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Effect of integrated nutrient management on growth and yield of chickpea (*Cicer arietinum* L.) in central region of Uttar Pradesh

Pranjali Singh and AS Yadav

Abstract
The study on "Effect of Integrated Nutrient Management on Growth and Yield of Chickpea (*Cicer arietinum* L.)" was conducted out in Agriculture Research Farm, Faculty of Agriculture Sciences and Allied Industries, Rama University, Kanpur. The chickpea variety named Digvijay which is also known as Phule G-9425-5 was used for the purpose. A total ten treatment including control was used for the purpose. The results revealed that the maximum number of plant population per meter square (31.67) was reflected in treatments T10 (50% RDF + Vermicompost (2.5 t/ha) + Rhizobium +PSB). In similar lines the maximum number of plant population (24.33) was observed for treatment T10 (50% RDF + Vermicompost (2.5 t/ha) + Rhizobium +PSB), The maximum plant height (15.90, 33.07, 41.07cm), respectively recorded highest with treatment T10 (50% RDF + Vermicompost (2.5 t/ha) + Rhizobium +PSB) at all growth stages 30, 60, 90 DAS. Maximum number of pods per plant (55) was recorded with T10 (50% RDF + vermicompost (2.5 t/ha) + Rhizobium +PSB) and The maximum grain yield 18.77 quintal per hectare was recorded with T10 (50% RDF + Vermicompost (2.5 t/ha) + Rhizobium +PSB).

Keywords: INM, chickpea, vermi-compost, rhizobium, PSB

Introduction
Pulses traditionally had been one of the maximum crucial constituents of the Indian cropping and intake patterns and long considered "the poor man's meat" as it's miles one of the much less costly source of protein (Mohanty and Satyasai, 2015) [2]. Pulses are an essential source of nutrients for billions of humans across the world. The terms ''legumes'' and ''pulses'' are interchangeable due to the fact all pulses are taken into consideration legumes however now no longer all legumes are taken into consideration pulses. Besides serving as an essential source of protein for a big part of the worldwide population, pulses contribute to healthy soils and climate change mitigation through their nitrogen-fixing properties.

Among the legumes, chickpea (*Cicer arietinum*) is valued as a food legume because of its use in growing populations worldwide. During 201718, 14.96 million hectares were cultivated worldwide, with a total production of 16.22 million tonnes (FAOSTAT, 2019) [1] with a total production of 1,252 kg/ha. Among them, India accounts for 70% of the world's chickpea production and 71% of the world's land area are in India. Besides India, Australia (12.35%), Myanmar (3.25%) and Ethiopia (2.92%) are the world's top chickpea producers. India's chickpea production increased from 3.85 million tonnes to 11.23 million tonnes between 2001 and 2017, the area increased further from 5.18 million hectares to 10.56 million hectares, and production increased from 744 kg/ha to 1063 kg/ha during the same period. Madhya Pradesh is the top state in terms of area and production, accounting for approximately 34% and 40% of total area and gram production (Annual Report 2017-18, Pulses Development Authority). After years of stagnant productivity, India's chickpea imports have shrunk significantly to offset short home deliveries, and consequently became a major importer of chickpeas (0.590 million tonnes) in 2017-18.Countries that export chickpeas to India are Canada, Australia, Iran, Myanmar, Tanzania, Pakistan, Turkey and France. Nevertheless, India is the third- largest exporter with 0.212 MT (FAO, 2019) to the US, UK, Saudi Arabia, UAE, Sri Lanka and Malaysia. Therefore, this study investigates chickpea production, value and exchange at the global and national level to identify trends in area, production and yield.

The pulse is an essential component of the human diet. Beans contain 20-25% protein and grains contain 8-15%. Chickpeas are a rich source of protein, carbohydrates, and minerals, and 100 grains (g) provides 358 calories (Panda, 2006) [3].

Moonshine obtained by grinding chickpeas is part of the average Indian vegetarian diet. Due to high yield potential and good market price chickpea remains as one of the demanded pulse crops in market and it always remains as remunerative pulse crop. Here an attempt is made to access the effect of INM on growth yield on growth, yield attributes and yields of chickpea.

Material and Methods

The study entitled, "Effect of Integrated Nutrient Management on Growth and Yield of Chickpea (*Cicer Arietinum* L.)" is proposed to be undertaken at Agriculture Research Farm, Faculty of Agriculture Sciences and Allied Industries, Rama University, Kanpur during the Rabi season of 2021-22. The data was collected to judge the growth and yield attributes and yield of the chickpea. The chickpea variety named Digvijay which is also known as Phule G-9425-5 was used for the purpose. The following observations were recorded regarding the same.

Growth parameters

1. Plant population

After whole emergence of seed, plant to plant spacing of 10 cm became maintained. There 45 day after plant populace in step with square meter become counted.

2. Plant height

Five plants had been selected randomly from every plot, tagged completely and used for dimension of plant height. Top of essential shoot i.e., from the floor surface to base of absolutely extended leaf became measured by way of meter scale in centimetre. Common plant height at 30, 60, 90 DAS and at harvest degree changed into worked out.

3. Plant leaves

Five plants had been selected randomly from every plot, tagged completely and used for counting of plant leaves. Common leaves at 30, 60, 90 DAS and at harvest degree changed into worked out.

4. Number of branches per plant

The five plants randomly selected and tagged completely in each plot for height determine were used to recorded the number of branches per plant at 30, 60 and 90 DAS, their average was worked out.

5. Leaf Area Index (LAI)

Leaf area index is the ratio of leaf area to the ground area per plant. Leaf area index was worked out at various stages of plant growth by using the formula LAI= Leaf area per plant (m2)/Land area per plant (m2)

Yield attributes and yield

1. Number of pods per plants

The randomly selected plants used for recording the height branches and for counting the full range of pods at harvest and their common turned into worked out to document quantity of pods per plant.

2. Test weight

One thousand seeds were randomly assigned to a sample that was randomly extracted from the fallen and purified product of each piece and its recorded test weight.

3. Grains yield (q ha-1)

The overall biomass of each plot become threshed and cleaned, the seeds obtained had been weighed and transformed into quintal per hectare.

Description of treatment

Table 1: The details of treatment is expressed

Treatment	Description
T1	Control (No Nutrient Application)
T2	100% RDF (18 N+46 P2O5 +20 S Kg/ha)
T3	75% RDF
T4	50% RDF
T5	75% RDF +Vermicompost (2 t/ha)
T6	50% RDF + Vermicompost (2.5 t/ha)
T7	75% RDF +Vermicompost (2 t/ha) +PSB
T8	50% RDF + Vermicompost (2.5 t/ha) +PSB
T9	75% RDF +Vermicompost (2 t/ha) + Rhizobium +PSB
T10	50% RDF + Vermicompost (2.5 t/ha) + Rhizobium +PSB

Result and Discussion

The present investigation entitled "Effect of Integrated Nutrient Management on Growth and Yield of Chickpea (*Cicer arietinum* L.)" conducted during rabi 2021-22 at Research Farm, Agriculture Sciences and Allied Industries, Rama University, Kanpur. The observations were recorded on different aspects *viz.* growth, yield, quality, nutrients uptake and nutrients balance in the soil. The data were statistically analyzed by using the analysis of variance techniques in order to find the significance.

A) Growth Parameter

1. Number of Plant per meter square

The data related to number of plants per meter square was presented in Table at 15 DAS and after harvest. Numbers of plants per meter square were affected significantly with different system of integrated nutrient management. Highest number of plant population per meter square (31.67) was reflected in treatments T10 (50% RDF + Vermicompost (2.5 t/ha) + Rhizobium +PSB) which was observed at par from treatment T9 (75% RDF +Vermicompost (2 t/ha) + Rhizobium +PSB) and significantly different from all other treatment for 15 DAS. Treatment T9 (75% RDF +Vermicompost (2 t/ha) + Rhizobium +PSB) was observed significantly at par with treatment T8 (50% RDF + Vermicompost (2.5 t/ha) +PSB) with number of plant per meter square 31.33 and 30.67 respectively. The minimum number of plant population per meter (27.67) square was recorded for treatment T1(Control) At harvest, maximum number of plant population (24.33) was observed for treatment T10 (50% RDF + Vermicompost (2.5 t/ha) + Rhizobium +PSB) that was found significantly at par with from treatment T9 (75% RDF +Vermicompost (2 t/ha) + Rhizobium +PSB) with plant population 23.67 per meter square. Apart from that, both treatment was observed with significantly different from all other treatment.

2. Plant height (Centimeter)

The data pertaining to plant height recorded for 30, 60, 90 DAS of crop had been reflected in Table. The data depicted maximum plant height (15.90, 33.07, 41.07cm), respectively recorded with treatment T10 (50% RDF + Vermicompost (2.5 t/ha) + Rhizobium +PSB) at all growth stages 30, 60, 90

DAS. At 30 DAS, the plant height was found significantly similar for 30 and 90 DAS period except 60 DAS period. While treatment T10 (50% RDF + Vermicompost (2.5 t/ha) + Rhizobium +PSB) was found statistically different from all other treatment for 60DAS period. The minimum plant height (14.53, 24.93, 33.60 cm) at 30, 60, 90 DAS were recorded for treatment T1 (control).

Table 2: Effect of INM on various growth stages of chickpea

		Plant population per m2	
Treatment	**Description**	**15 DAS**	**At harvest**
T1	Control (No Nutrient Application)	27.667e	16.667e
T2	100% RDF (18 N+46 P2O5 +20 S Kg/ha)	29.333c	21.667b
T3	75% RDF	29.333c	21.333b
T4	50% RDF	28.333de	18.333d
T5	75% RDF +Vermicompost (2 t/ha)	28.667cd	20.000c
T6	50% RDF + Vermicompost (2.5 t/ha)	28.667cd	18.333d
T7	75% RDF +Vermicompost (2 t/ha) +PSB	28.333de	19.667c
T8	50% RDF + Vermicompost (2.5 t/ha) +PSB	30.667b	18.667d
T9	75% RDF+ Vermicompost (2t/ha) + Rhizobium +PSB	31.333ab	23.667a
T10	50% RDF + Vermicompost (2.5 t/ha) + Rhizobium +PSB	31.667a	24.333a
	CD	0.737	0.842
	CV	1.357	2.421
	SE.m	0.230	0.283

Table 3: Effect of INM on various plant heights of chickpea

		Mean height of the plant		
Treatment	**Description**	**30 DAS**	**60 DAS**	**90 DAS**
T1	Control (No Nutrient Application)	14.53f	24.93i	33.60h
T2	100% RDF (18 N+46 P2O5 +20 S Kg/ha)	15.57c	31.40c	40.50b
T3	75% RDF	14.77e	27.27g	35.77f
T4	50% RDF	14.70e	26.73h	35.03g
T5	75% RDF +Vermicompost (2 t/ha)	15.13d	27.60fg	36.33e
T6	50% RDF + Vermicompost (2.5 t/ha)	15.57c	28.10ef	36.43e
T7	75% RDF +Vermicompost (2 t/ha) +PSB	15.60c	28.20e	37.17d
T8	50% RDF + Vermicompost (2.5 t/ha) +PSB	15.73b	29.53d	37.80c
T9	75% RDF +Vermicompost (2 t/ha) + Rhizobium +PSB	15.80ab	32.53b	40.80ab
T10	50% RDF + Vermicompost (2.5 t/ha) + Rhizobium +PSB	15.90a	33.07a	41.07a
	CD(0.05)	0.110	0.530	0.496
	CV	0.418	1.068	0.77
	SE.m	0.037	0.178	0.17

3. Number of Plant branches

The data pertaining to number of plant branches recorded for 30, 60, 90 DAS of crop had been reflected in Table. The number of branches per plant gradually increases under all the treatments at all growth stages of chickpea. The data showed that range of branches per plant was recorded
(2.17 to 2.83, 7.8 to 9.9 and 16.2 to 28.1) because of different integrated management practices. The data depicted maximum number of plant branches (2.83, 9.9, 28.1), respectively recorded with treatment T10 (50% RDF + Vermicompost (2.5 t/ha) + Rhizobium +PSB) at all growth stages 30, 60, 90 DAS. At 30 DAS, the plant height was found significantly similar for 60 DAS period and statistically different 30 and 90 DAS period. While treatment T10 (50% RDF + Vermicompost (2.5 t/ha) + Rhizobium +PSB) was found statistically different from all other treatment for 30DAS and 90DAS period. For 60 DAS treatment T10 was recoded statistically similar for treatment T2 (100% RDF (18 N+46 P2O5 +20 S Kg/ha)) with 98 number of branches. The minimum plant height (2.1, 7.8, 16.2) at 30, 60, 90 DAS were recorded for treatment T1 (control).

Table 4: Effect of INM on various plant branches of chickpea

		Mean branches of the plant		
Treatment	**Description**	**30 DAS**	**60 DAS**	**90 DAS**
T1	Control (No Nutrient Application)	2.17f	7.8f	16.2d
T2	100% RDF (18 N+46 P2O5 +20 S Kg/ha)	2.40bc	9.8a	26.7b
T3	75% RDF	2.23ef	8.4d	24.4c
T4	50% RDF	2.21f	8.2e	24.3c
T5	75% RDF +Vermicompost (2 t/ha)	2.23ef	8.4d	26.6b
T6	50% RDF + Vermicompost (2.5 t/ha)	2.30de	8.4d	26.7b
T7	75% RDF +Vermicompost (2 t/ha) +PSB	2.37cd	8.8c	26.8
T8	50% RDF + Vermicompost (2.5 t/ha) +PSB	2.40bc	8.9c	26.9b
T9	75% RDF +Vermicompost (2 t/ha) + Rhizobium +PSB	2.47b	9.6b	27b
T10	50% RDF + Vermicompost (2.5 t/ha) + Rhizobium +PSB	2.83a	9.9a	28.1a

	CD(0.05)	0.074	0.154	0.67
	CV	1.837	1.018	1.539
	SE.m	0.025	0.047	0.224

4. Number of leaves per plant

The data pertaining to number of plant leaves recorded for 30, 60, 90 DAS of crop had been showed in Table. The number of branches per plant moderately increases under all the treatments at all growth stages of chickpea. The number of leaves vary from different growth period *viz* 30, 60, 90 DAS for different integrated nutrient management treatment.

Table 5: Effect of INM on various numbers of leaves of chickpea

		No of leaves		
Treatment	**Description**	**30 DAS**	**60 DAS**	**90 DAS**
T1	Control (No Nutrient Application)	9.12e	48g	88.7f
T2	100% RDF (18 N+46 P2O5 +20 S Kg/ha)	15.2b	56.62b	136.7b
T3	75% RDF	14.12c	54.8d	126.3cd
T4	50% RDF	13.1d	52.68f	118.3e
T5	75% RDF +Vermicompost (2 t/ha)	13.8c	53.22ef	124.0d
T6	50% RDF + Vermicompost (2.5 t/ha)	14.7b	53.88de	128.3c
T7	75% RDF +Vermicompost (2 t/ha) +PSB	14.9b	54.56d	134.7b
T8	50% RDF + Vermicompost (2.5 t/ha) +PSB	15.2b	55.64c	135.0b
T9	75% RDF +Vermicompost (2 t/ha) + Rhizobium +PSB	15.9a	56.84b	136.0b
T10	50% RDF + Vermicompost (2.5 t/ha) + Rhizobium +PSB	16.1a	58.62a	140.0a
	CD (0.05)	0.542	0.716	3.020
	CV	2.27	0.766	1.389
	SE.m	0.13	0.241	1.01

At 30 DAS, Maximum number of leaves (16.1) were observed with T10 (50% RDF + Vermicompost (2.5 t/ha) + Rhizobium +PSB) was statistically at par with T9 (75% RDF +Vermicompost (2 t/ha) + Rhizobium +PSB) with 15.9 number of leaves. Treatment T2, T8, T7 and T6 was found statistically at par. The least number of leaves (9.12) was observed for Treatment T1 (Control).

At 60 DAS, Highest number of leaves (58.62) were recorded for treatment T10 (50% RDF + Vermicompost (2.5 t/ha) + Rhizobium +PSB). It was found statistically different from all other treatment. Treatment T9 ((75% RDF +Vermicompost (2 t/ha) was found statistically similar with treatment T2 (100% RDF (18 N+46 P2O5 +20 S Kg/ha)) with 56.84 and 56.62 number of leaves. The minimum numbers of leaves (48.0) were found for treatment T1 (control).

At 90 DAS, maximum number of leaves (140.0) was observed for treatment T10 (50% RDF + Vermicompost (2.5 t/ha) + Rhizobium +PSB) and found statistically different among all the treatment. In the similar line treatmentT9 (75% RDF +Vermicompost (2 t/ha) + Rhizobium +PSB) was found statistically similar with treatment T2 (100% RDF (18 N+46 P2O5 +20 S Kg/ha)). The minimum number of leaves was studied for treatment T1 (Control).

5. Yield characteristics parameter

1. Number of Pods per plant

The data related to number of pods per plant had been related to table. Number of pods per plant was increased significantly where bio-fertilizer used with inorganic recommended dose of fertilizer. The number of pods per plant varies 40 to 55. Maximum number of pods per plant (55) was recorded with T10 (50% RDF + Vermicompost (2.5 t/ha) + Rhizobium +PSB) which was significantly higher over T9 (52), T2 (52) and T8 (50.3) and so on of the treatment used in the research study, while minimum number of pods per plant (40) were recorded with treatment T1 (control).

Table 6: Effect of INM on pods/ plant, grain yield (q/ha), test weight (g) of chickpea

Treatment	**Description**	**Pods/plant**	**Grain yield(q/ha)**	**Test weight (g)**
T1	Control (No Nutrient Application)	40f	9.57h	180.6g
T2	100% RDF (18 N+46 P2O5 +20 S Kg/ha)	52b	17.60b	194.2a
T3	75% RDF	49d	15.20de	184.8e
T4	50% RDF	44e	11.40g	182.7f
T5	75% RDF +Vermicompost (2 t/ha)	45e	12.30f	181.4g
T6	50% RDF + Vermicompost (2.5 t/ha)	48d	14.80e	187.8d
T7	75% RDF +Vermicompost (2 t/ha) +PSB	49d	15.60d	189.2c
T8	50% RDF + Vermicompost (2.5 t/ha) +PSB	50.3c	16.30c	192.7b
T9	75% RDF +Vermicompost (2 t/ha) + Rhizobium +PSB	52b	17.17b	194.8a
T10	50% RDF + Vermicompost (2.5 t/ha) + Rhizobium +PSB	55a	18.77a	195.0a
	CD (0.05)	1.054	0.569	1.103
	CV	1.269	2.232	0.341
	S E.m	0.354	0.192	0.371

6. Yield Parameter

1. Grain Yield (quintal per hectare)

The data pertaining to grain yield of chickpea had been reflected to table. Indicated that grain yield of chickpea was recorded which was varied from 9.57 to 18.77 quintal per hectare due to different integrated nutrient management

practices.
The maximum grain yield 18.77 quintal per hectare was recorded with T10 (50% RDF + Vermicompost (2.5 t/ha) + Rhizobium +PSB) which was significantly different from among all other treatment. T9 (75% RDF +Vermicompost (2 t/ha) + Rhizobium +PSB) was found statistically similar with treatment T2 (100% RDF (18 N+46 P2O5 +20 S Kg/ha)) with 17.17 and 17.60 q per hectare yield respectively.

2. Test weight
The data regarding the test weight of chickpea was presented in the table 4.5 indicated that the test weight was varied from 180.6 g to 195.0 g due to different integrated nutrient management treatment. The Maximum test weight 195.0 g was recorded T10 (50% RDF + Vermicompost (2.5 t/ha) + Rhizobium +PSB) which was significantly superior all over the treatment except Treatment T9 and T2.
Application of 50% RDF with bio fertilizer (Rhizobium+ PSB) and vermicompost as well as 75% RDF +Vermicompost (2 t/ha) + Rhizobium +PSB increase the significantly similar over 100% RDF alone as well as similar with T9 and T8.The minimum test weight was recorded with treatment T1(control).

Summary and Conclusion
The study revealed that the maximum number of plant population per meter square (31.67) was reflected in treatments T10 (50% RDF + Vermicompost (2.5 t/ha) + Rhizobium +PSB) which was observed at par from treatment T9 (75% RDF +Vermicompost (2 t/ha) + Rhizobium +PSB) and significantly different from all other treatment for 15 DAS. Treatment T9 (75% RDF +Vermicompost (2 t/ha) + Rhizobium +PSB) was observed significantly at par with treatment T8 (50% RDF + Vermicompost (2.5 t/ha) +PSB) with number of plant per meter square 31.33 and
30.67 respectively. The minimum number of plant population per meter (27.67) square was recorded for treatment T1 (Control). At harvest, maximum number of plant population (24.33) was observed for treatment T10 (50% RDF + Vermicompost (2.5 t/ha) + Rhizobium +PSB) that was found significantly at par with from treatment T9 (75% RDF +Vermicompost (2 t/ha) + Rhizobium
+PSB) with plant population 23.67 per meter square. Apart from that, both treatment was observed with significantly different from all other treatment. The maximum plant height (15.90, 33.07, 41.07cm), respectively recorded with treatment T10 (50% RDF + Vermicompost (2.5 t/ha) + Rhizobium +PSB) at all growth stages 30, 60, 90 DAS. At 30 DAS, the plant height was found significantly similar for 30 and 90 DAS period except 60 DAS period. While treatment T10 (50% RDF + Vermicompost (2.5 t/ha) + Rhizobium +PSB) was found statistically different from all other treatment for 60DAS period. The range of branches per plant was recorded (2.17 to 2.83, 7.8 to 9.9 and 16.2 to 28.1) because of different integrated management practices. The data depicted maximum number of plant branches (2.83, 9.9, 28.1), respectively recorded with treatment T10 (50% RDF + Vermicompost (2.5 t/ha) + Rhizobium +PSB) at all growth stages 30, 60, 90 DAS. At 30 DAS, the plant height was found significantly similar for 60 DAS period and statistically different 30 and 90 DAS period. While treatment T10 (50% RDF + Vermicompost (2.5 t/ha) + Rhizobium +PSB) was found statistically different from all other treatment for 30DAS and 90DAS period. For 60 DAS treatment T10 was recoded statistically similar for treatment T2 (100% RDF (18 N+46 P2O5 +20 S Kg/ha)) with 98 number of branches. The minimum plant height (2.1, 7.8, 16.2) at 30, 60, 90 DAS were recorded for treatment T1 (control). The number of pods per plant varies 40 to 55. Maximum number of pods per plant (55) was recorded with T10 (50% RDF + vermicompost (2.5 t/ha) + Rhizobium +PSB) which was significantly higher over T9 (52), T2 (52) and T8 (50.3) and so on of the treatment used in the research study, while minimum number of pods per plant (40) were recorded with treatment T1 (control). The maximum grain yield 18.77 quintal per hectare was recorded with T10 (50% RDF + Vermicompost (2.5 t/ha) + Rhizobium +PSB) which was significantly different from among all other treatment. T9 (75% RDF +Vermicompost (2 t/ha) + Rhizobium +PSB) was found statistically similar with treatment T2 (100% RDF (18 N+46 P2O5 +20 S Kg/ha)) with 17.17 and 17.60 q per hectare yield respectively.

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