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Subhasmita Mishra
M.Sc. Scholar, Department of Agronomy, Naini Agricultural Institute, SHUATS, Prayagraj, Uttar Pradesh, India

Victor Debbarma
Assistant Professor, Department of Agronomy, Naini Agricultural Institute, SHUATS, Prayagraj, Uttar Pradesh, India

Corresponding Author:
Subhasmita Mishra
M.Sc. Scholar, Department of Agronomy, Naini Agricultural Institute, SHUATS, Prayagraj, Uttar Pradesh, India

Effect of nitrogen and weed management on growth and yield of Toria (*Brassica rapa* L.)

Subhasmita Mishra and Victor Debbarma

Abstract
A field experiment was conducted during *Rabi* 2021-22 at Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology And Sciences, Prayagraj, Uttar Pradesh, India to determine the "Effect of Nitrogen and Weed management on growth and yield of Toria (*Brassica rapa* L.)". The experiment was laid out on Randomized Block Design with nine treatments each replicated thrice on the basis of one year experimentation. The results showed that treatment-7 (50 kg/ha N + Hand Weeding) was recorded significantly higher plant height (112.22 cm), maximum dry weight (16.47 g/plant), maximum Number of Siliquae/plant (197.08), Number of Seeds/Siliquae (20.38), Test weight (3.81 g), Seed yield (1.48 t/ha) and Stover yield (3.61 t/ha) as compared to other treatments. Whereas significantly highest Crop growth rate (7.04 g/m^2/day) was recorded with the treatment-6 (40 kg/ha N + Weedy check).

Keywords: toria, nitrogen, hand weeding, weedy check, growth parameters and yield attributes

Introduction
Rapeseed (*Brassica campestris* var. toria) commonly known as raya, rai or lahi is an important oilseed crop among the Brassica group of oilseed in India. It's the second most important edible oilseed crop in India after groundnut and accounts for nearly 30% of the total oilseeds produced in the country**.** Indian mustard has multiple uses as a spice or condiment in preparation, seasoning and stuffing of several foods and pickles in India. Yield potential of this crop can be explored by the use of agronomic-techniques. The oil is utilized for human consumption throughout northern India in cooking and frying purposes. The whole seed is used as condiment in the preparation of pickles and for flavoring curries and vegetables. The mustard oil is also used in preparing vegetable ghee, hair oil, medicines, soaps, lubricating oil and in tanning industries. The oil content in mustard seeds varies from 37-49% (Bhowmik *et al.*, 2014) [1]. The oil cake is left after extraction is utilized as cattle feed and manure. It contains 25-30% crude protein, 5% nitrogen, 1.8-2.0% phosphorous and 1.0-1.2% potassium.
The top producer of rape seed-by far - is Canada (19.49 million metric tons) in 2021, followed by Europe (16.73 million metric tons), China ranking the third place by production of rape seed by producing (14.05 million metric tons) and India having the fourth place by producing (8.50 million metric tons) followed by Kazakhstan by producing (4.76 million metric tons). Hence, the total production of rape seed in the world is (73.88 million metric tons) in 2020-21. The total production of rape seed in India 2020-2021 was (8.5 million metric tons). The total area of rape seed in world 2020-21 was (34.90 million hectare) and in India (6.70 million hectare) USDA, 2022) [18]. Rajasthan being in the first number of rape seed production in India has contributed (4.51 million tons) of the total production followed by Madhya Pradesh (1.31 million tons) and Haryana ranking the 3rd place by contributing (1.28 million tons). The higher area is reported from the states Rajasthan (10.60 lakh ha), Madhya Pradesh (3.99 lakh ha), Haryana (1.46 lakh ha). The area of rape seed in Uttar Pradesh was (0.58 lakh ha). Hence, Uttar Pradesh has contributed (10.60%) of the total production of rape seed in India 2020-21 (GOI, 2021) [3].
Nitrogen is considered to be the most important nutrient for the crop to activate the metabolic activity and transformation of energy, chlorophyll and protein synthesis. Nitrogen is considered to be the most important nutrient for the crop to activate the metabolic activity and transformation of energy, chlorophyll and protein synthesis. Nitrogen also affects uptake of other essential nutrients and it helps in the better partitioning of photosynthates to reproductive parts which increased the seed: stover ratio (Singh and Meena, 2004) [15].
Weed competition in Indian mustard is more serious during early stage; because crop growth

during winter (rabi) season remains slow during the first 4-6 weeks after sowing (Chauhan *et al.*, 2005) [2]. Prevalence of higher temperature and availability of adequate moisture due to irrigation and adequate preparatory tillage provide most congenial conditions for quick growth of weeds in rabi season. Weeds are one of the major constraints for the poor yield of mustard crop as they compete with the crop plants for moisture, nutrients, light and space. Approximately, 20- 30 per-cent yield reduction cause by weeds in rape/mustard crop. Among the various factors, which influence the crop production, weed flora a single negative factor and serious menace, which plays key role for achieving high yield potential in any crop. The weeds cause substantial losses to agricultural production. Estimates showed that in India, weeds cause an annual monetary loss of 1980 million (Mukhopadhyay, 1992) [12]. Weed problem is one of the major barriers which responsible for low productivity of mustard because yields. Weeds compete with the crop for light, nutrient, water and carbon dioxide (Rao, 2000) [17] reported that reduction in crop yield has a direct correlation with weed competition. Thus the present investigation entitled, "Effect of Nitrogen and Weed management on growth and yield of toria (*Brassica rapa* L.)" was carried out at Crop Research Farm of Naini Agricultural Institute, Sam Higginbottom University of Agriculture Technology And Sciences, Prayagraj during Rabi Season 2021-22 for Toria crop.

Materials and Methods

This experiment was carried out during *Rabi* 2021-22 at Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture Technology And Sciences, Prayagraj, (U.P), which is located at 25.28ºN latitude, 81.54ºE longitude and 98 meters altitude above the mean sea level (MSL). The size of the each plot was (3 m x 3 m). The experiment was conducted in Randomized Block Design (RBD) with nine treatments each replicated thrice. The crop was sown on 21 October 2021 using variety T9. The treatments details are T1 30 kg/ha N + Hand Weeding, T2: 30 kg/ha N + Quizalofop ethyl, T3: 30 kg/ha N + Weedy check30 kg/ha N + Weedy check, T4: 40 kg/ha N + Hand Weeding, T5: 40 kg/ha N + Quizalofop ethyl, T6: 40 kg/ha N + Weedy check, T7: 50 kg/ha N + Hand Weeding, T8: 50 kg/ha N + Quizalofop ethyl and T9: 50kg/ha N + Weedy check. Growth parameters are plant height, plant dry weight and crop growth rate and the yield parameters like number of siliquae/plant, number of seeds/siliquae in yield, test weight, seed yield and stover yield were recorded and statistically analyzed using analysis of variance (ANOVA) as applicable to Randomized Block Design.

Results and Discussion

Effect of Nitrogen and weed management on growth attributes of Toria.

Plant height (cm)

At Harvest, significantly higher plant height (112.22 cm) was recorded in treatment 7 (50 kg/ha N + Hand Weeding). However, the treatment 8 (50 kg/ha N + Quizalofop ethyl) (111.87 cm) and treatment 4 (40 kg/ha N + Hand Weeding) was found to be statistically at par with 7 (50 kg/ha N + Hand Weeding). Significant and higher plant height was recorded with the application of (N 50 kg/ha) might be due to the mineral nitrogen and the carbohydrates synthesized in the green part of the plant are metabolized into amino-acid and family of the protein which allowed the plants to grow faster. The similar finding also reported by (Raghuvanshi *et al.*, 2018) [16]. Further, Plant height of mustard was significantly influenced under weed control treatments better growth and development of the crop under competition free environment with effective control of weeds due to different treatments showed influence on the formation of higher yield contributing characters. The similar results were obtained with (Kumar *et al.*, 2012) [8].

Plant dry weight (g/plant)

At Harvest, significantly maximum dry weight (16.47 g/plant) was recorded in the treatment 7 (50 kg/ha N + Hand Weeding) over the other treatments. However, treatment 8 (50 kg/ha N + Quizalofop ethyl) which were found to be statistically at par with 7 (50 kg/ha N + Hand Weeding) as compared to other treatments. Significant and maximum plant dry weight was recorded with the application of (N 50 kg/ha) might be due to the the positive effects of higher dose of N might be attributed to their direct role in formation of protoplasm and chlorophyll molecule in the leaf cells resulting in increased photosynthetically active leaf area. At harvest, highest dry matter accumulation was found at N3. The similar finding also reported by (Mahapatra *et al.*, 2019) [7]. Further, It might be due to the fact that both these herbicides when applied as pre-emergence and post-emergence suppresses the weed growth efficiently which is supplemented by hand weeding and inter culturing at the crucial stage of crop growth which checks the weed growth and resulted in better plant growth. This results were found to be in accordance with (Jangir *et al.*, 2017) [4].

Crop Growth Rate (g/m^2/day)

At 80 DAS-At Harvest interval, treatment with 6 (40 kg/ha N + Weedy check) was recorded with significantly highest Crop growth rate (7.04 g/m^2/day) over all the treatments. However, the treatment 3 (30 kg/ha N + Weedy check) (6.91 g/m^2/day) and treatment 7 (50 kg/ha N + Hand Weeding) which were found to be statistically at par with treatment 6 (40 kg/ha N + Weedy check).

Significant and higher crop growth rate was recorded with the application of (N 50 kg/ha) might be due to the all essential plant nutrients, its incorporation in soil promotes rapid vegetative growth and branching, thereby increasing the sink size in terms of flowering, fruiting and seed setting. This results were found to be in accordance with (Kumar *et al.*, 2017) [4].

Effect of Nitrogen and Weed management on yield and yield attributes of Toria

Number of Siliquae/plant

Significantly Maximum Number of Siliquae/plant (197.08) was recorded in treatment 7 (50 kg/ha N + Hand Weeding) over all the treatments. However, the treatment 8 (50 kg/ha N + Quizalofop ethyl) (195.21) which were found to be statistically at par with treatment 7 (50 kg/ha N + Hand Weeding).Significant and maximum number of Siliquae/plant was recorded with the application of (N 50 kg/ha) It might be due to nitrogen being the constituents of amino acids, protein, chlorophyll and protoplast would directly influence the growth and yield attributing characteristics through better utilization of photosynthates. The similar results were obtained with (Lalrammawii *et al*,. 2021) [9]. Further, in

addition the increase in yield attributes was mainly due to increase in photosynthesis activity of leaves, translocation of photosynthates from source to sink and nutrients uptake under higher nutrients availability in weed management. The similar finding also reported by (Singh *et al.,* 2020) [14].

Number of Seeds/Siliquae

Significantly Maximum Number of Seeds/Siliquae (20.38) was recorded in treatment 7 (50 kg/ha N + Hand Weeding) over all the treatments. However, the treatment 8 (50 kg/ha N + Quizalofop ethyl) (20.22) which were found to be statistically at par with treatment 7 (50 kg/ha N + Hand Weeding). Significant and maximum number of seed/siliquae was recorded with the application of (N 50 kg/ha). It might be due to the higher seed number per siliqua in N5D1 interaction implicated that in lower densities, due to lesser competition within the plants and a sufficient light intensity as a potent source for increasing crop biomass, higher dry matter accumulated in siliqua. The similar finding also reported by (Keivanrad *et al.,* 2012) [5]. Further, this might be due to adequate nutrient availability and less competition to weeds, which contributed to better growth parameters and yield attributes. Productivity of crop collectively determined by vigor of the vegetative growth and yield attributes which resulted in higher seed and straw yield. The similar results were obtained with (Singh *et al.,* 2020) [14].

Test weight (g)

Significantly highest Test weight (3.81 g) was recorded in treatment 7 (50 kg/ha N + Hand Weeding) over all the treatments. However, the treatments 8 (50 kg/ha N + Quizalofop ethyl) (3.70 g) which were found to be statistically at par with treatment 7 (50 kg/ha N + Hand Weeding). Significantly highest Test weight (3.81 g) was recorded in treatment 7 (50 kg/ha N + Hand Weeding). As, The increased seed yield ha in these treatment might be the cumulative effect of more number of siliquae/plant, more test weight and more seed yield (g) plant as well as higher weed control efficiency and lower total weed count as evidenced from the data creating the situation of lesser crop weed competition without any side effect. The similar results were obtained with (Mankar *et al.,* 2015) [10].

Seed yield (t/ha)

Significantly higher Seed yield (1.48 t/ha) was recorded in treatment 7 (50 kg/ha N + Hand Weeding) over all the treatments. However, the treatment 8 (50 kg/ha N + Quizalofop ethyl) (1.41 t/ha) which were found to be statistically at par with treatment 7 (50 kg/ha N + Hand Weeding). Significant and higher in seed yield was recorded with the application of (N 50 kg/ha) might be due to the Adequate supply of nitrogen facilitated better growth and development of crop plant, enhanced nutrient content and resulted in a significant increase in yield attributes. The similar results were obtained with (Raghuvanshi *et al.,* 2018) [16]. Further, the increase in growth and yield attributes under these treatments might be attributed due to the reduction in weed competitiveness with the crop which ultimately favoured better environment for growth and development of crop. The highest yield under farmers practice of two hand weedings at 20 and 35 DAS was due to the fact that this treatment controlled early as well as late flushes of weeds and provided weed free environment to the crop during critical period of crop weed competition. The similar results were obtained with (Mundra and Maliwal 2012) [13].

Stover yield (t/ha)

Significantly higher Stover yield (3.61 t/ha) was recorded in treatment 7 (50 kg/ha N + Hand Weeding) over all the treatments. However, the treatment 8 (50 kg/ha N + Quizalofop ethyl) (3.52 t/ha) which were found to be statistically at par with treatment 7 (50 kg/ha N + Hand Weeding). Significant and higher in stover yield was recorded with the application of (N 50 kg/ha) might be due to the nitrogen being the basic constituent of chlorophyll, protein and cellulose required for the process of photosynthesis and tissue formation for proper growth and thereby increasing the yield attributes. This results were found to be in accordance with (Keerthi *et al.,* 2017) [6]. Further, increase in stover yield of mustard might be due to luxurious crop growth and less crop weed competition This results were found to be in accordance with (Mankar *et al.,* 2015) [10].

Dry weight of weeds

Maximum dry weight (30.5 g/plant) was recorded in treatment 9 (50 kg/ha N + weedy check), whereas the minimum dry weight (21.7 g/plant) was recorded in treatment 5 (40 kg/ha N + Quizalofop ethyl). This might be due to effective weed control achieved under the efficient method of weed management in terms of lower weed population per unit area and less availability of underground (nutrient and moisture) and above-ground resources (light) to weeds due to more competitive and smothering effect of crop, resulting lower biomass of weeds and higher weed control efficiency. This results were found to be in accordance with (Jangir *et al.,* 2017) [4].

Table 1: Effect of Nitrogen and Weed management on Growth and Yield of Toria

Treatments	Plant height (g/plant)	Plant dry weight (g/plant)	Crop growth rate (g/m^2/day)
30 kg/ha N + Hand Weeding	109.79	15.75	6.38
30 kg/ha N + Quizalofop ethyl	108.90	15.43	6.43
30 kg/ha N + Weedy check	108.48	15.20	6.91
40 kg/ha N + Hand Weeding	111.55	16.23	6.54
40 kg/ha N + Quizalofop ethyl	110.20	15.93	6.15
40 kg/ha N + Weedy check	109.43	15.62	7.04
50 kg/ha N + Hand Weeding	112.22	16.47	6.82
50 kg/ha N + Quizalofop ethyl	111.87	16.37	6.42
50 kg/ha N + Weedy check	111.10	16.05	6.43
F test	S	S	S
S. EM (±)	0.23	0.06	0.14
CD (P = 0.05)	0.69	0.17	0.42

Table 2: Effect of Nitrogen and Weed management on Yield and Yield attributes of Toria

Treatments	Siliquae/plant	Seeds/siliquae	Test Weight (g)	Seed yield (t/ha)	Stover yield (t/ha)
30 kg/ha N + Hand Weeding	184.64	18.73	3.08	1.20	3.16
30 kg/ha N + Quizalofop ethyl	179.15	18.10	2.86	1.13	2.96
30 kg/ha N + Weedy check	176.63	17.78	2.74	1.01	2.84
40 kg/ha N + Hand Weeding	192.49	19.64	3.57	1.38	3.46
40 kg/ha N + Quizalofop ethyl	187.54	19.06	3.26	1.26	3.30
40 kg/ha N + Weedy check	181.47	18.47	2.97	1.18	3.08
50 kg/ha N + Hand Weeding	197.08	20.38	3.81	1.48	3.61
50 kg/ha N + Quizalofop ethyl	195.21	20.22	3.70	1.41	3.52
50 kg/ha N + Weedy check	190.58	19.39	3.45	1.33	3.36
F test	**S**	**S**	**S**	**S**	**S**
S. EM (±)	0.72	0.08	0.05	0.03	0.04
CD (P = 0.05)	2.16	0.23	0.14	0.08	0.11

Table 3: Effect of Nitrogen and weed management on weed dry weight (g/weed plant) of Toria

Treatments	Weed dry weight (g/plant)				
	20 DAS	**40 DAS**	**60 DAS**	**80 DAS**	**At Harvest**
30 kg/ha N + Hand Weeding	1.6	6.0	18.3	26.0	27.9
30 kg/ha N + Quizalofop ethyl	1.9	3.0	16.9	23.9	26.4
30 kg/ha N + Weedy check	1.4	7.7	23.2	22.9	24.6
40 kg/ha N + Hand Weeding	1.5	7.5	17.2	20.6	25.7
40 kg/ha N + Quizalofop ethyl	1.8	5.7	15.1	25.9	21.7
40 kg/ha N + Weedy check	1.9	5.6	16.4	24.7	23.3
50 kg/ha N + Hand Weeding	1.5	7.4	16.2	25.9	21.9
50 kg/ha N + Quizalofop ethyl	1.7	6.5	17.1	26.2	29.3
50 kg/ha N + Weedy check	2.3	8.2	26.3	27.1	30.5
F test	S	NS	NS	NS	NS
S. EM (±)	0.21	1.01	1.71	1.29	3.11
CD (P = 0.05)	0.63	3.03	5.14	3.88	9.33

Conclusion

It is concluded that application of 50 kg/ha N with Hand Weeding (treatment no 7) has performed better in growth parameters and yield attributes of Toria and also recorded significantly higher Seed yield as compared to other treatments. Since, the findings was based on the research done in one season it may be repeated further for conformation and recommendation.

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