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Response of Toria (*Brassica campestris* var. Toria) to Integrated Nutrient Management in Central Plain Region of Punjab, India

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ABSTRACT

An experiment was conducted during the *Rabi* season of 2022-23 at the Department of Agriculture, Lovely Professional University in Phagwara, Jalandhar (Punjab). The objective was to explore the implications of integrated nutrient management on the growth, yield and economic feasibility of toria. The experiment followed a randomized block design with three replications and consisted of twelve different treatments. Results revealed that treatment T2 (50% RDF + 50% RDN through Vermicompost) attained the highest values in plant height (61.05 cm, 120.21cm and 140.97 cm), number of primary (7.62 and 9.84) and secondary (8.17 and 11.34) branches, dry matter accumulation (8.30 g plant-1, 28.34 g plant-1 and 65.53 g plant-1) at all observation stages of the experiment which are statistically at par with treatment T3. In terms of yield attributes and yield of toria, treatment T2 (50% RDF + 50% RDN through Vermicompost) produce5d maximum number of siliquae (201.62), seeds per siliqua (11.87), seed yield (1450 kg ha-1), stover yield (2848 kg ha-1) and biological yield (4413 kg ha-1) which were in statistical terms, at par with treatment T3 (50% RDF + 50% RDN through FYM). The influence of different integrated plant nutrient management, treatment T2 (50% RDF + 50% RDN through Vermicompost) showed maximum value of gross returns (90,953 Rs ha-1). However, in terms of net returns (51,041 Rs ha-1) and benefit cost ratio (2.53), T1(RDF 100%) exhibit the greatest values. Furthermore, the control plots showed least values over other treatments at all the observation stages of the experiment.

Key words: *Vermicompost, FYM, Integrated Nutrient Management, RDF, Yield*

Introduction

Toria (*Brassica campestris* var. Toria) is a significant oilseed crop of *rabi* season, commonly known as sarson or lahi. It is considered as a carh crop due to its short life span, hardy and rapid growth characteristics. Toria seeds contain approximately 37-49% oil content and renowned for their high-quality edible oil, which has the lowest amount of saturated fats compared to other vegetable oils. Additionally, toria is rich in protein with a well-balanced amino acid profile, and it also holds potential for use as a biofuel. (Saha *et al.*, 2015).

The utilization of organic manure greatly impacts the improvement of soil's physical, chemical, and biological properties, thereby resulting in increased crop productivity. Farm yard manure and vermicompost holds significant importance as a primary supplier of organic substances and nutrients. The positive influence of these manures, when combined with the recommended amount of fertilizers, can be attributed to the organic matter's capacity to

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improve the soil's characteristics, creating a favourable environment for superior plant growth (Wu and Ma 2015). It enhanced the functionality of bacteria and fungi in the soil, which are responsible for transforming nutrients from an inaccessible state to available form while, vermicompost contributes to the reduction of the C:N ratio and enhances the humus content in the soil. It provides plants with a wide range of readily available nutrients and a higher concentration of beneficial microorganisms, such as nitrogen-fixing and phosphate-solubilizing bacteria, along with antibiotics, vitamins, hormones, enzymes, etc. These components have a positive impact on plant growth and yield (Kaur, 2020).

Biofertilizers are the source of Microbial inoculants. *Azotobacter* are free living bacteria, that are aerobic and have the capability of fixing nitrogen. These microorganisms have the ability to utilize nitrogen from the atmosphere to produce proteins within their cells. As a result, the soil is enriched with nitrogen, providing a significant portion of this essential element to the crop plants (Sumbul, 2020).

Nano-urea exhibits remarkable efficacy in precise nutrient management within the realm of precision agriculture, aligning seamlessly with the specific growth stages of crops to optimize nutrient provision throughout their entire development period. Nano-urea effectively enhances crop growth, achieving optimal concentrations that foster an increase in productivity. Furthermore, the application of liquid nano-urea contributes to notable improvements in crop yield, biomass production, soil health, and the nutritional quality of the harvested produce (Baboo *et al*. 2021).

Objective of the work

To explore the implications of integrated nutrient management on the growth, yield and economic feasibility of toria, we are currently undertaking the ensuing experiment.

Materials and Methods

Experimental Site and Design

The field experiment was carried out during the *Rabi* 2022-23 season at research farm of the Department of agronomy, school of Agriculture, Lovely Professional University located in Phagwara, Punjab, India. The study was conducted with the aim of delving into 'Effect of integrated nutrient management in toria (*Brassica campestris* var. Toria)'. The experiment followed a randomized block design with three replications and consisted of twelve different treatments. These treatments were as follows: T1 - 100% recommended dose of fertilizers (RDF), T2 - 50% RDF + 50% RDN through Vermicompost, T3 - 50% RDF + 50% RDN through FYM, T4 - 50% RDF + *Azotobacter*, T5 - 100% Nano Urea (0.4% spray @ 25 & 45 DAS), T6 - 50% Nano Urea (0.2% spray @ 25 & 45 DAS) + 50% RDN through Vermicompost, T7 - 50% Nano Urea (0.2% spray @ 25 & 45 DAS) + 50% RDN through FYM, T8 - 50% Nano Urea (0.2% spray @ 25 & 45 DAS) + *Azotobacter*, T9 -100% RDN through Vermicompost + *Azotobacter*, T10 - 100% RDN through FYM + *Azotobacter*, T11- Azotobacter and T12 - Control. The application of FYM and VC was done 15-25 days prior to sowing, following the respective treatments. The inorganics were provided via urea and single super phosphate. The initial soil fertility status consisted of 183.7 kg of available N, 26.4 kg of available P_2O_5 and 192.3 kg of K_2O per hectare, with an organic carbon content of 0.57%. The texture of the soil within the experimental field is sandy loam, exhibiting a pH value of 7.6. The toria cultivar TL-17 was employed in this study.

Statistical Analysis

Statistical analysis was performed using the OPSTAT software to assess the average values of each parameter across all treatments. Measurements were obtained for all treatments, and the parameters' mean values were calculated.

Results and Discussion

Growth Parameters

Data presented in Table 1, revealed that all treatments exhibited a significant increase plant height over control. Among the treatments, T2 (50% RDF + 50% RDN through VC) displayed the highest plant height (61.05 cm, 120.21cm and 140.97 cm) which is statistically at par with the treatment T3 (50% RDF + 50% RDN through FYM), while the control plot showed the lowest height (40.96 cm, 77.89 cm and 92.79cm) at all the observation stages viz. 30, 60 and 90 DAS. The elevation in plant height is ascribed to the N, P, and K supplied to the soil through a combination of chemical fertilizers and organic manures. The integration of these two nutrient sources ensured a continuous supply of nutrients to the plants,

Table 1. Effect of various treatments on growth parameters of toria

Treatments	Plant height (cm)			No. of branches per plant				Dry matter accumulation (g $plant^{-1}$)		
				Primary branches		Secondary branches				
	30 DAS	60 DAS	90 DAS	60 DAS	90 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS
T1	56.21	115.27	135.23	7.06	8.80	7.69	10.84	7.88	26.86	61.26
T2	61.05	120.21	140.97	7.62	9.84	8.17	11.34	8.30	28.34	65.53
T3	59.85	119.36	138.86	7.35	9.68	8.09	11.18	8.15	28.15	65.09
T4	51.60	90.32	110.46	5.94	7.51	6.16	9.53	7.20	22.56	52.22
T5	42.31	96.78	113.27	6.04	7.74	6.32	9.65	5.50	24.22	55.11
T6	49.39	109.76	127.18	6.83	8.61	7.43	10.53	6.76	26.45	58.63
T7	48.56	109.07	126.62	6.59	8.48	7.21	10.43	6.35	26.27	57.51
T8	43.34	88.21	107.15	5.69	7.39	5.86	9.22	5.95	21.82	50.43
T9	54.53	101.14	121.76	6.30	8.34	6.90	10.22	7.59	25.58	56.43
T10	53.43	97.93	114.38	6.14	7.90	6.55	9.81	7.34	24.61	55.57
T11	43.27	83.22	100.67	5.40	6.90	5.57	8.85	5.87	18.43	46.49
T12	40.96	77.89	92.79	5.22	6.35	5.15	8.20	5.41	15.56	41.58
SE(m)±	0.68	0.91	0.93	0.12	0.3	0.05	0.07	0.05	0.14	0.58
CD (P=0.05)	2.02	2.68	2.75	0.34	0.88	0.14	0.19	0.16	0.41	1.70

thereby promoting their plant growth. The findings correspond with the results reported by Sau *et al*. (2022), indicating consensus.

Significant distinctions were observed among the various treatments in terms of the number of primary and secondary branches per plant at 60 and 90 DAS. The highest counts for primary and secondary branches at 60 and 90 DAS were recorded in treatment T2 (50% RDF + 50% RDN through VC) with values (Primary) 7.62 and 9.84 & (Secondary) 8.17 and 11.34, respectively, which in statistical terms, at par with treatment T3 (50% RDF + 50% RDN through FYM). Control treatment obtained the lowest counts, (Primary) 5.22 & 6.35 and (Secondary) 5.15 and 8.20, respectively. Due to the Enhancement in the nutritional resources accessible to plants, leading to a subsequent impact on their vegetative development. Similar findings are supported by Sau *et al*. (2022) and Singh *et al*. (2011)

Regarding the accumulation of dry matter per plant at 30, 60 and 90 DAS, treatment T2 (50% RDF + 50% RDN through VC) showed the highest values of 8.30 g plant-1, 28.34 g plant-1 and 65.53 g plant-1 at 30, 60 & 90 DAS which is statistically at par with treatment T3 (50% RDF + 50% RDN through FYM) whereas obtained lowest values in the control plot with 5.4g plant-1, 15.56g plant-1and 41.58g plant-1 respectively. Due to the taller stature of these plants offered them expanded prospects to generate and store photosynthates, resulting in a higher production of dry matter. Consequently, this phenomenon ultimately led to an augmented accumulation of dry weight. The outcomes of this study align with the discoveries of Sau *et al.* (2022).

Yield Parameters

The results demonstrated in Table 2 that all the treatments exhibited significant superiority over the control. The data shown in Table, clearly indicated that the treatment T2 (50% RDF + 50% RDN through VC) produced the maximum value of siliquae per plant (201.62), seeds per siliqua (11.87), seed yield (1564 kg ha-1) and stover yield (2848 kg ha-1) and biological yield (4413 kg ha-1) which were statistically at par with T3 (50% RDF + 50% RDN through FYM) treatment. Conversely, the control plot showed the lowest counts. The findings correspond with the results reported by Singh *et al*. (2011), stated that the application of a well-balanced provision of nutrients promotes cellular division, photosynthesis, and subsequently transitions into the reproductive stage, leading to an increased quantity of siliqua per plant and seeds per siliqua. The application of vermicompost and the immediate accessibility of nutrients from synthetic fertilizers, overall provide an impact on enhancing the nutritional conditions, consequently leading to improved growth and development, which ultimately contributed to enhanced yield and overall crop production consequently resulting in enhanced overall biomass generation. The studies are in conformity with Lepcha *et al.* (2015), Alim *et al*. (2020) and Ajnar and Namdeo (2021), Tripathi *et al* (2011) and Yadav *et al*. (2018). Harvest index showed no significant results under

Table 2. Effect of various treatments on yield parameters and economics of toria

Treatments	No. of siliquae per plant	No. of seeds per siliqua	Seed yield (Kg ha^{-1})	Stover yield (Kg ha^{-1})	Biological yield (Kg ha^{-1})	Harvest index (%)	Gross Returns (Rs ha^{-1})	Net Returns (Rs ha^{-1})	Benefit Cost ratio
T1	187.64	10.96	1450	2650	4100	35.36	84326	51041	2.53
T2	201.62	11.87	1564	2848	4413	35.45	90953	45037	1.98
T3	199.58	11.65	1527	2816	4342	35.16	88835	44768	2.02
T4	150.79	9.44	980	1898	2878	34.05	57206	23889	1.72
T5	152.62	9.74	1013	2025	3038	33.34	59259	26709	1.82
T6	178.03	10.62	1334	2468	3802	35.09	77657	32108	1.70
T7	173.41	10.44	1301	2352	3653	35.61	75609	31909	1.73
T8	147.17	9.26	854	1628	2482	34.41	49799	16849	1.51
T9	164.03	10.28	1283	2552	3835	33.46	75028	15480	1.26
T10	161.57	9.90	1222	2438	3661	33.39	71494	15644	1.28
T11	141.41	8.85	686	1311	1997	34.36	40008	7658	1.24
T12	135.10	8.30	602	1207	1809	33.27	35205	3855	1.12
SE(m)±	3.32	0.18	34.78	42.56	56.54	0.94			
CD (P=0.05)	9.79	0.52	102.67	125.61	166.88	NS			

various nutrient management system.

Economics

There was a significant disparity in the overall gross returns, net returns and benefit cost ratio of toria across various methods of nutrient management. A perusal of data presented in Table 2 demonstrated that the treatment T2 (50% RDF + 50% RDN through VC) yielded the highest gross returns (Rs.90,953) whereas control plots exhibited the lowest gross returns (Rs.35,205) compared to the other nutrient management practices.

However, in terms of net returns and benefit cost ratio, maximum values were obtained under the treatment T1 (RDF 100%) with Rs 51,041 and 2.53, respectively. In contrast, the control plot recorded the lowest counts of Rs.3855 and 1.12, respectively. Due to the incorporation of organic manure has caused an upsurge in cost of production, thereby increase the overall cost of treatments (Gudade *et al*. 2022). Higher net returns and benefit-cost ratio were obtained due to lower cost of chemical fertilizers (Varma *et al.,* 2021).

Conclusion

Based on the current investigation, it can be inferred that employing 50% RDF + 50% RDN through Vermicompost out performed other treatments plant height, number of primary and secondary branches, dry matter accumulation, number of siliquae per plant, number of seeds per siliqua, seed yield, stover yield and biological yield. As the implementation of integrated nutrient management plays a crucial role in preserving the productivity, profitability, and quality of toria. By adopting integrated nutrient management practices, the productivity and fertility of the soil are enhanced and maintained, while concurrently safeguarding the environment against pollution. As a result, farmers in toria cultivating regions are strongly encouraged to incorporate a diverse range of inputs such as biofertilizers, farmyard manure, compost, vermicompost, nano urea along with inorganic fertilizers. This comprehensive approach ensures the attainment of high-quality crops with increased yields and numerous advantages.

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