Bangladesh J. Bot. **44**(4): 521-528, 2015 (December)

EFFECTS OF NPKS ON GROWTH, YIELD AND QUALITY OF LATE SOWN *TORIA* VARIETIES (*BRASSICA RAPA* L. VAR. *TORIA*) UNDER RAINFED CONDITION OF NORTH EAST INDIA

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Key words: NPKS, Growth, Yield, Quality, Late sown *toria*, Rainfed condition

Abstract

Results on the effect of various levels of NPKS on *toria* varieties (*Brassica rapa* var. *toria*) revealed that the growth attributes (plant height, branches/plant, dry matter/plant) and yield attributes (siliquae/plant, seeds/silique, length of silique and 1000-seed weight), seed, stover and biological yield increased with increasing the levels of NPKS application. Application of 150% RDF, which was at par with 125% RDF but showed significantly superior to 100% RDF and the control. Similarly, the higher economics, nutrient content (NPKS) and uptake, oil, protein content of seed and their yield were also increased with increasing levels of fertilizers (NPKS) up to 150% RDF. Amongst the three *toria* varieties, TS-38 and TS-36 had significantly higher growth and yield over M-27. Similarly, the economics, nutrient content and their uptake, oil, protein content and their yield were also significantly higher in TS-38 followed by TS-36.

Introduction

India is the fourth largest oilseed economy in the world. Among the seven edible oilseeds cultivated in India, rapeseed-mustard contributes 28.6% in total oilseeds production and ranks second after groundnut sharing 27.8% in Indian oilseed economy (Shekhawat *et al.*2012). It is estimated that 58 million tons of oilseeds will be required by the year 2020, wherein the share of rapeseed-mustard will be around 24.2 million tons (Bartaria *et al.* 2001). Rapeseed-mustard group broadly includes Indian mustard, yellow sarson, brown sarson, raya and *toria* crops. Crop can be raised well under both irrigated and rainfed condition. Brown sarson (*Brassica rapa* var. *sarson*) has two ecotypes lotni and *toria*. *Toria* (*Brassica rapa*) on other hand is cultivated in limited areas of foot hill condition of North East India. Adoption of improved varieties is important factor for enhancing the productivity and sustainability (Panwar *et al.* 2000). Improved varieties of rapseed-mustard stabilize the seed and oil yield through insulation of cultivars against the major biotic and abiotic stresses enhance the oil (low erucic acid) and seed meal (low glucosinolate) quality. *Toria* crop is obviously low yielding but it responds well to an adequate fertilization (Dhanki *et al*. 2004, Jadhav *et al.* 2012, Sharma 2013a). Hence, the present study was conducted to determine the effect of different levels of NPKS on productivity, profitability and quality in relation to late sown *toria* varieties under rainfed condition of Eastern Himalaya.

Materials and Methods

Field experiment was conducted during *rabi* (winter) season of 2010 - 2012 at Agricultural Research Farm of ICAR Nagaland Centre Jharnapani, Nagaland, located at 25.45^0 N latitude 93.53^0 E longitude with mean altitude of 281 m above mean sea level. The experimental soil was

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sandy loam with pH 5.32, analysing medium in organic carbon (0.58%), low in available N (175.4 kg/ha) and K_2O (138.5 kg/ha) and moderate in available P_2O_5 (11.0 kg/ha) as well as available sulphur (15.8 kg/ha). Experiment was laid out in split plot design with 3 replications having 12 treatment combinations involving the four fertility levels (control, 100, 125 and 150% RDF) in main plots and three varieties of *toria* (TS-38, TS-36 and M-27) as sub plots. Recommended dose of fertilizers *viz.* 60 kg N, 40 kg P_2O_5, 40 kg K_2O and 30 kg S/ha (100% RDF) were applied through urea (46% N), DAP (18% N and 46% P_2O_5), MOP (60% K_2O) and elemental sulphur (90% S), respectively. Sulphur was applied as per treatment two weeks before the sowing. Half of the entire quantity of N and full quantity of P and K were applied as basal and remaining dose of N was top dressed after one month of sowing. The crop was sown in rows of 30 cm apart with seed rate of 5 kg/ha. Thinning was done 10 - 15 days after sowing to maintain the plant to plant distance of 10 cm. The crops were harvested at physiological maturity. The data was collected on *viz.* plant height, branches/plant, dry matter production and yield attributes *viz.* siliquae/plant, seeds/silique, silique length, 1000-seed weight and yields at harvest. The oil (Soxhlet method) and protein content was estimated. Seed and stover samples were analysed for NPKS content as per the standard procedure. Data were statistically analyzed as per method suggested by Gomez and Gomez (1984).

Results and Discussion

Results from Table 1 revealed that application of various nutrient levels differed significantly in respect of growth and yield attributes *viz.*, plant height, branches/plant, dry matter production/plant, siliquae/plant, seeds/silique, silique length and 1000-seed weight. Taller plants with higher branches and more dry matter production of *toria* were recorded at the highest fertility level of 150% RDF, which was statistically similar with that of 125% RDF and was significantly superior to 100% RDF and the control. The higher in dry matter production with higher fertility levels i.e. 150% RDF of the crop could be attributed to better nutrition to plants resulted in more plant height and number of branches/plant, which resulted in better light interception and accumulation of more photosynhates. The information is corroborated with the findings of Patil and Acharya (2009) and Singh *et al.* (2010). A similar reflection was also observed in yield attributes. Many researchers have reported positive response of fertilizers on growth and yield attributes of *toria* (Jadhav *et al.* 2012, Meena *et al*. 2013).

Seed, stover and biological yield of *toria* varieties were significantly increased with nutrient levels (Table 2). The highest yield of seed (1411 kg/ha), stover (2866 kg/ha) and dry matter (4277 kg/ha) were recorded at 150% RDF, which was at par with 125% RDF. Similar results were also reported by Ghimire and Bana (2011), Singh *et al*. (2010), Sharma (2013b).

Oil and protein content in *toria* seed and their yield were influenced by different nutrient levels (Tables 3 and 4). Oil content was significantly higher with 100% RDF over control but 125% RDF and 150% RDF were recorded statistically at par. It is established fact that nitrogen has an adverse affect on oil content of mustard. The reduction in oil due to higher rate of nitrogen appears to be due to conversion of carbohydrates into protein. Thus, the amount of carbohydrates left to get converted into fats is too low as compared to other low nitrogen treated plants. Similar findings were reported by Singh *et al.* (2010). Oil yield increased significantly due to fertilizer application up to 150% RDF because of increased seed yield of *toria* varieties. However, protein content and yield increased up to 150% RDF, which was statistically similar with 125% RDF and significantly higher than those of 100% RDF and control (Tables 3 and 4). This might be due to the more accumulation of nitrogen in seed under higher supplies of nutrients. These findings are in close conformity with those of Malik *et al*. (2006).

Table 1. Effects of different nutrient levels on growth and yield attributes on *toria* varieties (pooled data of two years).

Treatments	Plant height (cm)	Branches/plant (No.)	Dry matter production (g)	Siliquae/plant (No.)	Seeds/siliqua (No.)	Siliqua length (cm)	1000-seed weight (g)
Nutrient levels							
Control	65.14	2.96	56.67	120.26	5.79	12.60	4.09
100% RDF	73.81	4.11	64.14	135.97	7.64	13.64	4.38
125% "	82.29	4.72	71.03	149.56	8.84	14.50	5.02
150% "	87.06	5.13	76.54	154.40	9.36	14.95	5.35
SEm ±	1.26	0.10	1.45	3.66	0.19	0.25	0.18
LSD (p = 0.05)	4.37	0.36	5.01	12.65	0.67	0.85	0.61
Varieties							
TS-38	81.41	4.62	71.73	149.88	9.02	14.50	5.15
TS-36	77.33	4.24	66.45	138.25	7.50	13.42	4.59
M-27	72.49	3.82	63.11	132.01	7.21	13.84	4.39
SEm±	1.20	0.06	1.04	2.54	0.18	0.19	0.18
LSD (p = 0.05)	3.60	0.18	3.12	7.61	0.55	0.57	0.55

*RDF (60, 40, 40, 30 kg N, P_2O_5, K_2O and S/ha).

Table 2. Effects of different nutrient levels on yield and economics on *toria* varieties (pooled data of two years)

Treatment	Seed yield (kg/ha)	Stover yield (kg/ha)	Biological yield (kg/ha)	Gross return (`/ha)	Net return (`/ha)	B : C ratio	Production efficiency (kg/ha/day)	Economic efficiency (`/ha/day)
Nutrient levels								
Control	960	2031	2991	38953	24826	1.76	11.29	292
100% RDF	1249	2558	3807	50255	32834	1.88	14.69	386
125% "	1373	2770	4143	55048	36804	2.02	16.16	433
150% "	1411	2866	4277	56647	37809	2.00	16.60	445
SEm±	25	54	68	897	897	0.03	0.29	11
LSD (P = 0.05)	87	186	236	3104	3104	0.11	1.02	37
Varieties								
TS-38	1343	2635	3978	53459	36302	2.09	15.80	427
TS-36	1230	2570	3800	49749	32591	1.89	14.47	383
M-27	1172	2463	3635	47470	30313	1.77	13.79	357
SEm±	15	26	34	499	499	0.03	0.17	6
LSD (p = 0.05)	44	79	101	1496	1496	0.10	0.52	18

Table 3. Effects of different fertility levels on NPKS, protein and oil content (%) of *toria* varieties (pooled data of two years).

Treatments	N		P		K		S		Seed	
	Seed	Stover	Seed	Stover	Seed	Stover	Seed	Stover	Protein	Oil
Nutrient levels										
Control	2.68	0.31	1.00	0.87	1.64	1.03	1.79	0.34	16.73	36.85
100% RDF	2.87	0.35	1.10	0.95	1.79	1.12	1.99	0.38	17.97	36.16
125% "	3.12	0.40	1.20	1.06	1.96	1.23	2.15	0.41	19.48	33.81
150% "	3.21	0.42	1.22	1.08	2.00	1.27	2.19	0.42	20.04	31.70
SEm±	0.05	0.01	0.02	0.02	0.04	0.02	0.04	0.01	0.32	0.56
LSD ($p = 0.05$)	0.18	0.03	0.07	0.07	0.12	0.07	0.14	0.02	1.11	1.94
Varieties										
TS-38	3.09	0.40	1.19	1.05	1.91	1.21	2.11	0.41	19.33	35.23
TS-36	3.04	0.38	1.15	1.01	1.88	1.17	2.06	0.40	19.02	34.58
M-27	2.77	0.33	1.06	0.91	1.75	1.11	1.93	0.36	17.31	34.09
SEm±	0.03	0.01	0.02	0.02	0.02	0.02	0.03	0.01	0.21	0.41
LSD ($p = 0.05$)	0.10	0.03	0.06	0.05	0.07	0.05	0.08	0.02	0.63	1.22

Table 4. Effects of nutrient levels on nutrient uptake, protein and oil yield of *toria* varieties (pooled data of two years).

Treatment	N		P		K		S		Seed	
	Grain	Stover	Grain	Stover	Grain	Stover	Grain	Stover	Protein yield (kg/ha)	Oil yield (kg/ha)
Fertility levels										
Control	25.68	6.31	9.60	17.64	15.72	20.91	17.20	6.95	160.52	304.30
100% RDF	36.01	9.01	13.80	24.43	22.38	28.80	24.98	9.79	225.05	422.01
125% "	43.03	11.06	16.53	29.41	26.94	34.01	29.57	11.39	268.96	497.54
150% "	45.18	11.83	17.26	31.03	28.20	36.52	30.75	12.06	282.40	520.74
SEm±	1.07	0.27	0.44	0.93	0.81	1.19	0.92	0.35	6.71	10.72
LSD (p = 0.05)	3.71	0.94	1.52	3.22	2.81	4.13	3.19	1.21	23.21	37.11
Varieties										
TS-38	42.09	10.81	16.10	28.03	25.91	32.15	28.34	10.97	263.09	479.54
TS-36	37.84	9.65	14.28	26.27	23.30	30.47	25.63	10.27	236.49	428.24
M-27	32.50	8.21	12.52	22.59	20.73	27.57	22.89	8.90	203.13	400.67
SEm±	0.74	0.25	0.39	0.61	0.46	0.48	0.54	0.23	4.61	6.57
LSD (p = 0.05)	2.21	0.74	1.16	1.84	1.38	1.45	1.62	0.68	13.83	19.70

Nutrient content and uptake (NPKS) in seed as well as stover was influenced by fertility levels (Tables 3 and 4). Higher nutrient content and uptake in seed and stover were recorded with the highest dose of fertilizer but remained at par with moderate doses of fertilizer applied. Similarly, NPKS uptake by seed was increased with increasing levels of fertility and the maximum uptake of NPKS were recorded with 150% RDF but it was statistically similar to 100% RDF. NPKS uptake followed a similar trend in stover yield in respective treatments. This may be attributed to the higher NPKS content in seed and stover and higher biological yield. Ghimire and Bana (2011) and Meena *et al.* (2013) reported similar findings in mustard crop.

Gross return, net return, B: C ratio, production efficiency and economic efficiency were significantly improved by different fertility levels in most of the cases (Table 2). The highest gross return (`56,647/ha), net returns (' 37,809/ha), production efficiency (16.6 kg/ha/day) and economic efficiency (` 445/ha/day) were realized with 150% RDF. Whereas, the maximum B: C ratio (2.02) was recorded with application of 125% RDF it was at par with 150% RDF. This might be due to higher productivity of crop in this treatment. Similar findings were also made those of Singh *et al.* (2010) and Sharma (2013a) in mustard.

Among the *toria* varieties, TS-38 and TS-36 remained at par and showed significantly higher values of growth and yield attributes over M-27. Toria var. M-27 revealed the lowest growth and yield attributes (Table 1). The varietals differences in *toria* cultivars were also reported by Pati and Acharya (2009) and Jadhav *et al*. (2012).

TS-38 being at par to TS-36 produced significantly higher seed yield, stover yield and biological yield over M-27 (Table 2). Toria var. TS-38 recorded seed yield of 1343 kg/ha and stover of 2635 kg/ha, which in turn recorded 14.6 and 7% higher seed and stover yield than M-27, respectively. Increase in growth attributes and longer duration resulted in better reproductive growth and caused an increase in number of branches, number of siliquae/plant and higher 1000-seed weight in the variety of TS-38 and TS-36 as compared to M-27. Similar findings, indicating the varietal differences for various yield attributes have also been reported by Panwar *et al*. (2000), Mina *et al.* (2003) and Jadhav *et al.* (2012).

Among the *toria* varieties, TS-38 recorded the maximum gross returns of ` 53,459/ha, net returns of ` 36,302/ha and B: C ratio of 2.09 which were significantly superior over TS-36 and M-27. Similarly, the higher production efficiency of 15.8 kg/ha/day and economic efficiency of ` 427/ha/day was also recorded for TS-38. This might be ascribed to higher seed and stover yields of the variety. Similar results were also made by Singh *et al.* (2010) and Meena *et al.* (2013) in mustard.

Higher oil and protein content was recorded in TS-38 and TS-36, whereas, the lowest was in M-27 (Table 3). Similarly, the highest oil and protein yields were also found with TS-38 which was significantly superior to TS-36 and M-27. *Toria* var. TS-38 being statistically similar to TS-36 and significantly better to nutrient content in seed and stover over M-27 (Table 4). Similarly higher uptake of N, P, K and S by seed as well as stover were observed in TS-38, which was significantly superior over TS-36 and M-37.

It is observed that among the three varieties, TS-38 was found very responsive in producing the maximum value in the form of economic traits like seed and oil yield index while grown with fertilizer application of 125% RDF.

Acknowledgments

The authors expressed their gratitude to the Joint Director ICAR RC Nagaland Centre, Jharnapani for providing the necessary facilities while conducting the experiment. Author is grateful to the tribal sub plan project (TSP) for providing the financial support for demonstration the experiment.

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(Manuscript received on 24 December, 2014: revised on 1 April 2015)