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Response of Manures and Inorganic Sources of Nutrient on Growth, Yield and Quality of Chickpea (*Cicer arietinum* L.)

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ABSTRACT

The present investigation entitled "Response of Manures and Inorganic Sources of Nutrient on Growth, Yield and Quality of Chickpea (*Cicer arietinum L.*)" was carried out to examine the response of both organic manure and inorganic sources of nutrient, in a single or combined application on growth, yield and quality of chickpea. The field experiment was conducted during winter season, 2019 at Agricultural Research Block of S.G.R.R University, Dehradun, Uttarakhand. The experiment was carried out in randomize block design with 12 treatments and 3 replications. The investigation revealed that the performance of chickpea was significantly influenced by combined application of manure and inorganic nutrients (NPK). Among all the treatments treatment T_{12} [FYM (5t/ha) + Neemcake (2t/ha) + 100% RDF] per ha was found best with respect to plant height (59.40 cm), dry matter accumulation per plant (30.66 g), number of pods per plant (50.14), number of seeds or grain per plant (58.13), test weight (25.21 g), grain yield per plant (18.99 g), grain yield (19.35 q per ha), straw yield (26.52 q per ha), harvest index (41.98%), nitrogen content in grain and straw (3.78% and 1.57) and protein content in grain and straw (23.63% and 9.80%). Based on overall performance, it can be concluded that under prevalent climatic conditions of Dehradun region, the combined application of inorganic fertilizer and manures (Integrated Nutrient Management), *i.e.* application of FYM (5t/ha) + Neemcake (2t/ha) + 100% RDF, can be recommended to an alternative to inorganic fertilizers for efficient nutrients use efficiency and achieving maximum growth, nodulation, grain yield and quality of Chickpea during *Rabi* season.

Key words *Chickpea, Organic manures, FYM, NEEM CAKE, Grain yield, NPK.*

Introduction

Pulses are one of the major food items to be included in a vegetarian diet. Pulses are the cheapest source of protein. It is also considered as poor men's meat. Pulses contribute 16-18 percent of total protein of Indian average diet. India is the world's biggest producer of the pulses and occupies an area of 23.89 milion hectares with the production of 15.12 million tons (Anon., 2014), which is comparatively very low to the average pulse yield (857kg/ha) of the world. In 2014 the area and the production were increased to 26.40 million hectares and 18.24 million tons respectively with the productivity of 690 kg/ha

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(Anon., 2014). Chickpea (*Cicer arietinum L.*) belongs to a Leguminosae or Fabaceae family. It is commonly known as Bengal gram in English and Black chana in Hindi. It is an annual rabi crop. The ripened seeds of chickpea are consumed in the form of processed foods which are boiled, roasted, fried, steamed, and sprouted. It is also used as a 'dal' or as flour (besan), fresh green seeds are also consumed as green vegetable. It is also used for preparing a variety of snacks, sweets. Chickpea is a good source of protein, carbohydrate, fat, minerals (calcium, phosphorus and iron) and vitamins. It is also useful as an animal feed and has a good forage value. It is the largest produced food legume in South Asia and globally the third largest after common bean (*Phaseolus vulgaris* L.) and field pea (*Pisum sativum* L.). India is the major chickpea growing country in the world which accounts for about 76 percent of total area and 67 percent production of the world. In India, the total area employed is about 9.18 million hectares with total production of 8.22 million tons and an average productivity of 900 kg/ha (Anon., 2014). The major chickpea producing state Madhya Pradesh, Rajasthan, Maharashtra, Uttar Pradesh, Karnataka and Andhra Pradesh which contributes 92%of the production and 95% of the area in the country altogether. Although chickpea is very important pulse daily diet and also in agricultural production, its productivity is very low. Nitrogen plays an important role in synthesis of chlorophyll, amino acids and other organic compounds which add to the building units of proteins in the plant system. The photosynthesis action of the plants and their ability to use available nutrients increases by nitrogen application. It increases the growth and development, dry matter production and yield of crops even under dry and land conditions. Phosphorus is one of the most important major nutrient elements required for proper growth and yield of legumes. Ryan *et al.* (2012) has clearly demonstrated the significance of phosphorus for all animals and plant life on the earth. Sharma *et al.* (2014) reported that the application of phosphorus was found to increase the production of pulse crops. Potassium is one of the three major essential nutrients required by crop plant. It influences the water economy and crop growth through its effects on water uptake, root growth, maintenance of turgor, transpiration and stomatal regulation (Nelson, 1980). Although potassium unlike N and P, does not enter into the composition of any product, yet literature on Reveals that it has an important role either direct or indirect, under different environments, in major plant processes such as photosynthesis, respiration, protein synthesis, water uptake, enzyme activation, growth and yield of plant (Sharma *et al.,* 2006 and Singh and Jagdish, 1997). Neemcake protects plant roots from nematodes, soil grubs and mite ants probably due to its residual limonoid content. All plant parts of neem show some characteristics of insect repellence, seeds and seed kernels provide the greatest amount of insecticidal limonoids. Neem seed kernel extract on chickpea reduced egg laying, larval population and pd damage by H. armigera. It also acts as a natural fertilizer with pesticides properties. Neem powder is applied when you are preparing soil for sowing. Plough the soil deeply and mix the neem powder. This process gives yield better results with harvest in chickpea crop. Since the information on these aspects is very meagre and fragmentary, it is imperative to generate relevant and systematic information on these aspects. Therefore, a study envisaged to find out the effect of manure and inorganic sources of nutrient on growth, yield and quality of chickpea for sustainable agriculture.

Materials and Methods

A field experiment was carried out during Rabi season of 2019 – 20 in the Agricultural Research centre of School of Agriculture Sciences, SGRRU, Dehradun, Uttarakhand, India. In order to find out mechanical composition and fertility status of the soil of experimental site, samples were collected randomly from 0-30 cm soil layer just before sowing and after harvesting of the crop with the help of soil sampling auger. All the collected soil samples were brought to the laboratory for analysing their chemical properties. The analysis revealed that the soil of the experimental site was Sandy loam in texture poor in organic matter, low in available nitrogen, medium in available phosphorus and Potassium contents with neutral in reaction and normal in electrical conductivity. Dehradun is situated in the North-Western part of Uttarakhand at 30^0-19′ North latitude and 78°- 1' East longitude, at an altitude of 653 metres above the mean sea level. It has humid subtropical climatic conditions with cold winters, warm and colourful spring's humid and hot summer and an elongated monsoon. The maximum tem-

perature occasionally reaches 35 °C and minimum temperature reaches 11°C, and total rainfall 108.9 mm, respectively. Meteorological observations recorded at the meteorological observatory at the Research Farm of Shri Guru Ram Rai University, Patel Nagar, Dehradun. The experiment laid out in RBD with three replications there were 12 treatments consisting of FYM, Neemcake & NPK the crop chickpea variety (PUSA-256) was sown in year 2019-20 (rabi season) with a spacing of 30*25cm. Sowing was done in furrows opened by hand plough to a depth of 4-5 cm. Seeds were dropped by hand maintaining a definite quantity measured for each plot on the basis of recommended seed rate (100 kg/ha). Seed were treated with Captan @ 2.5 per kg of seed before sowing against fungal diseases. After sowing of seeds, furrows were covered with thin layer of soil manually to avoid moisture loss. Three plants of each experimental plot were selected randomly and tagged. Plant height (cm) of chickpea was recorded with the help of the meter scale from base to the upper most tip of the plant at each stage of observation, averaged them and expressed in cm. Total number of branches on three randomly selected tagged plants was counted and the average number of branches per plant was worked out. Three plants were randomly selected then removed border rows of experimental plot. Sun dried tagged plants were dried also in an oven at 65 °C temperature. The dry weight of plant was recorded according to experimental treatments on weighing balance at 45, 90 and at harvest. A representative sample was taken from each net plot and the weight of 100 seeds was recorded in gram (g) and expressed as test weight. The plants from each net plot were harvested and grains were separated by threshing. After sun drying for three days grain yields obtained in each plot were weighed (kg) and further it was calculated on the hectare basis (q/ha). Yield was calculated by subtracting the grain yield from the total biological yield of the crop. Finally, straw yield per plot was converted in to kg/ha. The percent protein content in the Chickpea Grain and straw were estimated from total Nitrogen content (% concentration) in the chickpea grain and straw by multiplying Protein correction factor (6.25) respectively. Protein content in grain and straw was estimated by assaying total nitrogen (Kjeldahi method) present in seed by multiplying the nitrogen percent 6.25.

Results and Discussion

Growth characters

Plant Height

Application of T_{12} [FYM (5t/ha) + Neemcake (2t/ha) + 100% RDF] per ha significantly improved the plant height, it was statistically at par with Treatment T_{11} [FYM (5t/ha) + Neemcake (2t/ha) + 50% RDF] and T_9 [FYM (5t/ha) + 100% RDF] during all growth stages of chickpea. The plant height may be increased under treatment T_{12} because of combined application of manures and inorganic sources. Combined application of manures and inorganic sources enhance the decomposition rate of manures, hence the availability of nutrients maximum under integration of manures and inorganic sources. These results are in close conformity with those of Singh *et al.* (2012) and Sohu *et al.* (2015).

Number of total leaves per plant

The maximum number of leaves per plant was recorded under the treatment T_{12} [FYM (5t/ha) + Neemcake 2t/ha) + 100% RDF) as compared to all the other treatments at all the stages of crop growth but remained statistically at par with the treatments T_{11}[FYM (5t/ha) + Neemcake (2t/ha) + 50% RDF] T_9 [FYM (5t/ha) + 100% RDF] and T_6 [Neemcake (2t/ha) + 100% RDF]. Judicious Use of fym and NPK increased number of leaves per plant. These findings were supported by Agasimani and Hosmani (1989) and Dobariya (1984).

Number of Branches per Plant

As the crop growth advanced, the number of branches per plant increased steadily till harvest stage. The higher number of branches per plant was also increased under treatment T_{12} [FYM (5t/ha) + Neemcake (2t/ha) + 100% RDF] per per ha except treatments T_{11} [FYM (5t/ha) + Neemcake (2t/ha) + 50% RDF] and T_9 [FYM (5t/ha) + 100% RDF] which remained statistically at par with each other's at 45 days after sowing stage. However, at 90 days after sowing and at harvest stages all the combination of manure and inorganic treatment shows significantly highest number of branches per plant. It may be due to increased plant height under treatment T_{12}. Judicious use of FYM, phosphorus and potassium increased vegetative growth of plant, that's why the number of branches increased. The similar results

were also reported by Goverdhan Singh (1985). The significantly maximum plant spread was recorded under Treatment T_{12} [FYM (5t/ha) + Neemcake (2t/ha) + 100% RDF] which was statistically at par with Treatment T_{11} FYM (5t/ha) + Neemcake (2t/ha) + 50% RDF], and T_9 [FYM (5t/ha) + Neemcake (2t/ha)], At 45 DAS. Whereas, at 90 DAS it was at par with treatment T_{11} [FYM (5t/ha) + Neemcake (2t/ha) + 50% RDF], T_9 [FYM (5t/ha) + Neemcake (2t/ha)] and T_6 [Neemcake (2t/ha) + 100% RDF], however, at harvest stage the Treatment T_{12} [FYM (5t/ha) + Neemcake (2t/ha) + 100% RDF] significantly maximum plant spread but remained statistically at par with Treatment T_{11} [FYM (5t/ha) + Neemcake (2t/ha) + 50% RDF], T_9 [FYM (5t/ha) + Neemcake (2t/ha)], T_6 [Neemcake (2t/ha) + 100% RDF] and T_3 [100%RDF] respectively.Use of manures and NPK increased vegetative growth of plant, that's why the plant spreaded more.

Number of Nodules Per Plant

The number of nodules at 45 DAS stage recorded maximum in T_{12} [FYM (5t/ha) + Neemcake (2t/ha) + 100% RDF] treatment being significantly superior over all the other treatments except T_{11} [FYM (5t/ha) + Neemcake (2t/ha) + 50% RDF] and T_9 [FYM (5t/ha) + 100% RDF], however, at 90 DAS stage all the combination of organic manure and inorganic fertilizer treatments recorded significantly maximum number of nodules per plants. Use of organic manures (FYM) highly increased nodule per plant, that's why the number of nodule increased. These findings were supported by Patil *et al.* (1998), Adu and Nnadi (1990) and Singh *et al.* (2012). The effect of manures and inorganic sources of nutrition on dry matter accumulation per plant significantly highest under treatment T_{12} [FYM (5t/ha) + Neemcake (2t/h) + 100% RDF] followed by the treatment T_{11} [FYM (5t/ha) + Neemcake (2t/ha) + 50% RDF], at 45 DAS and harvest stages of crop growth. It was due to the reason that the biomass of the plant i.e. plant population, plant height, branches, leaves and plant spread, nodules were maximum with combined application of manures and inorganic sources. The branches increased the total number of leaves per plant, hence the total accumulation of photosynthates and better growth of

The effect of various treatments on plant height (cm), leaves and branches per plant at different stages of Chickpea growth

Symbol	Treatments	Plant Height (cm per plants)			Number of total leaves per plants			Number of Branches per Plants			Number of Nodules per plants	
		45 Days	90 Days	At Harvest	45 Days	95 Days	At Harvest	45 Days	95 Days	At Harvest	45 Days	95 Days
T_1	Control	20.17	42.32	47.22	56.27	76.84	145.22	4.37	8.52	12.52	4.86	16.71
T_2	50%RDF	20.33	43.61	49.11	62.36	89.33	148.00	4.28	10.96	13.96	5.44	18.54
T_3	100%RDF	24.34	45.80	53.03	102.69	136.00	191.77	5.32	14.43	20.93	5.60	23.98
T_4	Neemcake(2t/ha)	22.27	44.53	50.93	64.40	95.67	155.29	4.49	12.00	14.30	6.34	20.96
T_5	Neemcake(2t/ha)+50%RDF	23.34	44.37	53.00	73.11	113.97	183.55	4.78	14.00	16.37	6.43	23.71
T_6	Neemcake (2t/ha)+100%RDF	26.33	46.55	55.44	107.77	151.50	209.95	5.72	15.06	21.89	6.73	24.48
T_7	FYM (5t/ha)	22.17	43.72	51.49	66.46	111.93	173.84	4.50	12.55	14.89	7.34	20.23
T_8	FYM (5t/ha)+50%RDF	23.16	44.82	52.88	79.78	118.50	184.62	5.27	14.22	17.58	7.50	22.48
T_9	FYM (5t/ha)+100%RDF	27.50	47.54	54.82	110.81	158.84	214.33	6.08	15.74	21.55	7.82	24.84
T_{10}	FYM(5t/ha)+Neemcake (2t/ha)	23.67	45.45	52.44	79.95	125.50	172.05	5.38	14.85	16.52	7.93	21.65
T_{11}	FYM(5t/ha)+Neemcake (2t/ha)+50%RDF	29.34	48.85	57.35	114.46	164.67	220.42	6.16	16.52	22.85	8.47	24.47
T_{12}	FYM (5t/ha)+Neemcake(2t/ha)+100%RDF	30.17	50.25	59.40	117.23	170.67	234.13	6.49	17.10	24.00	8.69	25.91
	SEm±	1.05	1.08	1.71	3.55	10.69	9.70	0.16	1.12	2.55	0.20	1.59
	CD(P=0.05)	3.12	3.19	5.04	10.47	31.55	28.62	0.47	3.32	7.53	0.58	4.70

RDF: Recommended Dose of Fertilizer FYM: Farm Yard Mannure

plants with combined application of manures and inorganic sources. These findings were similar to Shrivastava and Verma (1982), Singh *et al.* (2012) and Sohu *et al.* (2015).

Yield and Quality parameters

Test weight (g)

The test weight of grain was significant influence by the combined application of organic manure and inorganic sources of nutrition. The significantly maximum test weight was recorded under Treatment T_{12} [FYM (5t/ha) + Neemcake (2t/ha) + 100% RDF], as compared to all the other treatments except the T_{11} [FYM (5t/ha) + Neemcake (2t/ha) + 50% RDF] respectively, which was statistically at par with each other, whereas the minimum test weight was recorded under the control treatment T_1. These findings were similar to those reported by (Kousar *et al.*, 2019; Mohan and Thiyagarajan, 2019).

Grain and Straw yield

Different treatments of the organic manure and inorganic sources of nutrients had favourably affected grain yield, straw yield and biological yield per ha of Chickpea crop except harvest index. The significantly maximum grain yield, straw yield and biological yield per ha were observed under treatment T_{12} [FYM (5t/ha) + Neemcake (2t/ha) + 100% RDF], followed by the treatment T_{11} [FYM (5t/ha) + Neemcake (2t/ha) + 50% RDF] T_9 [FYM (5t/ha) + 100% RDF] T_6 [Neemcake (2t/ha) + 100% RDF] and T_3 [100%RDF] respectively, however none of the treatment had significantly effect on harvest index of chickpea crop. It was due to the number of pod per plant as well as seed weight per plant which is directly related to grain yield. Straw yield directly influenced by plant height, branches and leaves as well as dry matter accumulation. These factors are influenced by combined application of manures and inorganic fertilizers. Hence the grain yield and straw was maximum under same Treatment T_{12} [FYM (5t/ha) + Neemcake (2t/ha) + 100% RDF]. Harvest index calculated by the values of economic yield (grain) and biological yield (grain + straw) that's why harvest index was maximum under treatment T_{10} [FYM (5t/ha) + Neemcake (2t/ha)]. These findings were similar to those reported by Singh *et al.* (2012) and Sohu *et al.* (2015).

Quality parameters

Quality parameters of chickpea shoes nitrogen and protein content in grain, and straw. The Nitrogen content in grain was significantly higher under Treatment T_{12} [FYM (5t/ha) + Neemcake (2t/ha) + 100% RDF], followed by the treatment T_{11} [FYM (5t/ha) + Neemcake (2t/ha) + 50% RDF] T_9 [FYM (5t/ha) + 100% RDF] and T_6 [Neemcake (2t/ha) + 100% RDF] respectively, as compared to all the other treatments, however, the nitrogen content in straw and

The effect of various treatments on yield attributing characters per plant, grain, straw, biological yield (q per ha) and harvest index (%) of Chickpea crop

Symbol	Treatments	Test weight (g)	Grain yield (q per ha)	Straw yield (q per ha)	Nitrogen Content (%)		Protein Content (%)	
					Grain	Straw	Grain	Straw
T_1	Control	13.32	9.69	11.23	2.82	0.66	17.61	4.15
T_2	50% RDF	13.85	10.95	13.04	2.91	0.72	18.17	4.48
T_3	100% RDF	20.25	15.61	21.73	3.43	1.16	21.46	7.25
T_4	Neemcake (2t/ha)	14.43	13.36	14.56	3.06	0.74	19.11	4.60
T_5	Neemcake (2t/ha)+50% RDF	17.39	14.35	19.28	3.28	1.04	20.48	6.50
T_6	Neemcake (2t/ha)+100% RDF	21.13	17.67	23.24	3.47	1.25	21.67	7.83
T_7	FYM (5t/ha)	15.05	12.28	13.96	3.11	0.83	19.42	5.16
T_8	FYM (5t/ha)+50% RDF	17.88	13.95	19.56	3.34	1.13	20.90	7.04
T_9	FYM (5t/ha)+100% RDF	21.31	16.28	21.97	3.52	1.36	21.98	8.48
T_{10}	FYM (5t/ha)+Neemcake (2t/ha)	19.55	14.20	15.68	3.24	0.90	20.23	5.60
T_{11}	FYM(5t/ha)+Neemcake (2t/ha)+50% RDF	24.17	18.63	24.05	3.69	1.45	23.04	9.06
T_{12}	FYM(5t/ha)+Neemcake (2t/ha)+100% RDF	25.21	19.35	26.52	3.78	1.57	23.63	9.80
	SEm±	1.24	1.62	1.86	0.08	0.05	0.50	0.34
	CD(P=0.05)	3.66	4.78	5.50	0.24	0.16	1.49	1.00

RDF: Recommended Dose of Fertilizer FYM: Farm Yard Manure

protein content in grain, and straw were significantly higher under the treatment T_{12} [FYM (5t/ha) + Neemcake (2t/ha) + 100% RDF], followed by the treatment T_{11} [FYM (5t/ha) + Neemcake (2t/ha) + 50% RDF] as compared to all the other treatments. It was due to availability of N from different sources of manures and inorganic fertilizer which resulted maximum Nitrogen content in grain and straw of the chickpea crop. Protein content in grain and straw significantly high protein content in chickpea grain and straw in the treatment T_{12} [FYM (5t/ha) +Neemcake (2t/ha)+100% RDF] was due to more N accumulation in this treatment which results significantly protein content in grain and straw. The similar results had also reported by Sohu *et al.* (2015).

Conclusion

In the view of the experimental findings, summarized above, it may be concluded that the combined application of inorganic fertilizer and manures (Integrated Nutrient Management), *i.e.* application of FYM (5t/ha) + Neemcake (2t/ha) + 100% RDF, may be an alternative to inorganic fertilizers for efficient nutrients use efficiency and achieving more growth, Yield and Quality of Chickpea (*Cicer arietinum* L.) during *Rabi* season.

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