Indian Journal of Agronomy **70** (2): 236–239 (June 2025)
DOI: 10.59797/ija.v70.i2.5610

Research Communication

Effect of integrated nutrient management on growth, yield and economics of maize in vertisol of south eastern Rajasthan

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Received: June 2024; Revised accepted: May 2025

ABSTRACT

A field experiment carried out was during the *Kharif* 2023 at the Research Farm, Agricultural Research Station, Ummedganj-Kota, Rajasthan. The experiment comprised of 10 treatment combinations: T_1, Absolute control; T_2, 100% RDF; T_3, STCR; T_4, 50% RDF + 50% FYM; T_5, 100% FYM; T_6, 50% RDF + 50% poultry manure; T_7, 100% poultry manure; T_8, 100% RDF + biofertilizer; T_9, 50% RDF + 50% FYM + biofertilizer (*Azotobacter* + PSB), and T_{10}, 50% RDF + 50% PM + biofertilizer (*Azotobacter* + PSB). The field experiment, consisting of ten treatments replicated three times, was laid out in a randomized block design using the maize hybrid variety 'PHM-3' as the test crop. The results demonstrated that the application of treatment T_3 (STCR) recorded the highest growth parameters, including plant height at 30, 60 days after sowing (DAS) and harvest (141.7, 251.7, and 266.9 cm, respectively), plant dry matter (31.7 and 149.7 g/plant), leaf area index (1.48 and 4.40) and chlorophyll content (1.13 and 2.23 mg/g) at 30 and 60 DAS, respectively. The significant yield and economics improvement with STCR observed as it had the highest grain yield (5963 kg/ha), stover yield (8,984 kg/ha), biological yield (14,947 kg/ha) and economic benefits (net return 105,633 Rs/ha and B:C ratio of 2.55).

Key words: Integrated nutrient management, Maize, Organic manure, STCR

Maize (*Zea mays* L.) is one of the most important cereals, ranking third globally following rice and wheat (Shekhawat *et al*., 2021; Lavanya *et al*., 2024). As a highly productive and nutrient responsive crop, its productivity heavily depends on nutrient management. An adequate and balanced supply of plant nutrients is critical for improving maize productivity. Maize requires both micro and macro nutrients throughout its growing period to achieve maximum yield potential (Wailare and Kesarwani, 2017; Goyal *et al*., 2024). Hybrid maize, known for its high genetic yield potential, is often referred to as the 'miracle crop' and queen of cereals (Singh *et al*., 2025). In India, maize is cultivated over an area of 10.74 million hectares, with a production of 38.09 million tonnes and a productivity of 3.54 tonnes per hectare (Anonymous, 2023). In Rajasthan, maize occupies 0.95 million hectares with an annual production of 2.04 million tonnes and a productivity of 21.49 t/ha (Anonymous, 2022). In the Kota division, it is grown over an area of 1.09 lakh hectares, producing 2.33 lakh tonnes with a productivity of 2138 kg/ha (Anonymous, 2023).

Based on a part of M.Sc. Thesis of the first author submitted to Research Farm, Agricultural Research Station, Ummedganj-Kota, Rajasthan in 2023 (unpublished)

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Integrated Nutrient Management (INM) involves the use of chemical fertilizers in conjunction with organic manures, which are rich inputs produced through biological processes (Chandrawanshi *et al*., 2024; Sahoo *et al*., 2024). The incorporation of organic sources such as FYM (Farmyard Manure), poultry manure and biofertilizers like *Azotobacter*, phosphorus solubilizing bacteria and *vesicular arbuscular mycorrhiza*, along with chemical fertilizers, is effective in increasing nutrient availability in the soil and improving its physical properties and organic carbon content. The average nutrient content in FYM is 0.46% N, 0.25% P_2O_5 and 0.5% K_2O (Jat *et al*., 2013). Poultry manure contains higher nitrogen and phosphorus compared to other bulky organic manures with average nutrient contents of 3.03% N, 2.63% P_2O_5 and 1.4% K_2O (Perli *et al*., 2022). The application of FYM along with inorganic fertilizers (N and P) significantly increases the grain yield of hybrid maize cultivars and enhances certain soil chemical and physical properties, such as available P, cation exchange capacity (CEC), total nitrogen, texture, structure and water-holding capacity (Shah *et al*., 2009; Achieng *et al*., 2010). INM practices are proven to be environmentally non-degrading, technically appropriate, economically feasible and socially acceptable.

The Soil Test Crop Response (STCR) approach appears to be a viable technology for sustaining higher crop productivity and ensuring better soil quality under intensive agricultural systems. The STCR-based equations are useful for determining the appropriate dose of chemical fertilizers (Singh *et al*., 2020). This approach helps achieve higher grain yields by improving nutrient use efficiency.

Thus, this investigation into the "Effect of integrated nutrient management on growth, yield and economic of maize under south eastern Rajasthan" was essential due to this crop's significant role as a staple crop. Effective nutrient management is crucial for optimizing the productivity of maize, especially hybrid varieties with high yield potential. the study examines sustainable practices like integrated nutrient management (INM) and soil test crop response (STCR) to enhance crop productivity and crop yield. By using organic manures, biofertilizers and chemical fertilizers, the research aims to improve nutrient availability, soil properties and overall productivity. The results will provide valuable insights for sustainable agricultural practices that balance high yields with environmental health.

The field experiment was conducted at the Research Farm, Agricultural Research Station, Ummedganj-Kota, Rajasthan, during the *Kharif* 2023. The station is located in the southeastern part of Rajasthan at 75°25' E″ 25°13' N″ and an altitude of 258 meters above mean sea level. The experiment comprised ten treatments: T_1, Absolute control; T_2, 100% RDF; T_3, STCR; T_4, 50% RDF + 50% FYM; T_5, 100% FYM; T_6, 50% RDF + 50% poultry manure; T_7, 100% poultry manure; T_8, 100% RDF + biofertilizer; T_9, 50% RDF + 50% FYM + biofertilizer (*Azotobacter* + PSB) and T_{10}, 50% RDF + 50% PM + biofertilizer (*Azotobacter* + PSB). These treatments were evaluated in a randomized block design and replicated three times. The maize variety 'PHM-3' was used as the test hybrid, sown manually at 25 kg/ha on 6 July 2023, at a depth of 5 cm, with inter-row spacing of 60 cm and plant to plant spacing of 20 cm. The gross plot size was 4.6 m × 3.6 m.

The recommended dose of fertilizer (RDF) was 90 kg N and 30 kg P_2O_5/ha. Nitrogen was applied in three split doses (half at sowing, one-fourth at knee height and one-fourth at tasselling), while the entire phosphorus and organic manure were applied basally through band placement. FYM and poultry manure were applied based on their nitrogen equivalence.

The STCR equation was taken from Jabalpur, Madhya Pradesh (Anonymous, 2021). The target yield equation developed for maize crop were used for calculation of N and P_2O_5, considering the target yield 45 q/ha.

STCR – The fertilizer adjustment equation is given below:

$$FN = 4.40\ T - 0.23\ SN$$
$$FP_2O_5 = 2.38\ T - 1.40\ SP_2O_5$$
$$FK_2O = 2.07\ T - 0.08\ SK_2O$$

Where,

T = Target yield (q/ha)

FN = Nitrogen supplied through fertilizer in kg/ha

FP_2O_5 = Phosphorus supplied through fertilizer in kg/ha

FK_2O = Potassium supplied through fertilizer in kg/ha

SN, SP_2O_5 and SK_2O = Initial soil test value for available N, P_2O_5 and K_2O in kg/ha, respectively.

As per STCR equation, 148 kg/ha nitrogen and 72 kg/ha phosphorus has been applied.

Data on growth parameters, yield and economics were recorded according to standard procedures. Yield from each plot, including tagged plants, was sun-dried, recorded treatment-wise and expressed in kg/ha. Stover yield was calculated by subtracting grain yield from the respective biological yield of each plot and expressed in kg/ha. The unthreshed produce from the net plot area was weighed after thorough sun-drying to record the biological yield, also expressed in kg/ha. Leaf area index (LAI) was calculated at 30 and 60 DAS using standard formula (Reddy and Reddi, 2001).

$$\text{LAI} = \frac{\text{Leaf area/plant (cm}^2\text{)}}{\text{Ground area/plant}}$$

The total chlorophyll content of leaves at 30 DAS and 60 DAS was determined using the method described by Arnon (1949). A 20 mg leaf sample was crushed and suspended in a test tube containing 5 ml of Dimethyl Sulphoxide (DMSO). The test tube was then incubated at 60°C for one hour in an oven. After incubation, the absorbance of the extract was measured using spectrophotometer at wavelengths of 645 nm and 663 nm.

$$\text{Chlorophyll content} = \frac{(20.2 \times A_{645}) + (8.03 \times A_{663})}{1000 \times \text{Weight of leaf sample taken (g)}}$$

Effect on growth

Results from Table 1 showed that the STCR treatment significantly outperformed the 100% RDF in various parameters. Specifically, STCR achieved maximum plant heights of 141.7 cm at 30 DAS, 251.7 cm at 60 DAS and 266.9 cm at harvest. It also resulted in higher plant dry matter (31.7 g/plant at 30 DAS and 149.73 g/plant at 60 DAS), leaf area index (1.48 at 30 DAS and 4.40 at 60

Table 1. Effect of INM on growth attributes at different stages and yield of maize

Treatment	Plant height (cm)			Dry matter accumulation (g/plant)		Leaf area index		Chlorophyll content (mg/g)		Grain yield (kg/ha)	Stover yield (kg/ha)	Net returns (/ha)	Benefit: cost ratio
	30 DAS	60 DAS	At harvest	30 DAS	60 DAS	30 DAS	60 DAS	30 DAS	60 DAS				
Absolute control	93.4	169.7	174.0	8.28	87.44	0.94	2.43	0.70	1.31	3,107	5,385	43,404	1.24
100% RDF	133.8	233.9	250.5	24.17	137.80	1.32	4.12	1.09	2.15	5,196	8,169	91,087	2.40
STCR	141.7	251.7	266.9	31.70	149.73	1.48	4.40	1.13	2.23	5,963	8,984	105,633	2.55
50% RDF + 50% FYM	116.1	210.3	219.8	15.58	110.33	1.18	3.76	0.98	1.84	4,257	6,961	65,428	1.60
100% FYM	110.5	194.7	207.0	12.40	105.54	1.10	3.54	0.87	1.70	3,707	6,204	52,573	1.30
50% RDF + 50% poultry manure	118.7	217.4	229.3	18.63	123.83	1.21	3.86	1.02	1.93	4,362	7,069	68,318	1.69
100% poultry manure	113.5	201.2	222.2	14.82	108.98	1.16	3.68	0.91	1.76	3,849	6,404	55,827	1.37
100% RDF + Biofertilizer	137.2	239.8	253.3	26.30	142.50	1.35	4.28	1.11	2.19	5,353	8,310	94,484	2.48
50% RDF + 50% FYM + Biofertilizer (*Azotobacter* + PSB)	122.1	222.7	237.2	20.53	127.23	1.23	3.91	1.05	1.97	4,760	7,555	78,951	2.00
50% RDF + 50% PM + Biofertilizer (*Azotobacter* + PSB)	128.6	229.6	242.9	22.83	133.07	1.26	3.93	1.07	2.06	4,953	7,814	83,529	2.11
SEm±	5.6	8.8	10.8	1.14	5.29	0.05	0.15	0.03	0.04	196	253	4,161	0.10
CD (P=0.05)	16.8	26.2	32.1	3.38	15.71	0.16	0.43	0.08	0.13	583	754	12,362	0.31

T_1, Absolute control; T_2, 100% RDF; T_3, STCR; T_4, 50% RDF + 50% FYM; T_5, 100% FYM; T_6, 50% RDF + 50% poultry manure; T_7, 100% poultry manure; T_8, 100% RDF + Biofertilizer; T_9, 50% RDF + 50% FYM + Biofertilizer (*Azotobacter* + PSB) and T_{10}, 50% RDF + 50% PM + Biofertilizer (*Azotobacter* + PSB)

DAS) and chlorophyll content (1.13 mg/g at 30 DAS and 2.23 mg/g at 60 DAS). These improvements are attributed to crucial role of nitrogen in promoting rapid cell division and enlargement, along with adequate phosphorus and potassium levels that collectively support robust plant growth (Meena *et al*., 2013). The increased leaf area enhances crop growth through heightened photosynthetic activity and carbohydrate supplementation in maize (Parasuraman, 2008). These results are consistent with previous studies by Raghuramakrishnan *et al*. (2021) and Muttappanavar (2022).

Yield

Results from Table 1 showed that the STCR method significantly increased grain yield (5,963 kg/ha), stover yield (8,984 kg/ha) and biological yield (14,947 kg/ha) compared to the control. This higher grain production is attributed to the application of fertilizers according to the STCR recommendations, which consider both soil nutrient content and crop needs. Fertilizers in target yield approach, takes into account the crop needs and nutrients present in the soil. It may be due to coincidence of fertilizers application with critical stages of crop. It might have resulted in better assimilation of photosynthates to grain (Madhavi *et al.,* 2020). Similar results were reported by Muttappanavar (2022), Singh *et al*. (2023), and Biradar *et al*. (2013).

Economics

Application of fertilizer through the STCR method resulted in the highest net returns of 105,633 Rs/ha as compared to the 100% RDF. This increase in net returns is directly related to the significant rise in both grain and stover yield. Furthermore, the STCR method achieved the highest B:C ratio of 2.55. This is due to the well-balanced nutrient supply from fertilizers through the STCR approach concurrently. Similar findings were reported by Singh *et al*. (2020), Rawat *et al.* (2024) and Biradar *et al.* (2013).

Among these, the STCR (Soil Test Crop Response) approach emerged as the most effective, resulting in superior growth parameters such as increased plant height at various stages, higher plant dry matter accumulation, enhanced leaf area index and improved chlorophyll content compared to other treatments. This translated into significant increases in yield metrics, including grain yield, stover yield and biological yield. Importantly, the STCR method also delivered substantial economic benefits, yielding a net return of Rs 105,633 Rs/ha and a high benefit-cost ratio of 2.55.

REFERENCES

Achieng, J.O., Ouma, G., Odhiambo, G. and Muyekho, F. 2010. Effect of farmyard manure and inorganic fertilizers on maize production on Alfisols and Ultisols in Kakamega, Western Kenya. *Agriculture and Biology Journal of North America* **1**(4): 430–439.

Anonymous 2021. Agricultural Statistics at a Glance. Director of Economics and Statistics, Department of agriculture and Farmers Welfare, Ministry of agriculture and Farmers Welfare, Government of India. 1–272.

Anonymous 2022. Agricultural Statistics at a Glance, Government of India, Ministry of Agriculture Cooperation and Farmers Welfare, Director of Economics and Statistics. 1–262.

Anonymous 2023. Agricultural Statistics at a Glance, Government of India, Ministry of Agriculture Cooperation and Farmers Welfare, Director of Economics and Statistics. 1–262.

Arnon, D.I. 1949. Copper enzyme in isolated chloroplast, polyphenoloxydase in *Beta vulgaris*. *Plant Physiology* **24**: 1–15.

Biradar, A. and Jayadeva, H.M. 2013. Influence of targeted yield approach on yield, yield attributes, nutrient uptake and economics of maize. *Madras Agricultural Journal* **100**: 146–149.

Chandrawanshi, A., Bagri, P.K. and Karade, R. 2024. Effect of integrated nutrient management on growth and yield parameters of maize (*Zea mays* L.). *International Journal of Environment and Climate Change Volume* **14**(3): 630–637.

Goyal, M., Sepat, S., Kaur, R. and Kumar, M. 2024. Assessment of sowing dates and spacing for indogangetic plain zone kharif maize (*Zea mays*) cultivars to achieve higher productivity in Western IGP. *Indian Journal of Agronomy* **69**(4): 384–390.

Jat, M.K., Purohit, H. S., Singh, B., Garhwal, R. S. and Choudhary, M. 2013. Effect of integrated nutrient management on yield and nutrient uptake in sorghum (*Sorghum bicolor* L.). *Indian Journal of Agronomy* **58**(4): 543–547.

Lavanya, Y., Srinivasan, K. and Muraliarthanari, P. 2024. Impact of weed management strategies on weeds and nutrient uptake of maize. *Indian Journal of Agronomy* **69**(4): 391–396.

Madhavi, A., T. Srijaya, P. Babu, S. and Dey, P. 2020. Popularization of STCR Targeted Yield for Optimum Fertilizer Use and Enhanced Yields of Maize Crop through Field Level Demonstrations. *International Journal Current Microbiology and Applied Sciences* **9**(8): 2,209–2,214.

Meena, B.P., Kumar, A., Meena, S.R., Dhar, S., Rana, D.S. and Rana, K.S. 2013. Effect of sources and levels of nutrients on growth and yield behavior of popcorn (*Zea mays*) and potato (*Solanum tuberosum*) sequence. *Indian Journal of Agronomy* **58**(4): 474–479.

Muttappanavar, R.K., Chandrashekara, C.P. and Potdar, M.P. 2022. Growth and yield of maize (*Zea mays* L.) as influenced by nutrient management through soil test crop response (STCR) approach at varied Soil Fertility Gradients in Vertisols. *Biological Forum–An International Journal* **14**(2): 1,314–1,322.

Parasuraman P. 2008. Studies on integrated nutrient requirement of hybrid maize (*Zea mays* L.) under irrigated conditions. *Madras Agricultural Journal* **92**(1 and 3): 89–94.

Perli, V.H., Tommar, S.S., Kasi, R.G., Deepsikha and Kaushik, M. 2022. Influence of organic manures and bio-fertilizers on the growth and yield of green gram (*Vigna radiata* L.). *The Pharma Innovation Journal* **11**(6): 141–144.

Raghuramakrishnan, M., Sankaran, V.M. and Ramesh, P.T. 2021. Effect of micronutrients and STCR based macronutrients on growth, yield and nutrient uptake of hybrid maize. *The Pharma Innovation Journal* **10**(11): 251–225.

Rawat, S., Singh, R.K., Singh, P., Upadhyay, P.K., Shekhawat, K., Sangwan, S., Dash, S., Mondal, B.K. and Shukla, R. 2024. Different nitrogen levels with nano and prilled urea spray on productivity and profitability of maize (*Zea mays*) in alfisols of Jharkhand. *Indian Journal of Agronomy* **69**(3): 326–329.

Reddy, T.Y. and Reddi, G.H.S. 2001. Principle of agronomy, Kalyani Publishe, Ludhiana.

Sahoo, P., Singh, T., Saini, K.S. and Kaur, J. 2024. Effect of residue incorporation and INM on productivity of spring maize (*Zea mays*) in rice (*Oryza sativa*)-based cropping system. *Indian Journal of Agricultural Sciences* **94**(1): 080–085.

Shah, S.T.H., Zamir, M.S.I., Waseem, M., Ali, A., Tahir, M. and Khalid, W.A. 2009. Growth and yield response of maize (*Zea mays* L.) to organic and inorganic sources of nitrogen. *Pakistan Journal of Life Social Science* **7**(2): 108–111.

Shekhawat, A.S., Purohit, H.S., Jat, J., Doodwal, K., Aechra, S., Sharma, J.K. and Bamboriya, J.S. 2021. Effect of integrated nutrient management on productivity, quality and economics of maize (*Zea mays* L.) on typic Haplustepts of Rajasthan. *Annals of Plant and Soil Research* **23**(4): 407–410.

Singh, S., Kumar, M. and Singh, V. 2025. Effect of zinc and boron on growth, productivity and quality of maize. *Indian Journal of Agronomy* **70**(1): 34–40.

Singh, V.Y., Singh, P., Meena, R.N. and Singh, S. 2020. Fertilizer economy through under soil-test crop response targeted yield model in maize crop in Chandauli district, Uttar Pradesh. *Journal of Pharmacognosy and Phytochemistry* **9**(1): 481–483.

Singh, Y.V., Bharteey, P.K. and Singh, S.K. 2023. Impact of nutrient management technologies on maize under irrigated Conditions in Chandauli District, Uttar Pradesh. *Environment and Ecology* **41**(3A): 1,606–1,612

Wailare, A.T. and Kesarwani, A. 2017. Effect of integrated nutrient management on growth and yield parameters of maize (*Zea mays* L.) as well as soil physico-chemical properties. *Biomedical Journal of Scientific and Technical Res*earch **1**(2): 294–299.