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Impact of integrated nutrient management on growth and yield of cumin (*Cuminium cyminium* L.) in western Rajasthan

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ABSTRACT

The study on impact assessment of integrated nutrient management practices in cumin revealed that application of NPK @ 50:30:20 kg/ ha with FYM @ 15 t/ ha FYM (T_{11}) performed better at 45 DAS, 90 DAS and at harvest respectively, in terms of plant height, number of branches per plant, and plant population. Treatment T_{11} was also shown to have the best results for test weight, seed yield, quantity of umbels and seeds per plant. This demonstrate the effectiveness of INM in increasing cumin production and growth, providing important information for growing cumin in western Rajasthan.

Introduction

The cumin, commonly known as *jeera* (*Cuminium cyminium* L.), is a member of the Apiaceae family. With over 22% of the country's spice acreage, it is the most extensively grown spice and it also makes up over 48% of the country's seed spice acreage, leading to the largest crop. In parts of M.P. and U.P., along with predominantly in Rajasthan and Gujarat, cumin is growing as a *rabi* crop. With 99% of India's cumin production, Gujarat and Rajasthan occupy significant production and area position (Meena *et al.*, 2021). Gujarat state has an excellent productivity, producing 2.74 lakh tonnes of cumin crop on 2.76 lakh hectares of area whereas, Rajasthan is the state with the largest area (6.59 lakh ha) and the highest production (3 lakh tonnes). India produces 5.77 lakh tonnes of cumin annually on 9.37 lakh hectares of area (Spice Board, 2023-24). In India in 2022-2023, cumin is the most widely cultivated seed spice and the second most widely grown spice, beneath chilli (8.44 lakh ha). According to Meena *et al.* (2022), the yield of cumin in India is 647 kg ha^{-1}, having variations from district to district in Gujarat (995 kg ha^{-1}) and Rajasthan (424 kg ha^{-1}). Cumin production is expected to decline in 2025 in both Gujarat and Rajasthan as compared to the year earlier. It is expected that the area used for cumin cultivation would decrease by 20% in Gujarat and by around 5% in Rajasthan. The main causes of this area reduction are weather-related problems and delayed sowing, both of which are predicted to result in poorer yields (Anonymous, 2025). There are fewer high-yielding and resistant varieties available, recommended plant production and protection technologies are not being adopted as widely, and farmers are not well-informed about the recommended package of practices specific to their area, which results in the crop's average productivity being extremely low both nationally and in Rajasthan. Using better practices techniques can have significant effects on the expanding area. Timely and sufficient fertilizer application is crucial for cumin yield,

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in addition to other suggested measures (such irrigation and intercultural activities). Furthermore, adopting easily available chemicals and organic methods to efficiently manage biotic and abiotic stresses at crucial times is vital to increasing crop yield and growth. It is well acknowledged that using chemical fertilizers in conjunction with organic composts is a significant agricultural approach that can yield additional benefits or at least effects that are equal to those obtained from using chemical fertilizers alone (Chouhan *et al.*, 2023). Crop production and nutrient availability are significantly improved when manure is used in place of some manufactured fertilizers. In addition to improving various soil properties and crop productivity, the combined use of chemical fertilizers and organic compost also significantly reduces the use of chemical fertilizers, which in turn saves energy, reduces the risk of pollution, increases fertilizer use efficiency, minimizes costs for farmers, particularly in low-income countries, and ensures ecosystem sustainability against the decline of soil and water resources (Kumar *et al.*, 2024).

Well-decomposed farm yard manure (Organic manure) should be applied and evenly distributed across the field before ploughing in order to improve soil fertility, productivity, and aeration as well as to maintain the C: N ratio in the field, which leads to a better yield. If rainwater falls in excess before the crop is seeded, the nutrients might flow off. Well-rotted farm yard manure should be thoroughly incorporated into the soil just before to the crop being sown. Like any other commercial fertilizer, FYM has a direct impact on plant development since it contains plant-based nutrients. It also contains traces of micronutrients in addition to essential nutrients (Kumar and Singh, 2023). The current study was conducted to examine the impact of N, P, K, and FYM on cumin growth and yield while taking all of these factors into consideration.

Material and Methods

Pali lies in western plain of luni basin agro climatic zone of India. The soil of the experimental field was sandy clay loam in texture while depth of soil is moderate too deep about 50 to 75 cm. It is suitable for cultivation but for low rainfall and high evaporation causes saline (pH 7.9 to 8.0) nature. Organic carbon at the farm field soil ranges from 0.22 to 0.33% and Nitrogen in surface layer is low (231.7 to 277.0 kg/ ha) whereas P_2O_5 (14.3 to 15.0 kg/ ha) and K_2O (210.3 to 214.3 kg/ ha) is medium. The last year (2021-22) lowest annual temperature was 4.1°C, while maximum annual temperature was 41.2°C and total rainfall was 224 mm at experimental site. The treatments accompanied with absolute control (T_1), 25 t/ ha FYM (T_2), NPK – 40:20:20 kg/ ha + 5 t/ ha FYM (T_3), NPK – 40:25:20 kg/ ha + 10 t/ ha FYM (T_4), NPK – 40:30:20 kg/ ha + 15 t/ ha FYM (T_5), NPK – 45:20:20 kg/ ha + 5 t/ ha FYM (T_6), NPK – 45:25:20 kg/ ha + 10 t/ ha FYM (T_7), NPK – 45:30:20 kg/ ha + 15 t/ ha FYM (T_8), NPK – 50:20:20 kg/ ha + 5 t/ ha FYM (T_9), NPK – 50:25:20 kg/ ha + 10 t/ ha FYM (T_{10}) and NPK – 50:30:20 kg/ ha + 15 t/ ha FYM (T_{11}). Full doses of all organic and inorganic fertilizers were applied at the time of sowing except, nitrogen which was applied in two split doses. All the parameters were noted at 45, 90 days after sowing and at harvest. Regular analysis of variance was performed for each trait for all three seasons and the combined (Pooled) analysis over seasons after testing error variance homogeneity was carried out according to the procedure outlined by Gomez and Gomez (1984), using the MSTATC version 2.1 (Michigan State University, USA) statistical package design. Significant differences between the treatments were compared with the critical difference at ± % probability by LSD.

Results and Discussion

The data collected on various growth and yield attributes from three replications of eleven treatment combinations were statistically analyzed, and the results are presented below under different subheadings

Growth and development parameters

According to the data in Table 1 on cumin growth and development characteristics, significant variations in plant height were observed at different growth stages, influenced by varying concentrations of FYM and NPK. At 45 DAS, treatment T_{11} (50:30:20 kg/ ha NPK+15 t/ ha FYM) had the considerably most significant plant height (9.19 cm), which was at par to treatment T_8 (45:30:20 kg/ ha NPK+15 t/ ha FYM (9.00), but much better than the other treatments. At 90 DAS, the treatment T_{11} had the maximum plant height (35.76 cm), substantially above treatments T_5 (31.33 cm), T_{10} (30.47 cm), and T_2 (29.84 cm). Increased plant height is the ultimate result of improved plant growth and development (Singh *et al.*, 2022). The results of the study supported with the findings of Shivran *et al.* (2017) in cumin and Ali *et al.* (2015).

The number of main branches per plant during the different growth phases was significantly impacted by the treatment of varying doses of FYM and NPK. Treatment T_{11} (4.39) had the most primary branches per plant at 45 days after sowing, followed by treatment T_8 (4.36). These treatments were comparable to treatments T_5 (4.14), T_{10} (4.11), T_2 (4.10), and T_7 (4.02), but much better than the other treatments. According to the data, at 90 DAS, treatment T_{11} had 8.90 primary branches per plant, which was comparable to treatments T_8 (8.70) and T_9 (8.49), but far superior to all other treatments. At harvest, the significantly higher primary branches was recorded under treatment T_{11} (11.26) than treatments T_6 (10.83), T_9 (10.68), T_8 (10.51) and T_7 (10.44). Waskela *et al.* (2017) and Meena *et al.* (2020) saw a similar rise in growth indices with higher fertilizer levels.

In Table 1, the results indicated that the various treatments had a substantial impact on the plant population per metre row length at 45 DAS, 90 DAS, and harvest. The highest plant population per metre row length (15.34) at 45 DAS was under treatment T_{11}, which was considerably better than the other treatments and on par with treatments T_8 (14.50), T_9 (14.49), T_{10} (14.45), T_7 (14.34), T_2 (14.26), and T_6 (14.04). The maximum plant population per metre row length (14.33) at 90 DAS was found to be at par with treatment T_9 (13.67), according to the analysis of variance. At harvest time, however, T_{11} (14.27) continued to be considerably superior to the other treatments. This could be due to the gain in morphological characteristics and higher chlorophyll content of leaves (Muvel *et al.,* 2015).

Yield attributing parameters

The test weight (g) data was significantly impacted by the application of different NPK and FYM amounts (Table 2). Treatment T_{11} (50:30:20 kg/ ha NPK+15 t/ ha FYM) was statistically the highest test weight (4.14), according to the data in Table 2. This was comparable to T_8 (45:30:20 kg/ ha NPK+15 t/ ha FYM; 4.07), and T_5 (40:30:20 kg/ ha NPK+15 t/ ha FYM; 4.02), but it was noticeably better than the other treatments. T_1 (absolute control) was used to record the lowest test weight (3.73). These findings are in close conformity with the results of Godara *et al.* (2014) and Yimam *et al.* (2015).

According to the results shown in Table 2, the highest seed yield (g plant^{-1}) was recorded under treatment T_{11}- 50:30:20 kg/ ha NPK+15 t /ha FYM (29.34). This was significantly better than the other treatments, but on par with treatments T_8- 45:30:20 kg/ ha NPK+15 t/ ha FYM (28.92), T_5- 40:30:20 kg/ ha NPK+15 t/ ha FYM (28.40), T_{10}- 50:25:20 kg/ ha NPK+10 t/ ha FYM (26.88), T_2- 25 t/ ha FYM (26.47), and T_7- 45:25:20 kg/ ha NPK+10 t/ ha FYM (26.18). In T_1 (absolute control), the lowest seed output (22.62 g plant^{-1}) was noted. The same results were reported by Sathyanarayana *et al.* (2017) in ajwain and Desai *et al.* (2020) in cumin.

Table 2 indicates that the number of umbels per plant was significantly influenced. The highest number of umbels per plant was recorded under treatment T_{11}, which was 50:30:20 kg/ ha NPK+15 t/ ha FYM (22.42). This was comparable to treatment T_8 (45:30:20 kg/ ha NPK+15 t/ ha FYM; 21.96), T_5 (20.91), T_{10} (20.53), and T_2 (19.54), but it was noticeably better than the other treatments. The findings of the treatment of different levels of NPK and FYM indicated that the treatment T_{11} - 50:30:20 kg/ ha NPK+15 t/ ha FYM produced the highest seed yield (5.32 q ha^{-1}), which was comparable to treatments T_8 - 45:30:20 kg/ ha NPK+15 t/ ha FYM (5.01) and T_7 - 45:25:20 kg/ ha NPK+10 t/ ha FYM (4.99), but significantly better than the other treatments. The results are consistent with those reported by Desai *et al.* (2020) in cumin.

Table 1. Effect of INM on plant growth and development of cumin

Treatments	Plant height (cm)			No. of primary branches/ plant			Plant population (per meter row length)		
	45 DAS	90 DAS	At harvest	45 DAS	90 DAS	At harvest	45 DAS	90 DAS	At harvest
Absolute control (T_1)	7.20	23.07	30.72	3.12	5.42	9.03	10.12	9.00	8.14
25 t/ ha FYM (T_2)	7.67	29.84	33.68	4.10	6.06	9.55	14.26	12.67	10.95
40:20:20 kg/ ha NPK+5 t/ ha FYM (T_3)	7.37	28.12	32.82	3.13	6.60	9.29	13.60	11.67	10.22
40:25:20 kg/ ha NPK+10 t/ ha FYM (T_4)	7.61	28.46	33.39	3.97	7.04	9.62	13.03	11.33	10.81
40:30:20 kg/ ha NPK+15 t/ ha FYM (T_5)	7.94	31.33	35.02	4.14	7.57	10.34	14.23	11.00	10.15
45:20:20 kg/ ha NPK+5 t/ ha FYM (T_6)	7.40	29.70	36.80	3.79	8.04	10.83	14.04	12.00	10.65

45:25:20 kg/ ha NPK+10 t/ ha FYM (T_7)	7.63	29.56	37.17	4.02	7.89	10.44	14.34	13.00	10.89
45:30:20 kg/ ha NPK+15 t/ ha FYM (T_8)	9.00	28.41	36.99	4.36	8.70	10.51	14.50	11.67	11.23
50:20:20 kg/ ha NPK+5 t/ ha FYM (T_9)	7.54	28.16	40.14	3.83	8.49	10.68	14.49	13.67	10.81
50:25:20 kg/ ha NPK+10 t/ ha FYM (T_{10})	7.77	30.47	42.91	4.11	8.22	10.06	14.45	12.33	11.10
50:30:20 kg/ ha NPK+15 t/ ha FYM (T_{11})	9.19	35.76	44.81	4.39	8.90	11.26	15.34	14.33	14.27
SEm±	0.105	0.423	0.125	0.030	0.112	0.049	0.312	0.289	0.323
CD at 5%	0.310	1.914	1.449	0.375	0.607	0.205	1.505	0.892	1.024

Table 2. Effect of INM on yield attributes parameters of cumin

Treatments	Test weight (g)	Seed yield/ plant (g)	Number of umbels/ plant	Seed yield (q/ ha)
Absolute control (T_1)	3.73	22.62	16.51	4.35
25 t/ ha FYM (T_2)	3.91	26.47	19.54	4.20
40:20:20 kg/ ha NPK+5 t/ ha FYM (T_3)	3.76	23.72	17.60	4.16
40:25:20 kg/ ha NPK+10 t/ ha FYM (T_4)	3.86	25.93	19.33	4.80
40:30:20 kg/ ha NPK+15 t/ ha FYM (T_5)	4.02	28.40	20.91	4.63
45:20:20 kg/ ha NPK+5 t/ ha FYM (T_6)	3.77	24.36	18.91	4.64
45:25:20 kg/ ha NPK+10 t/ ha FYM (T_7)	3.88	26.18	19.40	4.99
45:30:20 kg/ ha NPK+15 t/ ha FYM (T_8)	4.07	28.92	21.96	5.01
50:20:20 kg/ ha NPK+5 t/ ha FYM (T_9)	3.80	25.65	19.30	4.59
50:25:20 kg/ ha NPK+10 t/ ha FYM (T_{10})	3.93	26.88	20.53	4.50
50:30:20 kg/ ha NPK+15 t/ ha FYM (T_{11})	4.14	29.34	22.42	5.32
SEm±	0.056	1.138	0.480	0.112
CD at 5%	0.164	3.357	2.891	0.453

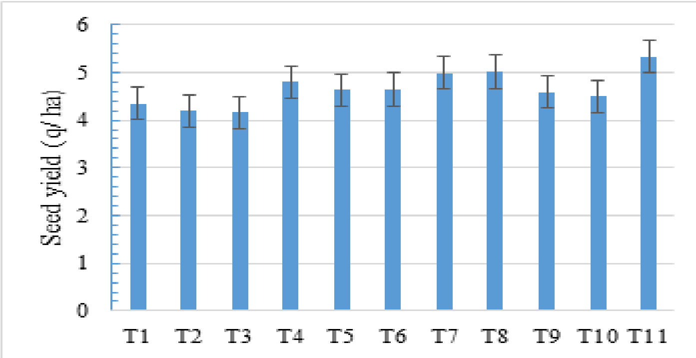

Fig. 1. Effect of INM on seed yield of cumin

Conclusion

The integrated nutritional approach to cumin cultivation was the most successful in terms of growth and yield indicators, according to the data above. Based on one year of study and the findings above, it can be said that the growth and yield characteristics of cumin were both considerably and non-significantly impacted by the different levels of key nutrients and organic manure. Therefore, T_{11} (50:30:20 kg/ ha NPK+15 t/ ha FYM) was the most effective of the eleven integrated nutrition treatments for improving cumin growth and production. It allowed the cumin crop the best growth potential and yield.

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Conflict of Interest

All authors agree to publication and there is no any conflict of interest.

Data Sharing

All relevant data are within the manuscript.

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