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RESEARCH ARTICLE

Response of red amaranth (*Amaranthus tricolor* L.) to integrated nutrient management (INM) on growth and yield

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Abstract

Amaranth is an economically important leafy vegetable valued for its high nutritional content, wider environmental adaptability, low risk of crop failure and tolerance to biotic and abiotic stress. However, its productivity largely depends on efficient nutrient management due to its short growth duration and C_4 photosynthetic nature. A field experiment was conducted during the *rabi* season of 2022–2023 at ICAR-CAZRI, KVK, Pali-Marwar (Rajasthan) to evaluate the effect of integrated nutrient management (INM) on growth and leaf yield of amaranth. The experiment comprised ten treatments involving combinations of inorganic fertilizers (RDF) and organic manures (PROM, FYM, vermicompost, and poultry manure). The study's key findings were that various integrated nutrition management techniques had a substantial impact on growth and leaf yield characteristics at each developmental stage (*i.e.*, 20, 40 and 60 DAS). Results were lowest in the application of T1 (Control) and highest in the application of T_{10} (75% RDF + 25% PROM + 25% Vermicompost + 25% Poultry manure + 25% FYM). From an economic perspective, the application of T_2 [100% RDF + FYM (25 t/ha)] came after treatment T_{10}, which likewise recorded the highest net monetary returns (Rs. 68790/ha) with a B:C ratio of 3.66. With a B:C ratio of 3.31, T_1 (Control) had the noticeably lowest net economic returns, at Rs. 40600/ha. The study demonstrates that integrated use of organic and inorganic nutrient sources is an effective strategy for improving the productivity and profitability of amaranth.

Keywords: Amaranth, integrated nutrient management, fertilizers, economics, sustainable.

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Introduction

Amaranths are a diverse group of short-lived perennial plants that belong to the genus Amaranthus. An underutilized crop, amaranth is sometimes referred to as chaulai or lal bhaji (Isaaac, 2025). It is the vegetable of those who are impoverished and is a member of the Amaranthaceae family. According to Kumar et al. (2018), *Amaranthus tricolor* L., the predominant leafy form of amaranth, is native to South East Asia, namely India. The most widely produced leafy vegetable in India during the winter and a rainy season is amaranth (Mondal, et al. 2016). Leafy amaranth grows best in light winter, while summers are prevalent for amaranth production. Amaranthus has high dietary fiber content and is gluten-free. Due to its high iron and β-carotene content, amaranth assists in avoiding iron and vitamin "A" inadequacies. The presence of high amount of folic acid helps in increasing the blood hemoglobin level. The other use of amaranth is for extracting natural dyes and in the pharmaceutical (Laxative) industries (Pan & Singh, 2018).

Amaranthus is a fast-growing, C4 plant characterized by high biomass per unit area and short duration, making it suitable for crop rotation systems. Amaranth is a bushy, quick-growing C_4 plant with thick stalks and has a large potential for production. Its short lifetime and high production of edible materials per unit area make it a good option for a crop rotation. It is also highly adaptable, resistant to pests and diseases, and tolerant of both drought and salt. The availability of nutrients in the soil, which are released via the prudent use of fertilizers and manures, is essential for amaranth growth and production. By contaminating the environment, the increased use of inorganic fertilizers in agricultural production degrades soil health and disrupts the natural equilibrium. Excessive use of chemicals destroys beneficial bacteria, reduces the amount of manure, and diminishes the texture and composition of the soil. Besides, now-a-days gradual deficits in soil organic matter and reduced yield of crops are alarming problems in India. Due to their high cost and occasionally limited availability on the market, farmers are unable to apply inorganic fertilizers to their crops at ideal times.

In the meantime, farmers can readily obtain organic manure, and it is less expensive than synthetic fertilizers. Evidence from long-term fertilizer tests indicates that combining graded amounts of chemical fertilizers with farmyard manures, vermicompost, bio-compost and other materials is promising for sustaining increased productivity and providing the highest level of crop production stability. It is not advised to completely replace inorganic fertilizers with organic ones, such as vermicompost. This is because, in general, organic manures have lower nutrient content than inorganic fertilizers. Vermicompost is implemented as organic manure produced by the use of earthworms. It contains about 1.60% N_2, 2.20% P_2O_5 and 0.67% K_2O. Among the sources of organic manures, vermicompost has a special place because of the presence of readily available plant nutrients, growth-enhancing substances, and a number of beneficial microorganisms like N_2 fixing, P solubilizing and cellulose decomposing organisms (Kumar et al., 2024). FYM alone or in combination with Bio-fertilizer helps in the proper supply of nutrition and maintains soil health. FYM is beneficial for its residual value. It contains about 0.42% N_2, 0.23% P_2O_5 and 0.51% K_2O. Poultry manure is nutrient-rich organic manure. Poultry manure contains 2.87% N_2, 2.93% P_2O_5 and 2.35% K_2O (Chaudhary et al., 2018). Phosphate rich organic manure (PROM) is produced by co-composting of high grade (32% P_2O_5) rock phosphate in very fine size with organic manure. The efficiency of PROM is totally dependent on the particle size of rock phosphate. More the fine of rock phosphate, more the efficiency of PROM. Rock phosphate works well in both acidic and alkaline soils because it is soluble phosphate. In order to promote sustainable agriculture, farmers should be aware of the agronomical advantages of PROM.

With the right application of inorganic and organic fertilizers along with bio-fertilizers, there is a lot of opportunity to enhance the amount of amaranth foliage grown per unit area. The combination of organic manure and chemicals will not only maintain crop yield but also boost the effectiveness of applied fertilizers (Singh & Biswas, 2000). Thus, with these considerations in mind, the current study was conducted with the aim of determining how INM impacted amaranth's growth, leaf yield and economics.

Material and Methods

The present study was laid out at the demonstration field of ICAR-CAZRI, KVK, Pali (Rajasthan), during the *rabi* season of 2022-23. The land topography of the study site was almost uniform, with an adequate surface drainage and located at 25.802553^0 North latitude and 73.290409^0 East longitude in state of Rajasthan (India). The soil of the experimental field was sandy clay, suitable for cultivation but low rainfall and high evaporation (1854 mm per year) caused saline (pH = 7.90) conditions while, the electrical conductivity (0.32 dS/m) of soil was found normal. Organic carbon in the farm field soil was low (0.29%), and nitrogen in the surface layer was also low (235.8 Kg/ha), whereas P_2O_5 (14.33 Kg/ha) and K_2O (210.33 Kg/ha) were at a medium level. The average annual temperature was 4.1°C (Min.) and 41.2°C (Max.), while total average rainfall was 550.30 mm with low relative humidity (20–35%) and high wind velocity (30–40 km per hour) during the experiment year. The present study was arranged in a randomized block design (RBD) with three replications of each treatment (total 30 plots with each 3 × 3 m size, and row-to-row and plant-to-plant spacing was 30 × 10 cm). The crop variety used was Lal Badshah SAS-313 (a private sector variety, procured from local market of Pali). The crop was sown on 15 December, 2022. Harvesting was carried out in three successive pickings: the first picking on 05 January, 2023, second picking on 25 January, 2023 and the third picking on 15 February, 2023.

There were different treatment combinations served as the 10 levels with recommended dose of fertilizer (RDF = 50:50:20 - N_2, P_2O_5, K_2O kg/ha), PROM (Phosphate rich organic manure = 10.40% P_2O_5), FYM (Farm yard manure = 25 t/ha), Vermicompost (5 t/ha) and Poultry manure (2.5 t/ha). The treatments formulation were; (T_1) Control; (T_2) 100% RDF + FYM (25 t/ha); (T_3) 100% PROM; (T_4) 50% PROM + 50% Vermicompost; (T_5) 50% PROM + 50% Poultry manure; (T_6) 50% PROM + 50% FYM; (T_7) 25% PROM + 25% Vermicompost + 25% Poultry manure + 25% FYM; (T_8) 25% RDF + 25% PROM + 25% vermicompost + 25% poultry manure + 25% FYM; (T_9) 50% RDF + 25% PROM + 25% vermicompost + 25% poultry manure + 25% FYM and (T_{10}) 75% RDF + 25% PROM + 25% vermicompost + 25% poultry manure + 25% FYM. Light irrigation was applied immediately after seeding, followed by another irrigation seven days later, and then, based on crop needs, regular irrigations were carried out every fifteen days. In order to prevent weeds growth, loosen the soil for adequate aeration, and prevent lodging, weeding and hoeing were carried out. At each 20-day harvest, observations of the amaranth characteristics under study were taken from each tagged plant in each plot. As explained by Panse & Sukhatme (1989), data collected during the experiment were submitted to analysis of variance (ANOVA) using a randomized block design. The "F" (variance ratio) test was used to assess the treatment effect's significance. Economic parameters such as gross returns, net returns, and benefit–cost ratio were computed based on yield data of respective treatments, as described by Gomez & Gomez (1984).

Results and Discussion

The data collected on various aspects of yield attributes and soil properties with three replications of ten treatment combinations were statistically analyzed, and the results obtained are presented here under under different subheadings.

Plant height

The plant height varied significantly due to different INM practices at 20, 40 and 60 DAS (Table 1), the maximum mean height (22.66 cm) was recorded in treatment T_{10} (75% RDF + 25% PROM + 25% vermicompost + 25% poultry manure + 25% FYM) followed by (21.09 cm) T_2 (75% RDF + 25% PROM + 25% Vermicompost + 25% Poultry manure + 25% FYM). Whereas the minimum (15.71 cm) plant height was observed in treatment T_1 (Control). The increase in plant height by the use of vermicompost with the integration of NPK may be due to the beneficial influence of nitrification inhibition properties of vermicompost in the soil. Besides, it may also be due to rapid elongation and multiplication of cells in the presence of adequate nitrogen availability. Similar results were reported in the amaranth crop by Tongos (2016), Patel et al. (2019) and Saikrishna et al. (2021).

Number of leaves per plant

Numbers of fully opened green leaves from five randomly selected plants was counted and it significantly varied in all three observations (20, 40 and 60 DAS). The maximum mean value of the number of leaves (17.61) was observed in T10 (75% RDF + 25% PROM + 25% Vermicompost + 25% Poultry manure + 25% FYM), followed by T_2 (16.58) [100% RDF + FYM (25 t/ha)]. However, the minimum (12.03 & 12.22) numbers of leaves were observed in treatment T_6 (50% PROM + 50% FYM) and T_1 (Control), respectively. The increased number of leaves might be due to promotive effects of nitrogen from both inorganic and organic sources on vegetative growth which ultimately lead to more photosynthetic activity. Similar findings have been reported by Islam et al. (2016) and Saikrishna et al. (2021) in the amaranth crop.

Leaf length

The leaves were selected randomly from different plants, and their lengths were measured from the tip of the leaves to the base of the petiole and expressed in centimeters

Table 1: Response of integrated nutrient management on yield attributes in red amaranth (*Amaranthus tricolor* L.)

Treatments	*Plant height (cm)*				*Number of leaves per plant*				*Leaf length (cm)*			
	20 DAS	*40 DAS*	*60 DAS*	*Mean*	*20 DAS*	*40 DAS*	*60 DAS*	*Mean*	*20 DAS*	*40 DAS*	*60 DAS*	*Mean*
T_1-Control	8.02	15.88	23.25	15.71	8.66	15.00	12.99	12.22	4.52	7.00	6.88	6.13
T_2-100% RDF + FYM (25 t/ha)	10.33	21.33	31.61	21.09	10.56	21.66	17.53	16.58	6.52	9.52	8.99	8.34
T_3-100% PROM	9.55	18.96	27.10	18.53	6.45	17.11	13.82	12.46	4.81	7.87	7.14	6.61
T_4-50% PROM + 50% Vermicompost	10.20	20.00	29.80	20.00	9.33	19.00	14.50	14.28	5.22	8.78	7.45	7.15
T_5-50% PROM + 50% Poultry manure	11.02	19.33	29.40	19.91	8.67	18.33	13.63	13.54	4.54	8.00	7.36	6.63
T_6-50% PROM + 50% FYM	8.96	17.89	26.25	17.70	6.11	16.54	13.45	12.03	4.82	7.69	7.08	6.53
T_7-25% PROM + 25% Vermicompost + 25% Poultry manure + 25% FYM	8.25	18.00	28.10	18.11	6.67	18.00	14.21	12.96	4.80	7.90	7.33	6.68
T_8-25% RDF + 25% PROM + 25% Vermicompost + 25% Poultry manure + 25% FYM	9.22	20.11	30.50	19.94	6.67	19.33	15.21	13.74	5.39	8.89	7.92	7.40
T_9-50% RDF + 25% PROM + 25% Vermicompost + 25% Poultry manure + 25% FYM	9.33	20.44	31.00	20.25	10.67	20.33	16.88	15.96	5.79	9.11	8.55	7.82
T_{10}-75% RDF + 25% PROM + 25% Vermicompost + 25% Poultry manure + 25% FYM	11.23	23.89	32.87	22.66	10.99	23.33	18.51	17.61	6.90	9.96	9.66	8.84
SE(m)±	0.46	0.98	1.16	-	0.30	0.65	0.37	-	0.49	0.30	0.38	-
CD at 5%	1.36	2.91	3.43	-	0.91	1.94	1.11	-	1.46	0.88	1.13	-

(cm). Significantly higher leaf length was recorded with treatment T_{10} (75% RDF + 25% PROM + 25% Vermicompost + 25% Poultry manure + 25% FYM) (6.90, 9.96 & 9.66 cm), followed by T_2 (6.52, 9.52 & 8.99 cm) [100% RDF + FYM (25 t/ha)], respectively at 20, 40 and 60 DAS. While, application of T_1 (Control) resulted in significantly lower leaf length (4.52, 7.00 & 6.88 cm) at 20, 40 and 60 DAS. The study clearly demonstrates that integrated nutrient management (INM), particularly treatment T_{10}, significantly enhances leaf growth due to improved nutrient availability and soil health. The slight decline in leaf length at later stages is attributed to crop phenology (Shift from vegetative to reproductive phase, the rate of cell division and elongation is highest during early growth stages (20–40 DAS). After this period, growth slows down, leading to stabilization or slight decline in leaf size) and physiological shifts (Canopy competition and self-shading) rather than treatment effects (Taiz et al., 2015 and Marschner, 2012).

Leaf area

Leaf area of the whole sampled plants was determined at first, second and third harvest at after every 20 days by measuring the individual leaf length and width and multiplying by 0.64 (Law-Ogbomo & Ajayi, 2009) and the result obtained was recorded and analyzed statistically as per design. Leaf area was significantly influenced by the different INM treatments (Table 2). The highest leaf area (27.47, 35.84 & 38.01 cm^2) was recorded with application of T_{10} (75% RDF + 25% PROM + 25% Vermicompost + 25% Poultry manure + 25% FYM) at 20, 40 and 60 DAS, respectively. It was at par with application of T_2 (100% RDF + FYM (25 t/ha) which recorded leaf area (25.34, 35.67 & 37.85 cm^2) at 20, 40, and 60 DAS, respectively. Whereas application of T1 (Control) resulted in significantly the lowest leaf area (19.89, 23.74 & 26.56 cm^2) at 20, 40 and 60 DAS, respectively. The enhanced leaf area observed under T10 can be attributed to the balanced and sustained supply of nutrients from integrated organic and inorganic sources, along with improved soil physico-chemical properties. The combined application of FYM, vermicompost, poultry manure, and PROM likely enhanced soil structure, moisture retention, and microbial activity, thereby facilitating efficient nutrient uptake. Such favorable soil conditions promote cell division, elongation, and expansion, ultimately leading to increased leaf length and area. Similar improvements in vegetative growth under integrated nutrient management have also been reported in amaranthus (Tongos 2016; Saikrishna et al. 2021).

Table 2: Response of integrated nutrient management on yield attributes in red amaranth

Treatments	*Leaf area (cm^2)*				*Fresh weight (g/plant)*				*Yield (t/ha)*			
	20 DAS	*40 DAS*	*60 DAS*	*Mean*	*20 DAS*	*40 DAS*	*60 DAS*	*Mean*	*20 DAS*	*40 DAS*	*60 DAS*	*Mean*
T_1-Control	19.89	23.74	26.56	23.40	146.33	176.12	162.97	161.81	0.98	1.56	1.34	1.29
T_2-100% RDF + FYM (25 t/ha)	25.34	35.67	37.85	32.95	192.45	213.33	186.00	197.26	1.49	2.32	1.85	1.89
T_3-100% PROM	22.67	24.54	27.81	25.01	152.00	240.05	211.67	201.24	1.07	1.79	1.57	1.48
T_4-50% PROM + 50% Vermicompost	20.88	29.15	31.83	27.29	149.04	251.67	220.00	206.90	1.22	2.03	1.73	1.66
T_5-50% PROM + 50% Poultry manure	20.82	29.03	31.73	27.19	153.46	226.67	203.33	194.49	1.13	1.86	1.69	1.56
T_6-50% PROM + 50% FYM	21.33	25.32	27.35	24.67	150.00	254.83	204.49	203.11	1.01	1.73	1.44	1.39
T_7-25% PROM + 25% Vermicompost + 25% Poultry manure + 25% FYM	22.67	28.45	31.14	27.42	150.33	233.67	205.33	196.44	1.13	1.81	1.64	1.53
T_8-25% RDF + 25% PROM + 25% Vermicompost + 25% Poultry manure + 25% FYM	21.54	30.90	33.61	28.68	156.95	220.67	190.67	189.43	1.34	2.22	1.80	1.79
T_9-50% RDF + 25% PROM + 25% Vermicompost + 25% Poultry manure + 25% FYM	23.38	34.05	37.56	31.66	191.23	255.33	227.67	224.74	1.38	2.27	1.99	1.88
T_{10}-75% RDF + 25% PROM + 25% Vermicompost + 25% Poultry manure + 25% FYM	27.47	35.84	38.01	33.77	204.67	261.67	232.00	232.78	1.58	2.57	2.16	2.10
SE(m)±	1.16	0.88	1.06	-	8.48	14.94	13.94	-	0.09	0.16	0.11	-
CD at 5%	3.43	2.61	3.14	-	25.18	44.40	41.41	-	0.27	0.49	0.34	-

Fresh weight of plant

Data recorded in respect of fresh weight of plant (g/plant) of red amaranth has been presented in Table 2 and observed that it differed significantly. The higher fresh weight mean (232.78 g/plant) was recorded with application of T_{10} (75% RDF + 25% PROM + 25% Vermicompost + 25% Poultry manure + 25% FYM) followed by application of T_9 [50% RDF + 25% PROM + 25% Vermicompost + 25% Poultry manure + 25% FYM] (224.74 g/plant). Whereas, application of T_1 (Control) resulted in significantly lower fresh weight (161.81 g/plant). Consequently, more leaf area accelerated photosynthesis, which in effect resulted in an increase in the fresh weight of the leaves. Similar results have been reported by Saikrishna et al. (2021) and Patel et al. (2019) in the amaranth crop. The use of fertilizers and organic manures together may have contributed to the increased growth. The activity of soil microorganisms, which develop a range of growth-promoting substances that aid in enhanced plant development, was increased with organic manures. In the same way, the crop benefited from the application of inorganic fertilizers by receiving a balanced supply of nutrients, which increased absorption and improved growth of the crop.

Yield

The yield of any crop is the final index of the experiment which indicates the success or failure of any treatment with this view leaf yield of red amaranth was recorded. The data for the yield per plot under different treatments were recorded and converted into leaf yield per hectare (t). At 20, 40 and 60 DAS, significantly highest yield (1.58, 2.57 and 2.16 t/ha) was recorded with treatment T_{10} (75% RDF + 25% PROM + 25% Vermicompost + 25% Poultry manure + 25% FYM) which was at par with T_2 (1.49 and 2.32 t/ha) [100% RDF + FYM (25 t/ha)] in 20 and 40 DAS, respectively while in 60 DAS it was at par with application of T_9 (1.99 t/ha) (50% RDF + 25% PROM + 25% Vermicompost + 25% Poultry manure + 25% FYM). Whereas, application of T_1 (Control) resulted in significantly lowest yield (0.98, 1.56 & 1.34 t/ha), respectively. The higher leaf yield recorded under T_{10} can be attributed to the integrated application of inorganic fertilizers and organic manures, which ensured a balanced and sustained supply of nutrients. The slow and continuous release of nutrients from PROM, FYM, vermicompost, and poultry manure, along with readily available N and P from inorganic fertilizers, likely enhanced nutrient concentration within plant tissues. This improved nutrient availability and uptake promoted better vegetative growth, resulting in increased fresh and dry biomass. Additionally, organic manures may have facilitated nutrient solubilization and improved soil conditions, thereby contributing to higher leaf yield. These findings are in agreement with those reported by Kushare et al. (2010) and Tayade et al. (2012) in amaranthus.

Economic parameters

Economics of red amaranth influenced by different INM practices are presented in Table 3. Highest total yield (6.31 t/ha) was recorded in treatment T_{10} (75% RDF + 25% PROM + 25% Vermicompost + 25% Poultry manure + 25% FYM) followed by treatment T_2 (5.66 t/ha) [100% RDF + FYM (25 t/ha)], which were at par with each other and found non-significant. Whereas, application of T_1 (Control) resulted in the lowest total yield (3.88 t/ha). The maximum gross monetary returns (Rs. 94650/ha), net monetary returns (Rs. 68790/ha), total cost of cultivation (Rs. 25860/ha) and cost benefit ratio (3.66) were recorded under treatment T_{10} (75% RDF + 25% PROM + 25% Vermicompost + 25% Poultry manure + 25% FYM). However, the minimum gross

Table 3: Total yield (t/ha), gross monetary returns (Rs/ha), cost of cultivation (Rs/ha), net monetary returns (Rs/ha) and B:C ratio of red amaranth

Treatment combinations	*Total yield (t/ha)*	*Gross monetary returns (Rs/ha)*	*Cost of cultivation (Rs/ha)*	*Net monetary returns (Rs/ha)*	*Benefit cost ratio (B:C ratio)*
T_{1-} Control	3.88	58200	17600	40600	3.31
T_2- 100% RDF + FYM (25 t/ha)	5.66	84900	23720	61180	3.58
T_3 - 100% PROM	4.43	66450	18928	47522	3.51
T_4 - 50% PROM + 50% Vermicompost	4.98	74700	22476	52224	3.23
T_5 - 50% PROM + 50% Poultry manure	4.68	70200	21945	48255	3.20
T_6 - 50% PROM + 50% FYM	4.18	62700	18569	44131	3.38
T_7 - 25% PROM + 25% Vermicompost + 25% Poultry manure + 25% FYM	4.58	68700	20273	48427	3.39
T_8 - 25% RDF + 25% PROM + 25% Vermicompost + 25% Poultry manure + 25% FYM	5.36	80400	23080	57320	3.48
T_9 - 50% RDF + 25% PROM + 25% Vermicompost + 25% Poultry manure + 25% FYM	5.64	84600	24068	60532	3.51
T_{10} - 75% RDF + 25% PROM + 25% Vermicompost + 25% Poultry manure + 25% FYM	6.31	94650	25860	68790	3.66

**Red Leafy Amaranth Market Selling Price ₹ 15.00 per kilogram.

monetary returns (Rs. 58200/ha) and net monetary returns (Rs. 40600/ha), and total cost of cultivation (Rs. 17600/ha) were observed under treatment T_1 (Control). While the minimum cost benefit ratio (3.20) was observed in treatment T5 (50% PROM + 50% FYM).

These results are conformity with the findings of Patel et al. (2005), who have also reported a similar type of results in grain amaranth. The accrued benefit of application of RDF and FYM on beneficial effects on soil over a period of time is not accounted for while calculating the returns. Findings corroborate with their results obtained in the amaranth crop Patel et al. (2005), Vipitha (2011), Pillai (2012) and Chaudhary et al. (2018).

Conclusion

Based on the data above, it can be said that the integrated strategy to leaf amaranth cultivation was the most effective in terms of growth indicators as well as economics. It was determined that the T_{10} application (75% RDF + 25% PROM + 25% Vermicompost + 25% Poultry manure + 25% FYM) was the best of the different integrated nutrition treatments. It provided the amaranth crop's optimal growth, production and economic variables. Nonetheless, under treatment T_1 (Control), the lowest growth, yield and economic variables were recorded.

Authors' Contribution

Both the authors (CK and DS) involved in this study contributed to the study design, fieldwork, data collection, analysis, interpretation and writing of the manuscript.

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सारांश

चौलाई एक आर्थिक रूप से महत्वपूर्ण पत्तेदार सब्जी है, जिसे उसके उच्च पोषण मूल्य, व्यापक पर्यावरणीय अनुकूलता, फसल विफलता के कम जोखिम तथा जैविक एवं अजैविक तनावों के प्रति सहनशीलता के लिए जाना जाता है। तथापि, इसकी उत्पादकता मुख्यतः कुशल पोषक तत्व प्रबंधन पर निर्भर करती है, क्योंकि इसकी वृद्धि अवधि अल्प होती है तथा यह सी4 प्रकाश संश्लेषण प्रणाली वाली फसल है। रबी 2022-23 के दौरान काजरी-कृषि विज्ञान केन्द्र, पाली-मारवाड़) राजस्थान (में समेकित पोषक तत्व प्रबंधन के प्रभाव का मूल्यांकन करने हेतु एक क्षेत्रीय प्रयोग संचालित किया गया था। इस प्रयोग में कुल दस उपचार शामिल किए गए, जिनमें अकार्बनिक उर्वरकों) अनुशंसित उर्वरक मात्रा (तथा कार्बनिक खादों) फॉस्फेट समृद्ध कार्बनिक खाद, गोबर की सड़ी हुई खाद, वर्मी कम्पोस्ट एवं पोल्ट्री खाद (के विभिन्न संयोजन शामिल थे। अध्ययन के प्रमुख निष्कर्षों से स्पष्ट हुआ कि विभिन्न समेकित पोषक तत्व प्रबंधन पद्धतियों का, चौलाई की वृद्धि एवं पत्ती उपज गुणों पर प्रत्येक विकास अवस्था 40 ,20) एवं60 बुवाई उपरांत दिन (में महत्वपूर्ण प्रभाव पड़ा। परिणामों में न्यूनतम मान टी1 (नियंत्रण (में तथा अधिकतम मान टी10 (75 प्रतिशत अनुशंसित उर्वरक मात्रा25 + प्रतिशत फॉस्फेट समृद्ध कार्बनिक खाद, + 25 प्रतिशत वर्मी कम्पोस्ट25 + प्रतिशत पोल्ट्री खाद25 + प्रतिशत गोबर की सड़ी हुई खाद (में दर्ज किए गए। आर्थिक दृष्टिकोण से, टी2{100 प्रतिशत अनुशंसित उर्वरक मात्रा + गोबर की सड़ी हुई खाद25) टन प्रति हेक्टेयर [(, उपचार टी10 के पश्चात दूसरे स्थान पर रहा, जिसमें सर्वाधिक शुद्ध आर्थिक लाभ) ₹ 68,790 प्रति हेक्टेयर (तथा लाभ-लागत अनुपात3.66 प्राप्त हुआ। इसके विपरीत, टी1 (नियंत्रण (में न्यूनतम शुद्ध आर्थिक लाभ ₹ 40,600 प्रति हेक्टेयर तथा लाभ-लागत अनुपात3.31 दर्ज किया गया। यह अध्ययन दर्शाता है कि कार्बनिक एवं अकार्बनिक पोषक तत्वों का समेकित उपयोग चौलाई की उत्पादकता एवं लाभप्रदता बढ़ाने की एक प्रभावी रणनीति है।