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Integrated Nutrient Management (INM) and Varietal Impact on Toria (*Brassica campestris* L. var. toria) Growth, Yield, and Economics

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Oilseeds, particularly rapeseed-mustard, play a vital role in India's agricultural landscape, contributing significantly to the economy. *Toria*, a winter oilseed crop, is of particular importance, cultivated in both irrigated and rainfed conditions. Fertilizers, especially nitrogen (N), phosphorus (P), and sulfur (S), play a crucial role in enhancing *toria* yield. Integrated nutrient management (INM), which includes the use of farmyard manure (FYM), is a sustainable approach to maintain soil

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health and improve crop productivity. The study evaluates the impact of nutrient management practices on *toria* growth and yield. Additionally, it compares the performance of the newly released *toria* variety 'Tapeswari' with traditional varieties ('T9' and 'T36'). The results indicate that 'Tapeswari' fertilized with 100% RDF + 25% N through FYM outperforms traditional varieties in terms of growth, yield attributes, and overall yield. The study underscores the importance of effective varietal selection and nutrient management for enhancing rapeseed-mustard production, profitability, and soil fertility.

Keywords: FYM; oilseed; Tapeswari; T9; T36.

1. INTRODUCTION

Oilseeds play a crucial role in India's agricultural economy, following food grain crops. Oilseed crops, particularly rapeseed and mustard, have been a dynamic sector in global agriculture, with a 4.1% annual growth rate. Rapeseed-mustard plays a significant role in supporting the livelihoods of small and marginal farmers, particularly in rainfed regions. *Toria*, a winter oilseed crop in India, is an important one of them. Cultivated under both irrigated (79.2%) and rainfed (20.8%) conditions, either as a pure rabi crop or as a catch crop. It requires cool temperatures, sufficient soil moisture during growth, and a dry harvest period [1;2]. Fertilizers play a crucial role in enhancing *toria* yield, with nitrogen (N), phosphorus (P), and sulphur (S) being the major influencers. Nitrogen contributes to increased protein content, dry matter, and overall yield. The presence of P and K, along with N, promotes flowering, siliqua setting, and yield, particularly in areas with frost concerns [3]. Optimal phosphorus supply enhances root growth, influences oil content, and supports the initial growth of plants. Sulphur is essential, with split application increasing the number of pods per plant and grain. The combined application of nitrogen, phosphorus, and sulphur yields better results than using them individually [2]. Among the various challenges contributing to the low productivity of mustard, the unpredictable climate, ineffective irrigation water and fertilizer management, and poor soil physical conditions are the primary factors leading to reduced crop yield. The deterioration of soil health poses a significant threat to Indian agriculture, intensified by excessive fertilizer use in less responsive soils with low organic matter content. Neither the sole use of chemical fertilizers nor reliance on organic sources can sustain soil fertility and crop productivity in high-input production systems [4]. A more effective alternative is integrated nutrient management (INM), which ensures both high crop production and the maintenance of soil health and fertilizer use efficiency. The aim is to reduce chemical fertilizer use, achieve a balance with crop nutrient requirements, and minimize environmental impact. Animal manure, such as farmyard manure (FYM), plays a vital role in supplying macro and micronutrients, improving soil structure, and promoting fertilizer use efficiency. The use of FYM enhances cation exchange capacity, helps retain soil micronutrients in an accessible form through its chelating action, and plays a crucial role in promoting soil microbial activity [5]. Genotype also influences oilseed production, and testing new varieties like Tapeswari against traditional ones (T9 and T36) can contribute to improved productivity. The study's objectives include assessing the impact of integrated nutrient management on *toria* growth and yield, as well as evaluating the economics of different treatments.

2. MATERIALS AND METHODS

Field trials were conducted in the rabi season (2021-22) at the IFS block of the Agricultural Research Farm, Department of Agronomy, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh (India). The farm is located in the Northern Gangetic Alluvial Plain at 25°18' North latitudes, 83°03' East longitudes, and an elevation of 80.71 meters above mean sea level. The location has a semi-arid to semi-humid climate, with temperatures ranging from 6.7°C to 31.9°C and 9.63 mm of total precipitation during the crop season. The soil is sandy clay loam with a pH of 7.63 and 0.35% soil organic carbon. The experiment was laid out in a split-plot design (SPD) with three replications. The main plot treatment consisted of four fertility levels, i.e.100% RDF (Recommended fertilizers dose), 75% RDF + 25% N through FYM, 50%RDF + 50% N through FYM, and 100% RDF +25% N through FYM, and three varieties of *toria* (T9, T36, Tapeswari) in sub-plots (Table 1). The 100% RDF was taken as 100 kg N + 50 kg P_2O_5 +50 kg K_2O. Along with sulphur (20 kg ha^{-1}). According to the

Table 1. Treatment details of the experiment

S.No.	Treatments details	Symbol assigned
1	100 % RDF + T9	F_1V_1
2	100 % RDF + T36	F_1V_2
3	100 % RDF + Tapeswari	F_1V_3
4	75 % RDF+ 25% N through FYM + T9	F_2V_1
5	75 % RDF + 25% N through FYM + T 36	F_2V_2
6	75 % RDF + 25% N through FYM + Tapeswari	F_2V_3
7	50 % RDF + 50% N through FYM + T9	F_3V_1
8	50 % RDF + 50% N through FYM + T36	F_3V_2
9	50 % RDF + 50% N through FYM + Tapeswari	F_3V_3
10	100 % RDF + 25% N through FYM + T9	F_4V_1
11	100 % RDF + 25% N through FYM + T36	F_4V_2
12	100 % RDF + 25% N through FYM + Tapeswari	F_4V_3

treatment, FYM was applied and incorporated into the soil using a *kudal* (local furrow opener tool) before leveling the plots with a spade. Seeds of the *toria* varieties “T9” and “T36” and “Tapeswari” were sown at a rate of 4 kg ha^{-1} at a row spacing of 30 cm, as per the treatment. As the rainfall received during the crop season was very low, two irrigations were given to crop during the entire growth period. In *toria*, a pre-emergence application of Pendimethalin (30% EC @ 1 kg a.i. ha^{-1}) was done. Later on, at 25 days after sowing, a mechanical weeding with a hand rotary weeder was done. Mild infestation of aphid (*Lipaphis erysimi* Kalt) was noticed during peak flowering and to protect crops from aphids (*Lipaphis erysimi)* Dimethoate 30 EC was sprayed once @ 1.0 l ha^{-1} during flowerings besides this as a prophylactic measure against Alternaria blight Mancozeb (Dithane M-45) @ 2.5 kg ha^{-1} was also mixed with the spray solution for aphids. Data were recorded following standard procedures, including the measurement of chlorophyll content using a SPAD-502 chlorophyll meter and leaf area index (LAI) with a leaf area meter (Systronics 211). Statistical analysis was conducted using the appropriate analysis of variance method as outlined by Gomez [6].

3. RESULTS AND DISCUSSION

3.1 Effect of INM on Growth of *Toria* Varieties

The growth parameters of *toria*, including plant height, green leaves plant^{-1}, chlorophyll content (SPAD value), LAI, dry weight plant^{-1}, and number of primary and secondary branches plant^{-1}, were significantly influenced by INM and genotypes. The application of 100% RDF + 25% N through FYM (F4) exhibited notable improvements, particularly in plant height, green leaves plant^{-1}, and primary and secondary branches plant^{-1}. Tapeswari proved superior to 'T9' and 'T36' in terms of plant height, green leaves plant^{-1}, and number of secondary branches plant^{-1} at various growth stages. Additionally, the application of 100% RDF + 25% N through FYM (F4) significantly enhanced LAI and dry weight plant^{-1} compared to other treatments. A sufficient supply of nitrogen encourages more nutrient uptake, which in turn favours faster growth of leaves, better photosynthetic pigment accumulation, and ultimately, greater plant growth. Adequate nitrogen supply at 100% RDF + 25% N through FYM promotes robust plant growth by enhancing nutrient uptake, leaf development, and photosynthesis, resulting in quick cell division and cell enlargement and vigorous plant growth. Extensive use of organic manures improves soil health, retains moisture, and positively influences crop growth parameters [7]. The mineralization process during organic material breakdown produces organic acids, lowering soil pH, increasing nutrient concentrations, and boosting soil biological activity, reducing nutrient losses through gradual release [8,9]. The majority of plant nutrients were provided by FYM, which had both direct and indirect effects on the nutrients' availability to crop plants [10]. The increased availability of nutrients in the soil through balanced supply under fertility level of 100 % RDF + 25% N through FYM might have augmented meristematic activity (multiplication and elongation of cells) which leads to increased plant height, branches and dry matter accumulation. These findings were in close agreement with those reported by Tripathi et al. [11], Sau et al. [12], Saha et al.13].

Table 2. Effect of fertility levels on different growth attributes of *toria* varieties

Treatments	Plant height		LAI	SPAD	Primary branches plant^{-1}	Secondary branches plant^{-1}	Shoot dry Weight (g) plant^{-1}	
	70 DAS	At harvest	70 DAS	70 DAS	At harvest	At harvest	50 DAS	At harvest
Fertility levels								
F_1 - 100% RDF	117.9	119.1	0.48	30.2	6.26	4.6	2.6	33.9
F_2 - 75% RDF + 25% N through FYM	121.7	123.5	0.58	31.6	6.91	6.2	3.2	35.3
F_3 - 50% RDF + 50% N through FYM	116.5	117.8	0.411	30.1	6.12	4.3	2.5	32.5
F_4 - 100% RDF + 25% N through FYM	123.5	127.2	0.628	33.2	7.09	6.9	3.6	36.6
SEM±	1	1.5	0.01	0.5	0.19	0.2	0.1	0.7
CD (0.5)	3.4	5.2	0.036	1.9	0.65	0.8	0.4	2.3
Variety								
V_1 - T 9	120.2	121.7	0.495	30.6	6.52	5.6	2.9	34
V_2 - T 36	117.6	118.1	0.443	31.4	6.25	4.7	2.8	33.6
V_3 - Tapeswari	122	125.9	0.636	31.9	7.01	6.3	3.3	36.1
SEM±	0.8	1.7	0.013	0.37	0.15	0.2	0.1	0.6
CD (0.5)	2.6	5.1	0.038	1.12	0.45	0.5	0.2	1.8

Table 3. Effect of fertility levels on different yield attributes of *toria* varieties

Treatments	Siliquae on main shoot	Siliquae plant^{-1}	Siliquae Length (cm)	Seeds siliqua^{-1}	1000 –seed Weight (g)	Seed yield plant^{-1}
Fertility levels						
F_1 - 100% RDF	37.4	188.6	5.9	15.4	2.9	5.8
F_2 - 75% RDF + 25% N through FYM	40.2	203.9	6.0	15.9	3.1	6.9
F_3 - 50% RDF + 50% N through FYM	35.2	176.3	5.8	15.1	2.8	5.5
F_4 - 100% RDF + 25% N through FYM	43.0	208.3	6.3	16.3	3.3	7.2
SEM±	1.52	3.7	0.11	0.19	0.07	0.13
CD (0.5)	5.27	12.9	N.S.	0.65	0.23	0.46
Varieties						
V_1 - T 9	40.1	190.9	5.8	15.2	3.1	6.3
V_2 - T 36	36.1	188.0	6.1	15.6	2.9	6.1
V_3 - Tapeswari	40.7	203.9	6.2	16.2	3.1	6.5
SEM±	1.01	2.6	0.12	0.26	0.06	0.07
CD (0.5)	3.02	7.9	N.S.	0.77	N.S.	0.22

Table 4. Effect of fertility levels on yield and economics of *toria* varieties

Treatments	Seed yield (kg/ha)	Stover Yield (kg/ha)	Gross Return (`ha^{-1})	Cost of Cultivation (ha^{-1})	Net Return (ha^{-1})	B: C
Fertility levels						
F_1 - 100% RDF	1180	3359	81733	41542.7	40190	0.97
F_2 - 75% RDF + 25% N through FYM	1357	3474	93440	43955.5	49484	1.13
F_3 - 50% RDF + 50% N through FYM	1171	3128	80838	46368.1	34470	0.74
F_4 - 100% RDF + 25% N through FYM	1403	3618	96628	45553.3	51075	1.12
SEM±	33	38	2159	-	2159	0.05
CD (0.5)	116	132	7472	-	7472	0.17
Variety						
V_1 - T 9	1259	3412	86955	44354.9	42600	0.96
V_2 - T 36	1221	3291	84302	44354.9	39947	0.9
V_3 - Tapeswari	1354	3481	93222	44354.9	48867	1.1
SEM±	24	41	1569	-	1569	0.03
CD (0.5)	72	124	4705	-	4705	0.1

3.2 Effect of INM on Yield and Yield Attributes of *Toria* Varieties

Yield-related characteristics, including the number of siliquae plant^{-1}, siliquae on the main shoot, seeds siliqua^{-1}, seed weight plant^{-1}, and 1000-seed weight, showed an increase with the application of 100% RDF + 25% N through FYM (F4), which was comparable to 75% RDF + 25% N through FYM (F2). The incorporation of FYM into the soil promotes rapid vegetative growth and branching, expanding the sink area for flowering and seed setting. This, combined with INM, enhances plant height, dry matter production, and siliqua formation. The synergy of organic and inorganic nutrients contributes to increased physiological activity, leading to improved photosynthate partitioning and higher seed production siliqua^{-1}. These findings align with studies by Singh and Pal [10], Kumar et al. [14], Ajnar and Namdeo,15]. Increased nutrient availability in the soil due to INM led to increased vegetative growth and more dry matter accumulation in the plants, which might be the cause of increased seed and stover yield (Fig. 1). These results are in accordance with the findings of Pati and Mahapatra [16], Singh et al. [17]. It might be due to its better branching and overall growth performance, leading to the higher number of siliqua plant^{-1}, longer siliquae, better translocation of photosynthates to sink, which might have resulted in more number of seed siliqua^{-1} and higher test weight than the other two varieties. These results are in conformity with the findings of Sau et al. [12], Bhalavi et al. [18], Kalita et al.19].

Among the three *toria* varieties, 'Tapeswari' demonstrated significantly higher values for the number of siliquae plant^{-1}, seed siliqua^{-1}, seed weight plant^{-1}, seed, and stover yield (kg ha^{-1}) compared to 'T9' and 'T36' (Fig. 1). However, the differences were minimal for siliqua length and test weight. Conversely, the distinctions between 'T9' and 'T36' were not substantial concerning siliquae plant^{-1} and seed weight plant^{-1}. Significantly higher seed and stover yield in " Tapeswari " might be attributed to its better vegetative growth and superior yield-attributing character of the genotype as compared to " T9 ", and " T36 ". The maximum seed and stover yield are mainly due to an enhanced rate of photosynthesis and carbohydrate metabolism. The higher seed yield of Tapeswari may be due to its better partitioning of photosynthates.

3.3 Effect of INM on Economics of *Toria* Varieties

The gross return and net return increased significantly with the application of 100% RDF + 25 % N through FYM (F4) and being comparable to 75% RDF + 25% N through FYM (F_2) it recorded a significantly higher net return as 100% RDF (F_1) and 50% RDF + 50% N through FYM (F3), the highest B:C was noticed with 75% RDF + 25% N through FYM (F2). A distinct varietal difference was observed in gross return and net return. The highest gross return was obtained in var. ‘Tapeswari’ and showed significant superiority over variety ‘T9’ and ‘T36’. However, ‘T9’ and ‘T36’ remain at par with each other. The benefit-cost ratio also followed a

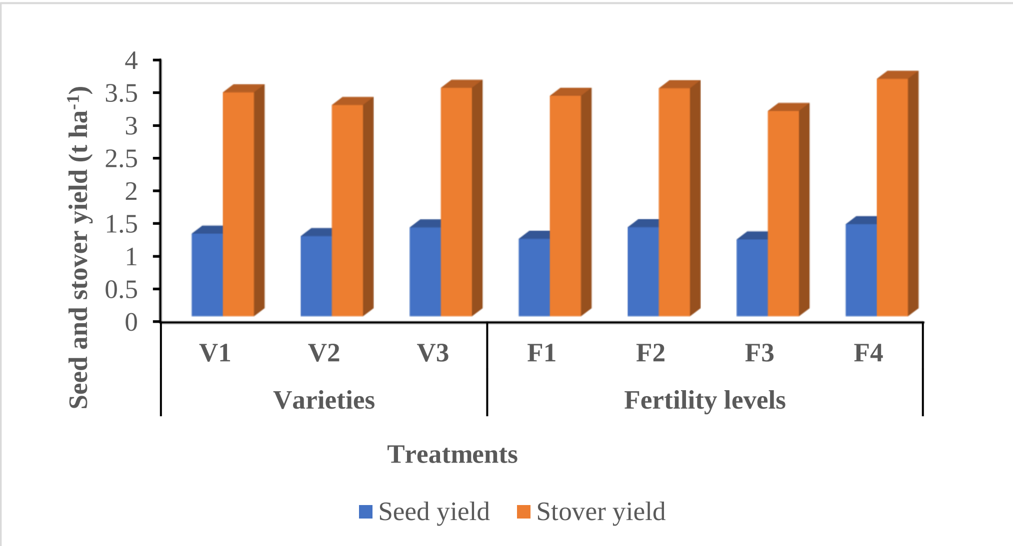

Fig. 1. Effect of fertility levels and varieties on seed and stover yield of *toria*

similar trend. The variations in seed and stover production led to differences in gross return among the three varieties under integrated nutrient management. On the other hand, the cost of cultivation differed depending on the varieties planted and the amounts of organic manure and inorganic fertilizer applied.

4. CONCLUSION

Based on the study results, the application of 100% RDF + 25% N through FYM led to the highest values for both growth and yield parameters in *toria*. The newly released *toria* variety 'Tapeswari' exhibited superior growth, yield attributes, and overall yield when compared to the traditionally cultivated varieties 'T9' and 'T36'. Additionally, 'Tapeswari' fertilized with 100% RDF + 25% N through FYM proved to be economically rewarding. Considering the economic analysis of the experimental findings, it is recommended to apply 100% RDF + 25% N through FYM for the cultivation of *toria* variety 'Tapeswari' to achieve the maximum yield and returns. Overall, effective varietal selection and nutrient management are critical for enhancing rapeseed-mustard production and profitability along with soil fertility.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Saini LB, Kakraliya M, Kumar P. Effects of different levels of NPK and sulphur on growth and yield attributes of rapeseed (Brassica campestris var. toria). J. Homepage. 2020;9(9). Available:http://www. ijcmas. com
2. Singh SB, Thenua O V S. Effect of phosphorus and sulphur fertilization on yield and NPS uptake by mustard (Brassica juncea L.). Progressive Res. Int. J. 2016;11:80- 83.
3. Famda L, Singh D, Jat BL. Effect of phosphorus and sulphur nutrients on Brassica campestris L. variety toria under dry land condition. Asian J. Environ. Sci. 2017;12:69-82
4. Singh T, Prakash V, Kumar J, Kumar M, Singh SRK. Effect of integrated nutrient management on growth and yield of mustard (*Brassica juncea* L.) in Irrigated Condition of Upper Gangetic Plain Zone of India. International Journal of Current Microbiology and Applied Sciences. 2017;6(1):922-932.
5. Sipai AH, Sevak K, Modi DB, Khorajiya KU, Jigar RJ. Effect of sulphur and zincwith and without FYM on yield, content anduptake of nutrients after harvest of mustard [*Brassica juncea* L. Czern & Coss] grown on lighttextured soil of Kachchh. The Ecoscan. 2016;10(3&4): 527-534
6. Gomez KA and Gomez AA. Statistical procedures for agricultural research. John wiley & sons; 1984.
7. Majumder S, Halder TK, Saha D. Integrated nutrient management of rapeseed (*Brassica campestris* L. var. yellow sarson) grown in a typic haplaquept soil. Journal of Applied and Natural Science. 2017;9(2):1151-1156.
8. Dotaniya ML, Meena HM, Lata M, Kumar K. Role of phytosiderophores in iron uptake by plants. Agricultural Science Digest-A Research Journal. 2013;33(1):73-76
9. Singh Y, Sharma DK, Sharma NL, Kumar V. Effect of different levels of NPK with combined use of FYM and sulphur on yield, quality and nutrients uptake in Indian mustard (*Brassica juncea L*.). International Journal of Chemical Studies. 2017;5(2), 300-304.
10. Singh SP and Pal MS. Effect of integrated nutrient management on productivity, quality, nutrient uptake and economics of mustard (*Brassica juncea*). Indian Journal of Agronomy. 2011;56(4):381-387.
11. Tripathi MK, Chaturvedi S, Shukla DK, Saini SK. Influence of integrated nutrient management on growth, yield and quality of Indian mustard (*Brassica juncea* L.) in tarai region of northern India. Journal of crop and weed. 2011;7(2):104-107.
12. Sau S, Barkha CS, Mallick M. Growth and yield of toria (Brassica campestris var. toria) under various Integrated nutrient management schedules in trans-gangetic Plains of Punjab. In Biological Forum–An International Journal. 2022;14(3);923-927.
13. Saha PK, Malik GC, Bhattacharyya P, Banerjee M. Integrated Nutrient

Management on Growth and Productivity of Rapeseed-mustard Cultivars. International Journal of Bio-resource and Stress Management. 2015;6(2):192-197.

14. Kumar S, Yadav KG, Goyal G, Kumar R, Kumar A. Effect of organic and inorganic sources of nutrients on growth and yield attributing characters of mustard crop (*Brassica juncea* L.). International Journal of Chemical Studies. 2018;6(2):2306-2309
15. Ajnar P Namdeo S. Effect of integrated nutrient management on Indian mustard yield attributes and yield. Journal of Pharmacognosy and Phytochemistry. 2021;10(2):545-548.
16. Pati, P and Mahapatra PK. Yield performance and nutrient uptake of Indian mustard (*Brassica juncea* L.) as influenced by integrated nutrient management. Journal Crop and Weed. 2015;11(1):58-61.
17. Singh P, Panotra N, Singh P, Singh KN, Kanht RH. Interaction effect of sulphur and potassium on nutritional quality and profitability of brown sarson (Brassica rapa var brown sarson) in temperate Kashmir. Indian Journal of Agronomy. 2013;58(1): 91-95
18. Bhalavi S, Sirothia P, Mishra A, Mishra US, Raghav RS, Singh OK, Jendre A. Effect of Integrated nutrient management on growth parameters, Yield Attributes and yield of mustard crop in Chitrakoot Area. International Journal of Plant & Soil Science. 2023;35(21):343-348.
19. Kalita N, Bhuyan S, Maibangsa S, Saud RK. Effect of Biofertilizer seed treatment on Growth, yield and economics of toria (*Brassica campestris* L.) under rainfed condition in hill zone of Assam. Current Agriculture Research Journal. 2019;7(3): 332.

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