

Evaluation of Integrated Nutrient Management Practices for Enhancing Productivity and Profitability of Chickpea (*Cicer arietinum L.*)

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Abstract - The present investigation entitled effect of integrated nutrient management practices on yield potential and economics of chick pea (*Cicer arietinum L.*) was conducted for and *rabi* seasons of 2022-23 agriculture experiment field (Department of Agronomy) of Rama University Mandhana Kanpur (U.P), Uttar Pradesh in Random Block design assigning eight treatment T₁) RDF (Control), T₂) 100% RDF (20:40:20NPKkg/ha), T₃) 75% RDF+FYM @5t/ha, T₄) 75% RDF + Vermicompost @2 t/ha, T₅) 75% RDF + Rhizobium inoculation, T₆) 75% RDF + Rhizobium + PSB inoculation, T₇) 50% RDF + FYM @5t/ha + Rhizobium+ PSB, T₈) FYM @5t/ha + Rhizobium + PSB. All treatments are randomized in trice times. The experiment was conducted on the chick pea variety KWR-108.

From the above overall study, it is observed that to obtain higher yield biological yield (qha⁻¹), grain yield (qha⁻¹), stover yield (qha⁻¹) and harvest index (%) and economics (cost of cultivation (Rs.ha⁻¹), gross return (Rs.ha⁻¹), net return (Rs.ha⁻¹) and b:c ratio, chickpea should be grown by T₇) 50% RDF + FYM @5t/ha + Rhizobium+ PSB under the agro-climatic conditions of Kanpur region of Uttar Pradesh.

Based on the results, farmers are advised to raise chickpea with T₇) 50% RDF + FYM @5t/ha + Rhizobium+ PSB for best growth, yield, economics, and soil health.

Key Words: -Chick pea crop, KWR-108 and Economics.

1. INTRODUCTION

Chickpea (*Cicer arietinum L.*) is one of the most important pulse crops grown in India, contributing significantly to nutritional security, soil fertility, and the agricultural economy. It contains about 18–22% protein, essential amino acids, minerals, and carbohydrates, making it a vital food crop, especially for vegetarian populations. India accounts for nearly 70% of global chickpea production, and within the country, Central Uttar Pradesh is a major chickpea-growing zone. However, declining soil organic matter, nutrient imbalance, and continuous nutrient mining by crops have led to reduced productivity and soil degradation in this region (Ali & Kumar, 2005).

In 2022, the global chickpea area was about 49 million hectares, with a total production of around 16.52 million tonnes and an average productivity of nearly 1,171 kg per hectare. In India, the most reliable estimates for 2021–22 (used for 2022 assessment) report a chickpea area of about 10.91 million hectares, production of 13.75 million tonnes, and productivity of around 1,260kg per hectare. In Uttar Pradesh, according to 2022–23 *rabi* season data, chickpea covered approximately 2.90 lakh hectares, produced about 3.55 lakh tonnes, and showed an average productivity of nearly 1,223 kg per hectare. (ICAR-IIPR.org.in 2022-23)

In India, chickpea was cultivated in an area of about 99 lakh hectares during the latest agricultural season, with a production of 107 lakh tonnes at the highest productivity level of 1086 kg ha⁻¹. Madhya Pradesh ranks first in area and production, contributing 28% of the total gram area and 34% of the total gram production in the country (Annual Report 2021-2022, DPD).

A wide variety of pulse crops are presently being grown different regions of the country, each adapting to diverse Agro-climatic conditions and specific seasonal patterns (Singh, 2017). In India, pulse crops are predominantly cultivated in soils that are considered to be of low fertility and unsuitable for growing other types of crops. Moreover, one of the remarkable features of

these pulse crops is their low water footprint (Dingetal., 2018). Chick pea is the most dominant pulse crop, with an average share of approximately 46% of the total pulse production over the past five years (Varma and Vishwanath, 2023).

The chick pea seeds contain on an average protein (23%) ,total carbohydrates(64%) ,starch (47%) ,soluble sugar (6%), fat (5%), crude fiber (6%) and ash (3%) (Chauhan et al., 2018). Chickpea requires only starter dose of nitrogen. Among the pulses, chickpea have higher protein bioavailability (Kishore et al., 2017) and contained 18-25%along with iron and higher amount of water-soluble vitamins therefore known as substitute of meat (Khamssi, 2011).

Organic manures like Farmyard Manure (FYM) and vermi compost provide a steady nutrient supply, increase water-holding capacity, improve soil structure, and boost microbial biomass. FYM at 5t/ha significantly improves soil fertility, plant growth, and yield attributes in chickpea (Singh & Agarwal, 2004; Sharma & Pathak, 2018). Vermicompost is rich in available nutrients, growth-promoting substances, and beneficial microorganisms that enhance root development and nutrient uptake, resulting in higher yield (Ansari, 2011; Kumar & Verma, 2020).

Biofertilizers such as *Rhizobium* and Phosphate Solubilizing Bacteria (PSB) play a crucial role in chickpea nutrition. *Rhizobium* enhances biological nitrogen fixation and improves nodulation, nitrogen content, and yield (Nouriyani et al., 2012; Lal & Khanna, 1998).

MATERIALS AND METHOD

The study was conducted in the agriculture experiment field (Department of Agronomy), Rama University Mandhana, Kanpur (U.P) during 2022-23. The Kanpur district experimental station is situated at 100-200 km in the northern center of Kanpur city on Kanpur NH 19, Road.

Geographically, Kanpur district is a part of the central plain area. Ganga River is the boundary of Kanpur in the north. Most of the area is under an average elevation of 300-450m from the sea level. Its latitude extension is from 23° 11' N to 26° 14' N and its longitudinal extension is from 81° 08' E to 77° 01' E falls in the zone of subtropical climate and may be characterized by a very hot summer and cold winter. The winter temperature goes up to 29-33°C and winter with a minimum temperature of 4-6°C. The physico-chemical properties of the soil. The experiment is on clay loamy soil (Black-brown in color) respectively. The experiment was conducted on clay loamy soil which is heavy soil and is distributed in the upland and lowland areas of Kanpur.

The treatments application in the experiment were T₁) RDF (Control), T₂) 100% RDF (20:40:20NPKkg/ha), T₃) 75% RDF+FYM @5t/ha, T₄) 75% RDF + Vermicompost @2 t/ha, T₅) 75% RDF + *Rhizobium* inoculation, T₆) 75% RDF + *Rhizobium* + PSB inoculation, T₇) 50% RDF + FYM @5t/ha + *Rhizobium*+ PSB, T₈) FYM @5t/ha + *Rhizobium* + PSB. In the chick pea crop variety KWR-108 was fertilized @80:40:40 Kg NPK/ha. Half of nitrogen, full dose of Phosphorus and potash was applied at the time of sowing and remaining half of the Nitrogen was applied after first irrigation at proper moisture conditions. The NPK requirement was fulfilled by urea, DAP and Muriate of Potash. There were 3 replications by using RBD design for field trial. RBD design for field was used for statistical analysis. The following field observations were recorded to yield (biological yield (qha⁻¹), grain yield (qha⁻¹), stover yield (qha⁻¹) and harvest index (%)) and economics (cost of cultivation (Rs.ha⁻¹), gross return (Rs.ha⁻¹), net return (Rs.ha⁻¹) and b:c ratio).

RESULT AND DISCUSSION

3.1. Total Biological yield (q/ha):

The total dry matter production is the total harvest from the net Plot which was recorded in Kg per net plot and converted into the quintal/ha. and analysis of variance have been included in Appendix Table. Thus, It is clear from the Table 4.1 maximum total dry matter production (Biological yield) has been observed in T₇) 50% RDF + FYM @5t/ha + *Rhizobium*+ PSB) 49.89 q/ha which was significantly superior over the rest of the treatments and lowest total dry matter production (Biological yield) has been observed in T₁ (Control) 38.24 q/ha.

3.2. Grain Yield (q/ha):

It is clear from the Table 4.1 that the maximum grain yield has been observed in T₇) 50% RDF + FYM @5t/ha + *Rhizobium*+ PSB) i.e. 22.36 q/ha and significantly superior over the rest of the treatments and lowest grain yield has been observed in T₁ (Control) 16.20 q/ha.

3.3. Straw yield (q/ha):

It is clear from the Table 4.1 that the maximum straw yield has been observed in T₇) 50% RDF + FYM @5t/ha + Rhizobium+ PSB) i.e. 27.89 q/ha and significantly superior over the rest of the treatments and lowest straw yield has been observed in T₁ (Control + RDF) 22.56 q/ha.

3.4. Harvest Index (%):

Harvest Index represent the grain and total biomass production ratio which is calculated in percentage. The data produced in Table 4.1 clearly indicated that the maximum harvesting index has been observed in T₇) 50% RDF + FYM @5t/ha + Rhizobium+ PSB) i.e. 45.73% which was at par with T₉ and significantly superior over the rest of the treatments and lowest harvesting index has been observed in T₁ (Control) 42.73 %.

Table No. 3.1. Biological yield (q/ha) Grain yield (q/ha) Straw yield (q/ha) Harvesting index (%) influenced by INM on chick pea.

Symbol	Treatment	Biological yield (qha ⁻¹)	Grain yield (qha ⁻¹)	Straw yield (qha ⁻¹)	Harvesting index (%)
T ₁	RDF (Control)	38.247	16.203	22.563	42.733
T ₂	100% RDF (20:40:20NPKkg/ha)	47.043	21.877	27.407	45.253
T ₃	75% RDF+FYM @5t/ha	40.000	18.020	23.710	44.040
T ₄	75% RDF + Vermicompost @2 t/ha	42.223	18.210	24.453	44.257
T ₅	75% RDF + Rhizobium inoculation	39.407	17.050	23.043	44.073
T ₆	75% RDF + Rhizobium + PSB inoculation	43.913	19.210	25.653	44.857
T ₇	50% RDF + FYM @5t/ha + Rhizobium+ PSB	49.893	22.360	27.890	45.730
T ₈	FYM @5t/ha + Rhizobium + PSB	41.243	18.547	26.420	43.970
	SEm±	0.663	0.333	0.422	0.633
	CDat5%	2.030	1.021	1.292	0.623

3.5. Cost of cultivation (Rs/ha):

It is clear from the Table 4.2 that the cost of cultivation of basic input (Control) are same for all treatment, i.e. Rs 33056.00 because no used extra input in control but other eight treatments are show different cost of cultivation due to application of treatments input then the treatment T₇) 50% RDF + FYM @5t/ha + Rhizobium+ PSB) found higher cost of cultivation i.e. Rs. 40354.00.

3.6. Gross Income (Rs/ha):

It is clear from the Table 4.2 that the highest gross income was found in T₇) 50% RDF + FYM @5t/ha + Rhizobium+ PSB) i.e. Rs. 123609.21 followed by T₂ treatment and the lowest gross income was found in T₁ (Control) Rs.89935.

3.7. Net Income (Rs/ha):

It is clear from the Table 4.2 that among all the treatment, highest net income was obtained in T₇) 50% RDF + FYM @5t/ha + Rhizobium+ PSB) i.e., Rs.83255.23 followed by T₂ treatments and lowest income obtained in T₁ (Control) Rs.56879.00.

3.8. Benefit: Cost ratio (B:C ratio):

The data pertaining to Benefit: Cost ratio of different of treatments was summarized in Table 4.2. The highest B:C ratio was found in T₇) 50% RDF + FYM @5t/ha + Rhizobium+ PSB) 2.06 followed by T₂ treatments and lowest B:C ratio was found in T₁ (Control + RDF) 1.72.

According to the cost-economic analysis of the several treatments in this study, T₇ treatment had the greatest cultivation costs (Rs. 33056.00) and the highest gross returns (Rs. 123609.21) from T₇) 50% RDF + FYM @5t/ha + Rhizobium+ PSB) and returns were significantly greater for treatment T₇) 50% RDF + FYM @5t/ha + Rhizobium+ PSB) i.e. Rs. 123609.21 than for other treatments.

Table No. 3.2. Cost of cultivation, Gross income, Net income and Benefit cost ratio influenced by INM on Chick pea.

Symbol	Treatments	Cost of cultivation (Rs/ha)	Gross income (Rs/ha)	Net income (Rs/ha)	Benefit cost ratio
T ₁	RDF (Control)	33056	89935	56879	1.72
T ₂	100% RDF (20:40:20NPKkg/ha)	38664	115190.50	76526.5	1.98
T ₃	75% RDF+FYM @5t/ha	35310	97393	62083	1.76
T ₄	75% RDF + Vermicompost @2 t/ha	36347	103721	67374	1.85
T ₅	75% RDF + Rhizobium inoculation	34976	93607.5	58631.5	1.75
T ₆	75% RDF + Rhizobium + PSB inoculation	36054	101009.2	64955.20	1.80
T ₇	50% RDF + FYM @5t/ha + Rhizobium+ PSB	40354	123609.23	83255.23	2.06
T ₈	FYM @5t/ha + Rhizobium + PSB	34363	92460.5	58097.5	1.74

SUMMARY AND CONCLUSION

The treatment combination T₇) 50% RDF + FYM @5t/ha + Rhizobium+ PSB) had the highest biological yield, grain yield, straw yield, and harvest index (49.89 q/ha, 22.36q/ha, 27.89 q/ha, and 45.73 % respectively) followed by T₂ (47.03 q/ha, 21.87 q/ha, 27.40qha⁻¹ and 45.25 % respectively) and T₆ (43.92 q/ha, 19.21 q/ha, 25.65 q/ha and 44.87% respectively) were next over the all treatments. T₇) 50% RDF + FYM @5t/ha + Rhizobium+ PSB) treatments had the greatest cultivation costs (40354.00 Rs/ha), along with the highest gross income (123609.23 Rs/ha), net income (83255.23 Rs/ha), and B:C ratio (2.06). Net income (56879, B:C ratio (1.72), and gross income (89835.00 Rs/ha) were all lowest in T₁ control.

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