost and various abiotic factors like disease caused by fungi, nematode and other microorganism. Also sulphur is an essential element in forming proteins, enzymes, vitamins and chlorophyll in plants. It is crucial in nodule development and efficient nitrogen fixation in legumes. Proper geometry is dependent on variety of chickpea, its growth habit and agro climatic condition. Plant density directly facilitate aeration and light penetration in to plant canopy for getting optimum rate of photosynthesis (Shiferaw *et al* 2018). Selection of cultivar and its adaptation on a particular environment is also an important factor. Keeping these facts in view, the present study was initiated using chickpea as test crop.

The field experiment was conducted at Campus for Research and Advanced Studies, Dhablan, Department of Agriculture, G.S.S.D.G.S. Khalsa College, Patiala during *rabi* season of 2019-20. The experiment was conducted in Factorial randomized block design. The soil of experimental field contained 262.64 kg ha^{-1} available N, 22.6 kg ha^{-1} available P and 129 kg ha^{-1} available K. Soil of experimental field was clayey in texture having soil pH 7.3 and 0.52% organic carbon. The experimental site was situated at 30º19′ North latitude and 76º24′ East longitude at an altitude of 250 metre above the mean sea level. The experiment consisted of 8 treatment combinations of two genotypes (PBG 7 and GPF 2), two planting densities (30 × 10 cm and 45 × 10 cm) and two fertility levels (20 kg N + 40 kg P_2O_5 + 20 kg K_2O + 20 kg S ha^{-1} and 30 kg N + 60 kg P_2O_5 + 30 kg K_2O + 20 kg S ha^{-1}) were replicated thrice. The different doses of fertilizers as per the treatment were applied in the form of urea, single super phosphate and murate of potash respectively at the time of sowing. The crop was sown on 23 October 2019 by manually. Cultural operations carried out in the experimental field were done by manually. Thinning and gap filling was done by 4 December 2019, hand weedings were done on 26 December 2019, 26 January 2020, 5 march 2020, respectively. Harvesting of crop was done on 2 April, 2020 and threshing was done on 8 April, 2020. The observations recorded in experiment were yield attributes and yield like number of pods $plant^{-1}$, number of grains pod^{-1}, test weight, grain yield $plant^{-1}$, grain yield, straw yield, biological yield and harvest index and economic parameters like gross return, net return and b:c ratio. Results for different observation were statistically analyzed using factorial randomized block design by using the OPSTAT software (Sheoran 2010) at P=0.05 level of probability.

*Corresponding author: gurinderv6@gmail.com

Table 1: Response of different genotypes, plant densities and fertility levels on yield attributing characters and yield of chickpea

Treatments	Pods plant^{-1}	Grains pod^{-1}	Test weight (g)	Grain yield plant^{-1} (g)	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})	Biological yield (q ha^{-1})	Harvest index (%)
Genotype								
PBG 7	42.48	2.04	136.71	5.45	18.01	19.98	37.99	47.47
GPF 2	44.65	2.32	137.46	7.55	16.62	21.06	37.68	44.41
SEm (±)	0.64	0.08	0.49	0.04	0.14	0.43	0.48	0.53
CD (P= 0.05)	1.94	0.25	NS	0.14	0.42	NS	NS	1.60
Plant density								
30 x 10 cm	42.02	2.15	136.97	6.35	17.47	22.51	39.98	43.68
45 x 10 cm	44.95	2.26	138.00	6.56	16.74	18.53	35.27	47.45
SEm (±)	0.64	0.08	0.49	0.04	0.14	0.43	0.48	0.53
CD (P= 0.05)	1.94	NS	NS	0.14	0.42	1.31	1.46	1.60
Fertility level (kg ha^{-1})								
20 N + 40 P + 20 K + 20 S	42.13	2.06	138.07	6.30	16.75	20.85	37.60	44.74
30 N + 60 P + 30 K + 20 S	45.90	2.35	136.90	6.71	17.88	20.19	38.07	47.15
SEm (±)	0.64	0.08	0.49	0.04	0.14	0.43	0.48	0.53
CD (P= 0.05)	1.94	0.25	NS	0.14	0.42	NS	NS	1.60

Data (Table 1) showed that genotype GPF 2 produced significantly higher 44.65 pods plant^{-1}, 2.32 grains pod^{-1} and grain yield plant^{-1} 7.55 g as compared to genotype PBG 7. PBG 7 produced significantly highest grain yield 18.01 q ha^{-1} and harvest index 47.47% as compared to GPF 2. This might be due to superior varietal characters and genetic potential of variety PBG 7. Test weight, straw yield and biological yield did not differ significantly between both genotypes of chickpea (Table-1). Gross return ₹ 87797 ha^{-1}, net return ₹ 64398 ha^{-1} and b:c ratio 2.75 were produced significantly higher with genotype PBG 7 due to efficient utilization of resources by genotype PBG 7 which were responsible for higher grain yield and ultimately produced significant highest results for economic parameters (Table-2). Similar results were also reported by Goyal *et al* (2010).

Plant density 45 × 10 cm resulted significant higher pods plant^{-1} 44.95, grains yield plant^{-1} 6.56 g and harvest index 47.45 g as compared to plant density 30 × 10 cm (Table-1). Grain yield 17.47 q ha^{-1}, straw yield 22.51 q ha^{-1} and biological yield 39.98 q ha^{-1} were significantly higher produced by plant density 30 × 10 cm as compared to 45 × 10 (Table 1). The number of pods plant^{-1} decreased with increase in plant density while total number of pods per unit land area increased with increase in plant density, which were responsible for higher grain yield with increased plant density 30 × 10 cm (Table 1). Grains pod^{-1} and test weight were not differed significantly among plant densities. Similar results were also observed by Nawange *et al* (2018). The results clearly suggest that individual plant under lower plant population density performed better than plant under higher plant population density, the improvement in yield attributing characters and yield plant^{-1} of individual plant under lower plant population was not sufficient enough to compensate the loss of density for higher seed yield. 30 × 10 cm produced significant higher gross return ₹ 85176 ha^{-1}, net return ₹ 61776 ha^{-1} and b:c ratio 2.64 as compared to 45 × 10 cm (Table 2). This might be due to the more grain yield at plant density 30 × 10 cm which directly increase the economic parameters. Similar results were also reported by Nawange *et al* (2018).

Higher fertility level 30 kg N + 60 kg P + 30 kg K + 20 kg S ha^{-1} significantly produced more pods plant^{-1} 45.90, grains pod^{-1} 2.35, grain yield plant^{-1} 6.71 g, grain yield 17.88 q ha^{-1} and harvest index 47.15 % as compared to lower fertility level 20 kg N + 40 kg P + 20 kg K + 20 kg S ha^{-1} (Table 1). This might be due to higher fertility levels could enhance the availability of additional amount of nutrients which favoured the better root and shoot system and also improved rate of photosynthesis resulted in higher yield. Similar results were also reported by Nawange *et al* (2018). Test weight, straw yield and biological yield did not significantly influenced by fertility levels (Table 1). The higher fertility level recorded significantly higher gross return ₹ 87167 ha^{-1}, net return ₹ 63117 ha^{-1} and b:c ratio 2.72 (Table 2). The possible reason for increase in economic parameters could be that higher fertilization dose improving dry matter production in turn might have resulted in greater synthesis of photosynthesis contributing to

Table 2: Response of different genotypes, plant densities and fertility levels on economic parameters of chickpea

Treatments	Gross return (₹/ha)	Net return (₹/ha)	B:C ratio
Genotype			
PBG 7	87797	64398	2.75
GPF 2	81036	57636	2.46
SEm (±)	688	688	0.02
CD (P= 0.05)	2089	2088	0.08
Plant density			
30 × 10 cm	85176	61776	2.64
45 × 10 cm	81607	58207	2.48
SEm (±)	688	688	0.02
CD (P= 0.05)	2089	2088	0.08
Fertility level (kg ha^{-1})			
20 N+40 P+20 K+20 S	81666	58916	2.59
30 N+60 P+30 K+20 S	87167	63117	2.72
SEm (±)	688	688	0.02
D (P= 0.05)	2089	2088	0.07

increase in number of pods plant^{-1} and ultimately led to higher grain yield which directly produced significant economic parameters with higher fertility level. Similar data was observed by Goyal *et al.* (2010).

From the above findings, it may be concluded that genotypes of chickpea crop responded significantly to optimum plant density with higher level of fertility (30 kg N + 60 kg P + 30 kg K + 20 kg S ha^{-1}) due to effective utilisation of resources by proper light penetration, reduced competition for resources and better nutrient availability to increase the productivity and profitability. Thus, it is inferred that application of 30 kg N + 60 kg P + 30 kg K + 20 kg S ha^{-1} to genotype PBG 7 at plant density 30 × 10 cm proved beneficial for obtaining higher production of chickpea in clayey textured soils of Patiala region, Punjab. These findings provide valuable insights for farmers, agronomists and policymakers enabling them to make informed decisions about fertility levels and planting densities.

REFERENCES

Dhima, K., Vasilakoglou, I., Stefanou, S. and Eleftherohorinos, I. (2015) Effect of cultivar, irrigation and nitrogen fertilization on chickpea (*Cicer arietinum* L.) productivity. *Agricultural Sciences* **6**: 1187-1194.

Goyal, S., Verma, H.D. and Nawange, D.D. (2010) Studies on growth and yield of kabuli chickpea (*Cicer arietinum* L.) genotypes under different plant densities and fertility levels. *Legume Research* **33**(3): 221-223.

Gupta, M., Bindra, S., Sood, A., Singh, I., Singh, G., Gaur, P.M., Chaturvedi, S.K., Dixit, G.P. and Singh, S. (2018) Identifying new sources of tolerance to post emergence herbicides in chickpea (*Cicer arietinum* L.). *Journal of food legumes* **31**(1): 5-9.

Islam, M., Mohsan, S., Ali, S., Khalid, R. and Afzal, S. (2012) Response of chickpea to various levels of phosphorus and sulphur under rainfed conditions in Pakistan. *Romanian Agricultural Research* **29**: 1-9.

Kumar, H., Yadav, B.S., Singh, R., Yadav, D.D., Chahal, V.P., Yadav, R. and Yadav, O.S. (2018) Effect of potassium levels on performance of chickpea (*Cicer arietinum* L.) under different genotypes. International *Jour. of Chemical Studies* **6**(6): 1675-1677.

Kumar, S., Khande, R.S., Sonboir, H.L., Pande, N. and Bhambri, M.C. (2018) Effect of sowing time, spacing and nipping on growth and yield of chickpea (*Cicer arietinum* L.) under irrigated conditions. International *Journal of Chemical Studies* ***6(1):*** 1218-1222.

Nawange, D.D., Verma, H.D. and Verma, H. (2018) Growth and yield performance of kabuli chickpea (*Cicer arietinum* L.) genotype under different planting geometry and fertility levels in Vindhya Plateau Region. *International Journal of Agricultural Sciences* **10**(5): 5291-5293.

Prasad, D., Bangarwa, A.S., Kumar, S. and Ram, A. (2012) Effect of sowing dates and plant population on chickpea (*Cicer arietinum* L.) genotypes. *Indian Journal of Agronomy* **57**(2): 206-208.

Sah, S., Singh, R.N. and Nain, A.S. (2019) Impact of weather parameters on simulated biophysical parameters of chickpea. *Jour. of Agricultural Physics* **19**(1): 58-66.

Sheoran, O.P. (2010) Online Statistical Analysis (OPSTAT), developed by CCS Haryana Agricultural University, Hisar, Haryana, India, *http://www.hau.ernet.in/opstat.html*

Shiferaw, M., Tamado, T. and Asnake, F. (2018) Effect of plant spacing on yield components and yield of kabuli chickpea (*Cicer arietinum* L.) varieties at Debre Zeit, Central Ethiopia. *International Journal of Plant and Soil Science* **21**(6): 1-6.

Singh, Z. and Singh, G. (2018) Role of Rhizobium in chickpea (*Cicer arietinum*) production - A review. *Agricultural Reviews* **39**(1): 3.