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Increasing toria yield through integrated nutrient management in Sonitpur district of Assam

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Abstract
The present study was carried out to investigate the impact of Integrated Nutrient Management (INM) on the productivity of *toria* (*Brassica rapa* var. Toria) in the rainfed agro-ecosystems of Sonitpur district, Assam, over three consecutive rabi seasons. Seventy-five farmers across five villages were selected for comparing INM practices using high-yielding toria variety TS 67 with local farmer practices. Results revealed that an average yield increase of 23% in INM plots over check plots, with the highest yield gain (26.2%) recorded in 2021-22. Soil analysis before and after the cropping seasons also demonstrated marked improvement in organic carbon (23.4% increase) and available macronutrients (N, P, K) in INM-treated fields. Economic analysis showed higher gross and net returns in demonstration plots. Yield gap analysis confirmed a reduction in both technology and extension gaps under INM.

Keywords: Toria, integrated nutrient management (INM), soil fertility, yield gap analysis, HYV

Introduction

Assam is basically an agrarian state where 85% of the farmers are small and marginal. Apart from paddy, which is the staple crop of the state, oilseed also occupies a reasonable space in the agriculture spectrum of the state. Among oilseeds, toria is one of the most important crops in the state occupying 2.85 lakh hectares of the state's cultivated land. Toria is a rabi crop grown in Assam mainly from October to February with a crop duration of 90-95 days. Production of toria in the state of Assam is 1.99 lakh tones of seed with a productivity of 698 kg/ha. This is rather a poor statistics in comparison to the national average of 1151 kg/ha. There could be many reasons that contribute to the low productivity of the crop ranging from poor nutrient management, rainfed cultivation practices, delay in sowing, moisture stress during active vegetative growth and pest and disease infestation etc. Due to combined impact of all the factors mentioned above, toria generally shows a lower productivity in the state which ultimately lead to reduction in farmer's income. Late sowing in toria mainly coupled with moisture stress during flowering affects siliqua formation and thereby leads to poor seed filling (Ojah *et al.*, 2020) [1]. Singh *et al.*, (1991) [2] reported that toria crop is very much sensitive to moisture stress during vegetative to early flowering stage.

Toria is cultivated in Sonitpur district of Assam as a rainfed crop and is particularly popular in areas where early maturing rice varieties cultivated. Oilseed occupies an area of 15734 ha in the district out of which toria occupies a major chunk. However, proper nutrient management regimes are still not followed by the farmers of the district. Improper nutrient management coupled with low yielding local varieties ultimately leads to decrease in yield of toria in Sonitpur district of Assam. Hence, present study was carried out to study the impact of integrated nutrient management (INM) on increasing yield of toria in Sonitpur district of Assam.

Materials and Methods

The study was carried out in five villages of Sonitpur district *viz* Napam, Bhalukjharoni, Samdhara, Beseria and Cheunichuk. A total of seventy five numbers of farmers were selected for the study under cluster frontline demonstration of Rabi oilseed during the year 2020-21, 2021-22 and 20222-23. Two treatments were undertaken *viz* INM plot and farmer's plot (check plot). The variety chosen for the demonstration plot was TS 67. TS 67 is a high yielding variety suitable for late sown condition.

The plant height of the variety reaches upto 103 cm and seed yield 9 q/ha with a maturity duration of 90-95 days, provided proper management practices. Toria crop was grown in both demonstration and farmer's field as a second crop after harvesting of Sali paddy.

Soil samples were collected from both demonstration and farmer's field from a depth of 0-15 cm, which were then shade dried, sieved and processed for further laboratory analysis. Soil samples were taken both before sowing and after harvest of toria crop. The soil samples were analyzed for five parameters *viz* organic carbon, pH, available nitrogen, phosphorus and potassium. The details of methodologies used for analyzing soil samples were present in Table 2.

Data for growth and yield attributing characters of the crop (plant height, no. of siliqua per plant, no. of seed per siliqua, seed yield) was recorded at the time of harvest. The details of technology (INM in demonstration plot) and farmers' practice for cultivation of Toria in the study were presented in table no 1.

From the collected data following indices were calculated out:

- Technology gap = Potential yield-demonstration yield
- Extension gap = Demonstartion yield-farmer's yield
- Technology index = (Potential yield-demonstration yield)/Potential yield

Results and Discussions

The three year study carried out during rabi season in the district of Sonitpur showed that there is an increase of 23% in toria seed yield in the demonstration plots compared to check plots. Similar findings are also reported by Ojah *et al*. (2020) [1].

Initial and final soil fertility status: Soil samples from both demonstration and farmer's plots (check plot) were analyzed to observe if there is any change in soil fertility status. The mean soil fertility values were presented in table 3. The mean value of soil pH for both demonstration and check plot showed little change. However, there was a positive shift observed in case of organic carbon over three years. There was an increase in organic carbon content (23.4%) in demonstration plots compared to check plots were recorded. Available N, P and K also showed an increasing pattern in the demonstration plots over check plots. This is attributed to combined application of chemical fertilizers as well as organic manures in the demonstration plots. In the farmer's plots toria is usually grown with residual soil fertility after harvesting of sali paddy. This shift could be due to INM practices as it improves nutrient uptake by mustard crop and hence increases nutrient use efficiency (Shekhawat, 2012) [8]. This result is in conformity with Dutta et al (2022) [9] and Ojah *et al*. (2020) [1].

Growth and yield attributing characters

Growth and yield attributing characters of both demonstration as well as check plots were presented in table no 4 in a year wise manner. Growth and yield attributing characters showed better results in demonstration plots in comparison to farmer's plots (check plots). Seed yield was found the highest in the second year (2021-22, 26.2%) than the first and third year. Over the years, an average of 23% yield increase was found in demonstration plots over check plots. This could be due to high performance of Toria var. TS 67 due to their genetic variability and environmental compatibility (Ojah *et al*., 2020) [1].

Economics of cultivation

The economic analysis of both demonstration and check plots were presented in table no. 5. It has been observed that gross return and net return were higher in demonstration plots and the third year recorded the highest gross return as well as net return (29530.00 and 9230.00 respectively). The average benefit cost ratio was found to be 1.45 in the demonstration plots for the second year which is higher than the check plots.

Yield gap analysis

Yield gap was studied by means of technology gap, extension gap and technology index that were calculated for three years and presented in the table no 6. A graphical presentation of these three indices (fig 1) showed that technology gap is lower in the second and the third year (2.3 q/ha) than the first year (2.5 q/ha). On the other hand, extension gap was found to be lowest in (1.2 q/ha) and technology index was highest (24.8%) for the first year (2020-21).

Table 1: Details of technology (INM in demonstration plot) and farmers' practice for cultivation of Toria in the study:

Particulars	Demonstration (INM)	Control
Land situation	Rainfed mediumland	Rainfed mediumland
Soil type	Sandy loam	Sandy loam
Variety used	TS 67	TS 67
Seedrate	10kg/ha	12kg/ha
Method of sowing	Line sowing	broadcasting
Time of sowing	Mid October-mid November	Mid October-mid November
Manures and fertilizers	45 kg N, 22.5 kg P_2O_5, 30 kg K_2O, B 10 kg/ha along with vermicompost 1.5 q/ha	Imbalanced fertilizer application that varied within the chosen locations
Plant protection measures	Dimethoate 30 EC @ 0.5 l /ha against Aphid	Nil

Table 2: Methods used for analyzing soil parameters

Particulars	Parameters	Analytical methods
1	Organic carbon (OC %)	Walkley and Black wet digestion method (Walkley and Black, 1934) [3]
2	pH	Glass electrode pH meter (Jackson, 1973) [4]
3	Available nitrogen	Alkaline potassium permanganate method (Subbiah and Asija, 1956) [5]
4	Available phosphorus	Olsen's method (Olsen et al., 1954) [6]
5	Available potassium	Ammonium acetate method (Merwin and Peech, 1951) [7]

Table 3: Mean values of soil fertility parameters in both demonstration and farmer's plot:

Year	Replication	Treatments	Parameters				
			pH	OC (%)	N	P	K
					(Kg/ha)		
2020-21	Initial	Demonstration	4.92	0.44	295.32	21.56	167.76
		Check	4.89	0.44	291.20	20.50	166.30
	Final	Demonstration	4.93	0.50	297.40	21.70	168.10
		Check	4.89	0.47	291.20	20.50	166.80
2021-22	Initial	Demonstration	4.92	0.41	296.10	21.56	170.76
		Check	4.89	0.37	292.10	20.50	167.30
	Final	Demonstration	4.97	0.50	298.20	21.90	170.81
		Check	4.89	0.44	293.30	20.50	167.80
2022-23	Initial	Demonstration	4.93	0.42	298.40	21.56	170.76
		Check	4.90	0.41	292.00	20.70	168.10
	Final	Demonstration	4.97	0.52	302.40	21.85	172.02
		Check	4.90	0.45	294.50	20.70	168.60

Table 4: Growth parameters and yield of demonstration and check plots

Year	Treatments	No. of siliqua/plant	No. of seed/siliqua	Plant height (cm)	Potential seed yield (q/ha)	Seed yield (q/ha)	Percent yield increase
2020-21	Demonstration	65.8	25.2	114.6	10	7.52	20%
	Check	55	17	104.5		6.3	
2021-22	Demonstration	65.2	27.5	115.2	10	7.7	26.20%
	Check	56.4	18.1	103.2		6.1	
2022-23	Demonstration	65.7	26.4	115.8	10	7.7	22.20%
	Check	55.8	18.3	104.6		6.3	

Table 5: Economic analysis of toria cultivation in both demonstration and check plots

Year	Treatments	Gross cost (Rs)	Gross return (Rs)	Net return (Rs)	B:C
2020-21	Demonstration	19854	28500	8646	1.435479
	Check	17800	23420	5620	1.31573
2021-22	Demonstration	19880	28870	8990	1.452213
	Check	17920	22500	4580	1.25558
2022-23	Demonstration	20300	29530	9230	1.45468
	Check	18430	23110	4680	1.253934

Table 6: Yield gap analysis for the years 2020-21, 2021-22 and 2022-23

Year	Technology gap (q/ha)	Extension gap (q/ha)	Technology index
2020-21	2.48	1.22	0.248
2021-22	2.3	1.6	0.23
2022-23	2.3	1.4	0.23

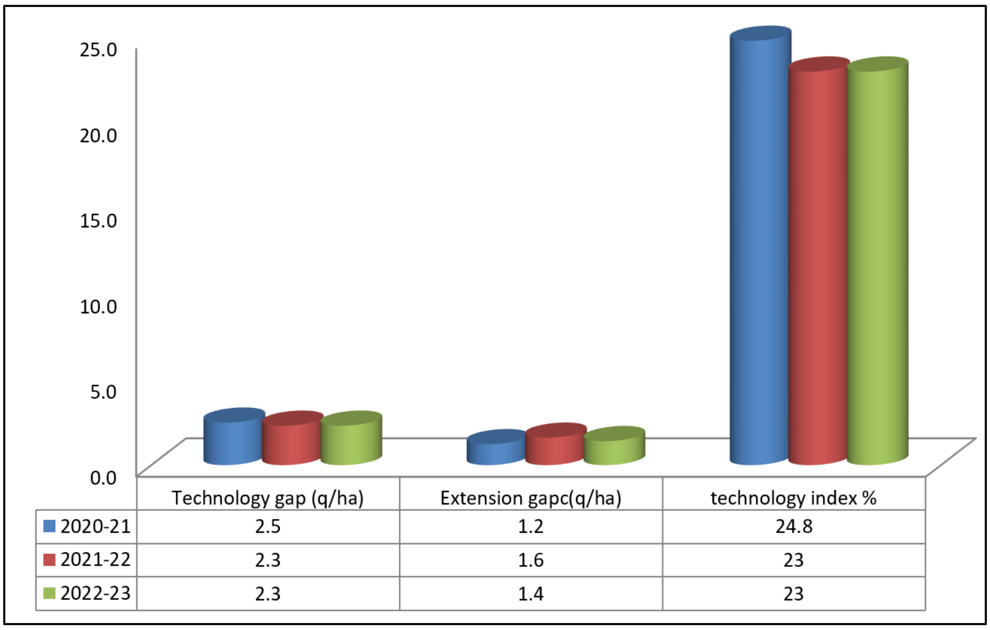

Fig 1: Graphical presentation of technology gap, extension gap and technology index for the three studied years

Conclusion

Integrated nutrient management (INM) is an approach of sustainable soil management that integrates chemical, organic and cultural methods of soil health management in order to prevent reduction in soil fertility which is occurring mainly due to injudicious use of soil fertility. The aftermath of imbalanced fertilizer uses are not only prevalent in poor soil physico chemical as well as biological heath, but it also greatly impacts crop yield. The present study delineates that INM has a positive impact on increase in toria yield in farmer's field, while maintaining soil fertility. This practice can possibly be considered as alternative to conventional toria cultivation as it can also reduce technology gap to a considerable extent, which in turn will lead to betterment of agricultural scenario of the district.

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