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Amal Vijay VS
M.Sc. Scholar, Department of Agronomy, Naini Agricultural Institute, SHUATS, Prayagraj, Uttar Pradesh, India

Akankhya Pradhan
Ph.D Scholar, Department of Agronomy, Naini Agricultural Institute, SHUATS, Prayagraj, Uttar Pradesh, India

Kumar Raj
Ph.D Scholar, Department of Agronomy, Naini Agricultural Institute, SHUATS, Prayagraj, Uttar Pradesh, India

Rajesh Singh
Professor, Department of Agronomy, Naini Agricultural Institute, SHUATS, Prayagraj, Uttar Pradesh, India

Corresponding Author:
Amal Vijay VS
M.Sc. Scholar, Department of Agronomy, Naini Agricultural Institute, SHUATS, Prayagraj, Uttar Pradesh, India

Effect of direction of sowing and phosphorus levels on yield attributes and economics of toria (*Brassica campestris* L.

Amal Vijay VS, Akankhya Pradhan, Kumar Raj and Rajesh Singh

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Abstract
A field experiment was conducted during Rabi season 2024 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P) on Toria. The soil of experimental plot was sandy loam in texture, low in organic carbon (0.72%), nearly neutral in soil Ph (7.2), Nitrogen (178.48 kg/ha), Phosphorous (27.80 kg/ha), Potassium (233.24 kg/ha). The Treatment consist of Direction of sowing (North-South, East-West, Control (NW-SE)) and Phosphorus (50, 60, 70 kg/ha) levels. The experiment was carried out in a randomized block design with ten treatments and were replicated thrice. The results revealed that significantly higher number of Siliqua/plant (222.40), number of seeds/Siliqua (19.40), seed yield (2.22 t/ha), stover yield (8.32 t/ha), Maximum gross return (INR 127400.00/ha), net returns (INR 84094.00/ha) and benefit cost ratio (1.94) were obtained in the treatment T_5 (East-West + 60 kg/ha P) in Toria crop.

Keywords: Toria, direction, growth, yield and economics

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. In Uttar Pradesh Toria crop was grown on an area of about 1.64 million hectares with a production of 0.53 million tones and the productivity of 831 kg ha^{-1}. The food grain demand of India will increase to about 291m ton by 2025 and to 377 m ton by 2050. The leaves of young plant are used as green vegetable as they supply enough Sulphur and minerals in the diet. In the tanning industry, mustard oils is used for softening leather.
The yield of the Indian mustard crop depends on the crop phenotype and the direction of sowing. Actual evapotranspiration (AET), water usage efficiency (WUE), and radiation interception all vary depending on the direction of planting, which causes variations in the biomass output of Indian mustard. Jha *et al.* (2015) [3] investigated how the Indian mustard's orientation of sowing affected its ability to intercept solar energy.
The second important nutritional component needed for crop growth and high-quality output is phosphorus (P). The root system of plants is where P has the most noticeable impact. It encourages siliqua flowering and setting, and it increases siliqua size and yield. Numerous significant substances, including as ATP, phospholipids, and nucleic acids, include phosphorus. In legume crops, it is advantageous for root development, robust growth, increased yield and quality, and nodule formation. It is also necessary for energy maintenance and transmission, as well as genetic trait transfer. Phosphorus-deficient plants grow more slowly and typically have a lower shoot-to-root dry matter ratio. Tillering is impacted in cereal crops. P shortage has a significant impact on fruit and seed production in fruit plants.

Materials and Methods
The experiment was conducted during the Rabi season 2024, at the Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences (SHUATS), Prayagraj (U.P.) which is located at 250

30’ 42’’N latitude, 810 60’ 56” E longitude and 98 m altitude above the mean sea level (MSL). This area is situated on the right side of the Yamuna River by the side of Prayagraj-Rewa Road about 12 km from the city. The experiment was conducted in Randomized Block Design with 10 treatments each replicated thrice. The plot size of each treatment was 3m x 3m. The factors are Direction of sowing (North-South, East-West, control (NW-SE)) and Phosphorus (50 kg/ha, 60 kg/ha,70 kg/ha). Toria variety PT-303 was selected for sowing. Seeds were sown in line manually. Seeds were covered with the soil immediately after sowing. The Toria crop was sown on 01 Oct 2024. Harvesting was done by taking 1m2 area from each plot. And from it five plants were randomly selected for recording growth and yield parameters. The observations were recorded for plant height, dry weight, Crop growth rate, number of siliquae/plants, number of seeds/siliquae, test weight, see yield and stover yield. The data was subjected to statistical analysis by analysis of variance method.

Result and Discussion

Yield Attributes Number of siliquae/plants

The data shown that there was a significant effect among treatments. However, highest number of siliqua/plant (222.40) was observed in treatment T_5 (East-West + Phosphorus 60 kg/ha). However, treatment T_3 (North-South + Phosphorus 70 kg/ha), treatment T_8 (control (NW-SE) + Phosphorus 60 kg/ha) and treatment T_2 (North-South + Phosphorus 60 kg/ha) were found to be statistically at par with treatment T_5.

Number of Seeds/siliquae

The data shown that there was a significant effect among treatments. However, highest number of seeds/siliqua (19.40) was observed in treatment T_5 (East-West + Phosphorus 60 kg/ha). However, treatment T_6 (East-West + Phosphorus 70 kg/ha) and treatment T_1 (North-South + Phosphorus 50 kg/ha) were found to be statistically at par with treatment T_5.

Seed Yield (t/ha)

Maximum seed yield (2.22 t/ha) was observed in treatment T_5 (East-West + Phosphorus 60 kg/ha). However, treatment T_4 (East-West + Phosphorus 50 kg/ha), treatment T_3 (North -South + Phosphorus 70 kg/ha) and treatment T_8 (Control (NW-SE) + Phosphorus 60 kg/ha) were found to be statistically at par with treatment T_5.

Stover Yield (t/ha)

Maximum stover yield (8.32 t/ha) was observed in treatment T_5 ((East-West + Phosphorus 60 kg/ha). However, treatment T_4 (East-West + Phosphorus 50 kg/ha), treatment T_9 (Control (NW-SE) + Phosphorus 70 kg/ha) and treatment T_2 (North-South + Phosphorus 60 kg/ha) were found to be statistically at par with treatment T_5.

Economics

Gross Return (INR/ha)

The higher gross return (127400 INR/ha) were obtained in treatment T_5 (East-West + Phosphorus 60 kg/ha) and minimum gross returns (90680 INR/ha) was noticed in treatment T_1 (North-South + Phosphorus 50 kg/ha).

Net Return (INR/ha)

The higher net return (84188 INR/ha) was obtained in treatment T_5 (East-West + Phosphorus 60 kg/ha) and minimum net return (46356 INR/ha) was noticed in treatment T_9 (Control (NW-SE) + Phosphorus 70 kg/ha).

Benefit Cost Ratio (B:C)

The higher B:C Ratio (1.95) was obtained in treatment T_5 (East-West + Phosphorus 60 kg/ha) and minimum B:C Ratio (1.05) was noticed in treatment T_9 (Control (NW-SE) + Phosphorus 70 kg/ha).

Discussion

East-West sowing direction generally leads to higher yield attributes like plant height, number of branches, and siliquae per plant compared to North-South direction, while also showing better seed yield. One possible explanation for these enhancements is the higher light intensity obtained when facing east-west. plant height, siliquae/plant, seeds/silique, and 1,000-seed weight, as a result of improved light interception, which results in longer photosynthetic activity in the former than in the latter (Bhan *et al.*). Phosphorus application positively influences yield attributes in toria (*Brassica campestris)*, leading to increased number of siliquae (pods) per plant, seeds per siliqua, and ultimately, higher seed and straw yields. Seed, stover and biological yield of toria varieties were significantly increased with nutrient levels. This behaviour of economic parameters due to Phosphorus levels was due to changes in marginal seed yield of the crop with successive increase in fertilizer nutrient and relative costs of inputs in relation to output.

Table 1: Effect of Direction of sowing and Phosphorus levels on yield attributes of Toria

S No	Treatment combinations	Number of siliquae/ plant	Number of Seeds/ Siliqua	Seed yield (t/ha)	Stover yield (t/ha)
1.	North-South + 50 kg/ha P	205.47	18.53	1.54	7.07
2.	North-South + 60 kg/ha P	216.53	18.40	1.75	7.45
3.	North-South + 70 kg/ha P	219.40	18.20	1.99	7.17
4.	East-West + 50 kg/ha P	216.20	18.00	2.10	8.24
5.	East-West + 60 kg/ha P	222.40	19.40	2.22	8.32
6.	East-West + 70 kg/ha P	207.87	19.07	1.64	7.18
7.	Control (NW-SE) + 50 kg/ha	199.13	18.13	2.01	7.26
8.	Control NW-SE) + 60 kg/ha	217.20	17.73	1.79	6.73
9.	Control (NW-SE) + 70 kg/ha	197.33	18.40	1.46	7.77
10.	Control (N:P: K-60:30:30 kg/ha)	196.20	17.47	1.79	7.13
	S. Em (±)	3.05	0.35	0.15	0.29
	CD (p = 0.05)	9.06	1.04	0.46	0.87

Table 2: Effect of Direction of sowing and Phosphorus levels on Economics of Toria

S No	Treatment combinations	Gross returns (INR/ha)	Net returns (INR/ha)	B:C ratio
1.	North-South + 50 kg/ha P	90680.00	48584.00	1.15
2.	North-South + 60 kg/ha P	101660.00	58448.00	1.35
3.	North-South + 70 kg/ha P	114220.00	69881.20	1.58
4.	East-West + 50 kg/ha P	121560.00	79464.00	1.89
5.	East-West + 60 kg/ha P	127400.00	84188.00	1.95
6.	East-West + 70 kg/ha P	95530.00	51191.00	1.15
7.	Control (NW-SE) + 50 kg/ha	115415.00	73319.00	1.74
8.	Control (NW-SE) + 60 kg/ha	102660.00	59448.00	1.38
9.	Control (NW-SE) + 70 kg/ha	90695.00	46356.20	1.05
10.	Control (N:P: K-60:30:30 kg/ha)	103760.00	63921.20	1.60

Conclusion
It is concluded that East-West Directional sowing along with application of Phosphorus (60 kg/ha) was observed higher yield attributes and economics in Toria.

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