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Effect of organic source of nutrients on growth, yield and quality of chickpea (*Cicer arietinum* L.)

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Abstract
A field experiment was planned and conducted during 2022-23 at Crop Research Center, School of Agricultural Sciences, Shri Guru Ram Rai University, Pathri Bagh, Dehradun, Uttarakhand, India to investigate the "Effect of organic source of nutrients on growth, yield and quality of chickpea (*Cicer arietinum* L.)". The experiment was laid out in randomized block design (RBD) with three replications and six treatments *i.e.,* T_1 Control, T_2 Rhizobium (100%), T_3 PSB (100%), T_4 Neem cake (1.25 t/ha), T_5 Neem cake (1.25 t/ha) + Rhizobium (100%), T_6 Neem cake (1.25 t/ha) + PSB (100%). The sowing was done on 26/11/2022 and final harvest at 11/03/2023. Observations on various attributes *viz.* growth, yield and economics were recorded. The results revealed that treatment T_5 (Neem cake (1.25 t/ha) + Rhizobium (100%) found to be most effective in terms of growth characters such as Plant height (51 cm), Number of Branches per plant (13.33), Number of leaves per plant (1119), Number of nodules per plant (23.66), Dry weight of plant (55 g); yield attributes *viz.* Number of pods per plant (43), Number of seeds per pod (2), Seed yield (23 qha^{-1}), Straw yield (37.66 qha^{-1}), Harvest Index (263.91%), Test weight (18.66 gm) were recorded highest under the than the other treatments.

Keywords: Organic, Growth and yield attributes, Rhizobium inoculation, PSB inoculation, Neem cake

Introduction
Chickpea (*Cicer arietinum* L.) is an ancient crop first taken into cultivation by Neolithic farmers. Today, Chickpea continues to play an important role in agricultural systems in the world, ranking 3rd behind dry bean (*Phaseolus vulgaris* L.) and field pea (*Pisum sativum* L.) in terms of grain legume production. It is a Legume which belong to family Fabaceae, is a type of pulse with high nutritive value rich in protein, dietary fiber, and dietary minerals. Availability of nitrogen in the soil is also an important factor for chickpea growth and productivity. Chickpea is a major source of protein in developing nations and is ranked 3rd on the basis of its consumption as well as importance worldwide. Cultivated chickpea and its wild progenitor, Cicer reticulatum, originate from Southeastern Anatolia, in modern Turkey. Chickpea is believed to have been domesticated about 10,000 years ago, with the oldest archaeological remains traced to northern Syria around 5000 BC. However, archaeological remains are scant and chickpea could well be confused with pea in a number of cases, and dates of its introduction to sub-Saharan Africa and the Indian subcontinent are unclear (Umadevi and Ganesan. 2007) [18]. Part of the reason for a limited genetic diversity in this crop could relate to the shift during early cultivation from winter to summer cropping to escape Ascochyta blight and the relatively narrow expansion of the wild progenitors. However, a recent recollection of wild progenitors has shown a larger diversity than what was available in the gene banks Ryan *et al*. (2012) [20]. Cultivated chickpea is erect, contrary to its wild progenitor, which is believed to have been a domestication criterion. India is the principal chickpea-producing country, with a 68% share in the global chickpea area and production. Globally, chickpea is grown on about 8.12-million-hectare area with a production of 7.49 million metric tons and an average productivity of 895kg/ha (FAOSTAT, 2021) [1]. The developing countries account for 90% of the global chickpea cultivation Chickpea 83 and South and Southeast Asia (SSEA) contribute about 79% of the global chickpea production. Chickpea, also known as gram or chana, is an important pulse crop in India. This crop was cultivated in about 99 Lha. The country harvested a record production of 107 Lt at a highest productivity level of 1086 kg/ha. As usual, MP has contributed a significant 28% of the total gram area and 34% of total gram production in the country, thereby ranking first both in area and production followed by Maharastra (19% & 18%) and Karnataka (10% & 6%). About 97% of gram production of the country during the

period under report has been realised by 10 states of Madhya Pradesh, Maharastra, Rajasthan, Karnataka, Uttar Pradesh, Andra Pradesh, Gujarat, chhattisgarh and Jharkhand. The variety CNG-2171 is considered primitive and popular variety of chickpea which is commonly known as gram. This variety of gram is resistant to wilt, stunt and root rot. This variety is developed by ARS (SKRAU) Sriganganagar, Rajasthan. This variety found in Punjab, Haryana, UP, J&K Delhi, Rajasthan, HP and Uttarakhand. Maturity of CNG-2171 is 163 days. Chickpea (*Cicer arietinum L.*) is the primary source of food protein for about 20% of the world population and is the second largest pulse crop after common bean, with a global production of about 17.2 Mt from 17.8 Mha. Chickpeas (*Cicer arietinum*) are legumes. Main usage at present is for being a popular staple food in the Indian subcontinent. The dry seeds are ground into flour, eventually after roasting to make it more flavourful. There are a few names used in parallel: Chickpea flour, besan flour, gram flour, and garbanzo (bean) flour. The flour is high in protein and gluten-free. Organic manures play a vital role in increasing the productivity of pulses by several means. For eg. FYM not only supplies all the major and micro nutrients but also acts as a soil conditioner, improves physico-chemical properties of soil and encourages the soil microbial activities too. It is quite useful particularly under limited water availability situations as it increases the water retention capacity of soil. The addition of Neem cake also positively affected the available soil organic carbon, N P K and Mn content of soil resulting better growth and grain yield of crop besides suppressing soil borne pathogens. The composition of Neem cake is 5.2% N, 1.0% P2O5, 1.4% K2O. Neem cake act as a nitrogen inhibitor means reduce the nitrification. It supplies the available nitrogen for a long time in the soil (Sharma *et al.* 2006 and Singh and Jagdish, 1997) [19].

Material and Methods

The field research was carried out in experimental field of Shri Guru Ram Rai University, Patel Nagar, and Dehradun, India during rabi season in 2022-2023 Effect of organic source of nutrients on growth, yield, and quality of chickpea (*Cicer arietinum* L.) under different organic manure and in combination with Rhizobium and PSB. The geographical situation of the farm lies in the north-Gangetic alluvial plain at 25º 18` north latitudes 83º03` East longitude and at an altitude of 128.93 meters above the mean sea level. The following therapies were used: T_1 Control, T_2 Rhizobium (100%), T_3 PSB (100%), T_4 Neem cake (1.25 t/ha), T_5 Neem cake (1.25 t/ha) + Rhizobium (100%), T_6 Neem cake (1.25 t/ha) + PSB (100%). The experiment was laid out in randomized block design with three replications. The soil of the experimental plot was sandy loam. The land was primarily ploughed followed by two harrowing. The field was given a pre-sowing irrigation before field preparation to obtained proper germination and establishment of the crop. Chickpea variety 'CNG-2171' was sown after pre-sowing irrigation using 80 kg/h seed rate. Neem cake was applied in the field as per the treatment details before sowing and mixed in soil. Accordingly, seeds were inoculated with rhizobium and PSB. Plant height (cm), Number of branches, Number of leaves, Number of nodules per plant and Pant dry weight (gm) was measured at harvest. The height of three randomly selected and tagged plants in second row of each plot was measured from ground surface to apex leaf and then average was taken. Three plants were randomly selected from each plot at 30 and 60 DAS and 90 DAS and uprooted carefully such that nodules were not lost by detaching in the soil. After washing the roots carefully, total number of nodules present on the roots were detached from the roots and counted and then averaged. Number of pods in sampled three plants was counted. The average number were computed and expressed as number of pods per plant. A representative sample of 100-grains of chickpea was sundried at 15% moisture level from each plot and weighed in gram. Grain yield after threshing, cleaning and sun drying were taken and finally recorded in quintal per hectare. After picking the pods, the remaining portion of the plant was harvested. The stover yield was calculated after the plant was completely dried. For obtaining the final straw yield, weight of straw of the observational plants were also added in the corresponding figures. The yield was then converted into quintal per hectare. The harvest index was calculated as the ratio of economic yield (grain) to biological yield (grain + straw) during kharif season 2022 respectively.

Results and Discussion

Plant height(cm), Branches, and Number of Leaves\Plant

The highest plant height was recorded with the application of T_5 (Neem cake 1.25 t/ha + Rhizobium 100%) *i.e.*, 21 cm at 30 DAS, 29 cm at 60 DAS and 51 cm at 90 DAS, which was significantly higher than the plant height observed under all the other treatments. The minimum plant height was observed with treatment T_1 (control) *i.e.*, 16.33 cm at 30 DAS, 23 cm at 60 DAS and 42.66 cm at 90 DAS. Similar result in the case of plant height significantly highest (50.10 cm). The highest number of branches per plant was recorded with the application of T_5 (Neem cake 1.25 t/ha + Rhizobium 100%) *i.e.*, 7.66 at 30 DAS, 10 at 60 DAS and 13.33 at 90 DAS, which was significantly higher than the number of branches per plant observed under all the other treatments. The minimum number of branches was observed with treatment T_1 (control) *i.e.*, 4.33 at 30 DAS, 6 at 60 DAS and 9.66 at 90 DAS. Similar result in the case of number of branches per plant significantly highest (13.20. The highest number of leaves per plant was recorded with the application of T_5 (Neem cake 1.25 t/ha + Rhizobium 100%) *i.e.*, 154 at 30 DAS, 537.33 at 60 DAS and 1119 at 90 DAS, which was significantly higher than the number of leaves per plant observed under all the other treatments. The minimum number of leaves was observed with treatment T_1 (control) *i.e.*,110 at 30 DAS, 370.33 at 60 DAS and 860.66 at 90 DAS.) were also reported by Shete *et al.* 2010 [2], Ghanshyam *et al.* 2010 [3], Meena and Ram 2013 [4], Sohu *et al.* 2015 [6] and Kiran *et al.* 2016 [5].

Number of Nodules and plant dry weight

The highest number of nodules per plant was recorded with the application of T_5 (Neem cake 1.25 t/ha + Rhizobium 100%) *i.e.*, 11.66 at 30 DAS, 19.66 at 60 DAS and 23.66 at 90 DAS, which was significantly higher than the number of nodules per plant observed under all the other treatments. The minimum number of nodules was observed with treatment T_1 (control) *i.e.*,7.33 at 30 DAS, 14.66 at 60 DAS and 19.33 at 90 DAS. Similar result in the case of number of nodules per plant significantly highest (12.4). The highest plant dry weight (gm) was recorded with the application of T_5 (Neem cake 1.25 t/ha + Rhizobium 100%) *i.e.*, 38.33 at 30 DAS, 55 at 60 DAS and 55 at 90 DAS, which was significantly higher

than the plant dry weight (gm) observed under all the other treatments. The minimum plant dry weight(gm) was observed with treatment T_1 (control) *i.e.,* 31 at 30 DAS, 43.66 at 60 DAS and 43.66 at 90 DAS. Similar result in the case of plant dry weight (gm) significantly highest (90.50) were also reported by Singh and Prasad (2008) [7] and Kumaravelu and Kadambian (2009) [8].

Table 1: Effect of organic source of nutrients on growth of chickpea (*Cicer arietinum* L.)

Treatment	Plant height at harvest (cm)	Number of branches (90DAS)	Number of leaves per plant (90DAS)	Number of nodules per plant at (90DAS)	Plant dry weight (90 DAS)
T_1	42.667	9.667	860.667	19.333	62.333
T_2	48	10.333	921.333	21.333	67.667
T_3	48	11	885	22.333	67.667
T_4	46.333	21	959.333	21.667	65
T_5	51	13.333	1,119.00	23.667	77
T_6	49.333	12.333	1,049.00	22.333	72.333
SE (m) ±	0.697	4.899	20.668	0.417	1.464
CD @ 5%	2.223	3.953	65.967	1.332	4.674

Number of pods, Seeds\Plant and Test weight-1000 seeds (gm)

The highest number of pods per plant was recorded with the application of T_5 (Neem cake 1.25 t/ha + Rhizobium 100%) *i.e.,* 43, which was significantly higher than the number of pods per plant observed under all the other treatments. The minimum number of pods per plant was observed with treatment T_1 (control) *i.e.,* 36. Similar result in the case of number of pods per plant significantly highest (42.75). The highest number of grains per pods was recorded with the application of T_5 (Neem cake 1.25 t/ha + Rhizobium 100%) *i.e.,* 2, which was significantly higher than the number of grains per pods observed under all the other treatments. The minimum number of grains per pods was observed with treatment T_1 (control) *i.e.,* 1. Similar result in the case of number of grains per pods significantly highest (1.55). The highest Test weight (gm) was recorded with the application of T_5 (Neem cake 1.25 t/ha + Rhizobium 100%) *i.e.,*18.66, which was significantly higher than the Test weight (gm) observed under all the other treatments. The minimum Test weight (gm) was observed with treatment T_1 (control) *i.e.,* 17.33. Similar result in the case of Test weight (gm) significantly highest (19.35) were also reported by Nekar *et al.* (2009) [10].

Seed, Straw yield and Harvesting Index

The highest grains yield (q/ha) was recorded with the application of T_5 (Neem cake 1.25 t/ha + Rhizobium 100%) *i.e.,* 23, which was significantly higher than the grains yield (q/ha) observed under all the other treatments. The minimum grains yield (q/ha) was observed with treatment T_1 (control) *i.e.,* 17.66. Similar result in the case of grains yield (q/ha) significantly highest (22.06) were also reported by (Patil *et al.* 2012) [11]. The highest straws yield (q/ha) was recorded with the application of T_5 (Neem cake 1.25 t/ha + Rhizobium 100%) *i.e.,* 37.66, which was significantly higher than the straws yield (q/ha) observed under all the other treatments. The minimum straws yield (q/ha) was observed with treatment T_1 (control) *i.e.,* 27.66. Similar result in the case of straws yield (q/ha) significantly highest (38.60). The highest harvest index (%) was recorded with the application of T_4 (Neem cake 1.25 t/ha) *i.e.,* 265.63, which was significantly higher than the harvest index (%) observed under all the other treatments. The minimum harvest index (%) was observed with treatment T_2 (Rhizobum 100%) *i.e.,* 245.45. (Swaminathan *et al.* 2007 and Somasundaram *et al*, 2007) [14, 12]. These results are agreement with the findings of Louduraj *et al*. 2005 [15]; Somasundaram and Singaram, 2006 [13]; Patil *et al.* 2012 [11]; Yadav and Tripathi, 2013 [17]; Bag *et al.* 2015 [16].

Table 2: Effect of organic source of nutrients on growth of chickpea (*Cicer arietinum* L.)

Treatment	Number of pods per plant	Number of seed per pods	Test weight (g)	Seed yield (q/ha)	Straw yield (q/ha)	Harvest index (%)
T_1	36	1	17.333	17.667	27.667	256.645
T_2	38.333	1.667	17.667	21.333	31	245.455
T_3	39.333	1.333	18	19.667	31.667	261.053
T_4	37.667	1.667	17.667	20.333	33.667	265.635
T_5	43	2	18.667	23	37.667	263.911
T_6	42.333	1.667	18.333	22.333	36	261.265
CD @ 5%	1.454	0.429	0.54	1.332	1.492	10.19
SE (m) ±	0.455	0.202	0.328	0.417	0.467	3.192

Conclusion

The results of the data's statistical analysis revealed that the treatments and grain yield varied significantly. Significantly, the Rhizobium inoculation (100%) + Neem cake 1.25 t/ha treatment generated the highest yield of grains when compared to all other treatments (Table 3). Combination of organic manures and biofertilizer significantly boosted chickpea grain output, which could be attributed to their direct impact on dry matter production in subsequent stages due to improved photosynthetic efficiency. The combined effects of the number of pods per plant, the weight of the seeds and straw yield are also said to increase seed yield.

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