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Effect of Light Intensity and Different Levels of Nitrogen on Growth, Yield and Photosynthetic Characteristics of Giant Mustard (*Brassica juncea var.* Wong Bok)

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ABSTRACT: This experiment was conducted to explore the shady places on agricultural land. In the experimental field it was done by giving different light intensity (with the help of shade net) to the crop along with different level of nitrogen. The field experiment was carried out in factorial Randomized block design with three replications, during *Rabi* season 2019-2020 in Horticulture Research Farm, Department of Horticulture, SHUATS. Experiment was setup in 18 treatments i.e. different levels of nitrogen in combination with different levels of light intensity (25% and 50%) on growth, yield and photosynthetic characteristics of giant mustard which include No. of leaves, Plant height (cm), Weight of plant (kg), Yield per plot (kg plot^{-1}), Leaf thickness (mm), Fresh leaf mass (g), Light Intensity (lux), Atmospheric temperature ($^{\circ}$C), Precipitation (mm). From the experiment, treatment combination T_{10} i.e. NPK (55:40:40) + 50% Shade (Green Net) was found superior for application of nitrogen @ 55 kg ha^{-1} in blend with light intensity 50% suitable for enhancing growth, yield and photosynthetic characteristics of giant mustard. Level of NPK 55:40:40 and level of shade 50% recorded significantly higher values for growth and yield attributing characters, viz., number of leaves highest observed in treatment T_{10} [NPK (55:40:40) +50% Shade (Green Net)] was 15.55, plant height 43.10 cm, Weight of plant 1558.33g, yield per plot 6.84 kg, Leaf thickness 0.79 mm, Fresh leaf weight 65.83g, Light Intensity (lux) 25% 9916.00 lux, Light Intensity (lux) 50% 8002.33 lux in comparison to other treatments. Level of NPK (55:40:40) + 50% Shade (Green Net) treatment also shows at par results when compared to other treatments, harvesting also showed non-significant better result. This study will help in understanding the proper light requirement for this crop and also the nitrogen level for the best growth of crop. This will clear the fact that not only open field but also the places which are partially shaded can be used efficiently to produce vegetables and other crops.

Keywords: Giant Mustard, NPK, Light Intensity, growth, yield.

INTRODUCTION

Horticulture plays a significant role in Indian Horticulture. India has predominantly an agriculture-based economy and will continue to be so for a pretty long time. With the rising of green revolution, the production and productivity of crops has increased substantially and is almost stabilized. Since the Indian population depends mostly on agriculture mainly oil, vegetables, hence vegetables are the most important component of Indian vegetarian diet. As far as vegetable consumption per capita per day is concerned at present it is 225 g/capita/day in India, as to the standard nutritional requirement of which should not be less than 300 g/capita/day. Therefore, to fill this gap certain steps through the central government have been taken for increasing the production of vegetable crops. The multiplicity of factors responsible for low yield of Indian mustard, poor nutrition is of great consequence. Mustard is an energy rich crop but it is mostly grown under energy starved condition. Nitrogen and Phosphorous are the important elements in mustard cultivation.

Among the major nutrients, nitrogen plays an important role in increasing the yield. Nitrogen is known to activate most of the metabolic activities and transformation of energy. Nitrogen being deficient in most Indian soils is the much important element in mustard production. It is a structural component of protein molecules, amino acids, nucleotides, enzymes, alkaloids, vitamins, chlorophylls and other constituents. Adequate supply of nitrogen promotes higher photosynthetic activity and vigorous vegetative growth.

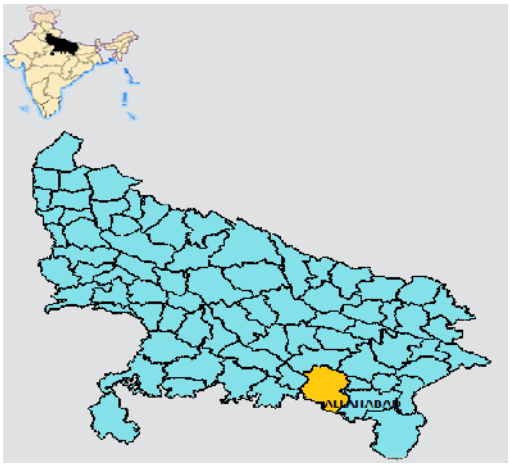
A high nitrogen supply favours the conversion of carbohydrates in to protein. in addition, UV-B light may also be deflected or scattered by atmospheric pollution, cloud cover, and surface reflection **(**McKenzie *et al*., 2003). Light intensity and nitrogen concentration of nutrient solution are shown to play a crucial role in the contents of vitamin C and nitrate in cultivated leaf vegetables. Increasing light intensity is able to induce the activity increase of main enzymes involved in the metabolism of nitrate and vitamin C (Smirnoff, 2000; Zhou *et al*., 2012). Moreover, high illumination provides more energy to fix CO_2 to accelerate vitamin C synthesis and nitrate assimilation in plant leaves (Demsar *et al*., 2004). Broken nitrogen treatment before harvest can decrease the nitrate accumulation,) while increasing vitamin C content in hydroponic vegetables. However, it is not yet available on the interaction between light intensity and nitrogen concentration of the solution to regulate the vegetable production and metabolism of nitrate and vitamin C. Here, we investigated the change of growth, yield and photosynthetic characteristics, of giant mustard in response to different combinations of light intensity (25% and 50%) and different nitrogen concentration. Jenkins and Brown, (2007) conducted an experiment on the quantity of UV-B light that plants receive depends on seasonal changes and geographic location. This study provides valuable insights into the combinational regulation of light intensity and nitrogen supply to improve production and quality (i.e. to increase vitamin C, while reducing nitrate concentration) of leafy vegetables cultivated in greenhouses and plant factories, grown *Brassica juncea* at New Delhi on sandy loam soil having combination of 40 or 60 kg S ha^{-1} and N 100 or 150 kg ha^{-1}. Abraham, (2000), Kumar *et al.,* (2000) noticed an increase in mustard yield by about 165% at the highest rates 60 kg N + 36 kg P + 24 kg K ha^{-1} fertilizer application. Narwal *et al.,* (2000) given 0, 20, 40, 60 kg N ha^{-1} with and without *Azotobacter* and reported oil and protein content increased with increasing N rate. Mina *et al.,* (2003) reported that application of P and Zn progressively increased the number of siliquae per plant, test weight seed and stover yields.

Tripathi *et al.,* (2011) reported that the interaction effect of different levels of NPK and Sulphur the important plant yield attributes parameters of mustard crop. Dong *et al.,* (2014) conducted an experiment treatment was selected as the plant material in this study. The sources of sulphur (gypsum, bentonite S, pyrite) did not influence significantly the yield attributes and yield of Indian mustard (*Brassica juncea* L.) in the experiment by Kumar *et al.,* (2011). Kumar and Gangwar, (2018) conducted an experiment and pointed out that application of 90 kg nitrogen per hectare increased the number of functioning leaves, number of primary and secondary branches and total dry-matter production in mustard crop. However, Singh, (1984) observed significant increase in plant height, number of primary and secondary branches per plant and dry-matter accumulation per plant due to increasing dose, of nitrogen. Kalai *et al.,* (2019), working at Bhubaneswar (Orissa), studied the effect of four levels of nitrogen (0, 25, 50 or 75 kg N/ha) on *Brassica juncea* cv. Pusa Bahar.

They found that 75 kg N/ha gave the highest seed yield and seed protein content increased and seed oil content decreased with increasing nitrogen levels. Kakatia and Kalita (2019) performed a field trial at Jorhat (Assam) to study the effect of nitrogen fertilizer application (0, 25, 50, 75 or 100 kg N/ha) on yield components of three cultivars *of Brassica juncea*, viz. Varuna, Tm 2 and Tm 3. They noted that all yield components and nitrogen uptake and seed and stover-nitrogen concentration increased with increasing nitrogen fertilizer levels, whereas seed oil concentration decreased and 1000-seed weight and seeds per siliqua remained unchanged. They also noted that Varuna was the highest yielding cultivar.

MATERIALS AND METHODS

The experimental material for the present investigation comprised of 18 treatment including control effect of light intensity and different levels of Nitrogen on growth, yield and photosynthetic characteristics of giant mustard at Horticulture Research Farm in the Department of Horticulture, Naini Agriculture Institute, Sam Higginbottom University of Agriculture, Technology and sciences, Prayagraj (U.P.) during Rabi 2019-20 (U.P.) site had sandy loam soil, low in organic carbon and nitrogen, medium in phosphorus, potassium and slightly alkaline (pH8.0) in nature mechanical mixture of soil constituted 60.4% sand, 27.8% silt and 11.3% clay.



Location map of study area.

Observations recorded were number of leaves**,** Plant height (cm), Weight of plant (kg), Yield per plot (kg $plot^{-1}$), Leaf thickness (mm), Fresh leaf mass (g), Light Intensity (lux), Atmospheric temperature (°C), Precipitation (mm). The experiment was laid out in Randomized Block Design with factorial concept in

three replications the mean data of each character was replicated three times and each character were worked out statistically by the method of factorial Analysis of variance using RBD (Factorial RBD Design used by John Bennet and Joseph Henry Gilbert).

Fig. 1. Transplanting in the main field at Horticulture Research Farm, Department of Horticulture, SHUATS.

Fig. 2. Installing shade nets in the main field.

Fig. 3. Growth of crop at 30 DAT in the main field at Horticulture Research Farm, Department of Horticulture, SHUATS.

Fig. 4. Recording light intensity in the shade net with the help of lux meter.

RESULTS AND DISCUSSION

A. Growth Parameters

The maximum number of leaves plant^{-1} (15.55) was observed in the treatment combination of NPK (55:40:40) +50% Shade (Green Net) and the minimum number of leaves plant^{-1} (6.55) was found with treatment combination T_9 NPK (65:40:40) +25% shade (Green Net).

The maximum plant height 43.10cm was observed in the treatment combination of T_{10} NPK (55:40:40) + 50% Shade (Green Net) and the minimum height of plant (29.84cm) was found with treatment combination T_9 NPK (65:40:40) + 25% shade (Green Net). The maximum leaf thickness of plant (0.79 mm) was observed in the treatment combination of T_{10} NPK (55:40:40) + 50% shade (Green Net) and the minimum leaf thickness (0.24 mm) was found with treatment combination T_9 NPK (65:40:40) + 25% shade (Green Net).

The results are in agreement with the finding of Krkati *et al.,* (2019; Kalai *et al.,* (2019) and Kumar *et al.,* (2002) in mustard. The data pertaining to these parameters are given in Table 1.

B. Yield Parameters

The yield parameters of giant mustard viz. weight of the plant (kg), fresh leaf weight (g), yield per plot (kg). The maximum weight of plant (1558.0 g) was observed in the treatment combination of T_{10} NPK (55:40:40) + 50% Shade (Green Net)] and the minimum weight of plant (613.0 g) was found with treatment combination T_9 NPK (65:40:40) + 25% Shade (Green Net). The maximum fresh weight of leaf (65.83) was observed in the treatment combination of T_{10} NPK (55:40:40) +50% Shade (Green Net)] and the minimum fresh weight of leaf (58.33) was found with treatment combination T_9 NPK (65:40:40) +25% Shade (Green Net). The maximum yield per plot (6.84kg) was observed in the treatment combination of T_{10} NPK (55:40:40) + 50% Shade (Green Net)] and the minimum yield per plot (2.35) was found with treatment combination T_9 NPK (65:40:40) + 25% Shade (Green Net).

Table 1: Mean performance of light intensity and different levels of Nitrogen on number of leaves, plant height (cm) and leaf thickness (mm).

Treatment	Treatment combinations	Number of leaves	Plant height (cm)	Leaf thickness (mm)
T_0	NPK (60:40:40) (Open Condition)	11.93	35.64	0.49
T_1	NPK (55:40:40) +25% Shade (Green Net)	10.30	35.25	0.45
T_2	NPK (50:40:40) +25% Shade (Green Net)	10.14	34.61	0.39
T_3	NPK (45:40:40) +25% Shade (Green Net)	9.83	33.83	0.36
T_4	NPK (40:40:40) +25% Shade (Green Net)	9.12	32.94	0.33
T_5	NPK (35:40:40) +25% Shade (Green Net)	8.49	31.86	0.31
T_6	NPK (30:40:40) +25% Shade (Green Net)	8.18	31.30	0.30
T_7	NPK (25:40:40) +25% Shade (Green Net)	7.59	30.83	0.29
T_8	NPK (20:40:40) +25% Shade (Green Net)	7.24	30.71	0.26
T_9	NPK (65:40:40) +25% Shade (Green Net)	6.55	29.84	0.24
T_{10}	NPK (55:40:40)+50% Shade (Green Net)	15.55	43.10	0.79
T_{11}	NPK (50:40:40) +50% Shade (Green Net)	15.18	42.48	0.76
T_{12}	NPK (45:40:40) +50% Shade (Green Net)	14.82	41.86	0.72
T_{13}	NPK (40:40:40) +50% Shade (Green Net)	14.48	41.25	0.69
T_{14}	NPK (35:40:40) +50% Shade (Green Net)	13.92	40.55	0.68
T_{15}	NPK (30:40:40) +50% Shade (Green Net)	13.80	39.80	0.61
T_{16}	NPK (25:40:40) +50% Shade (Green Net)	12.47	39.43	0.60
T_{17}	NPK (20:40:40) +50% Shade (Green Net)	12.33	38.46	0.59
T_{18}	NPK (65:40:40) +50% Shade (Green Net)	12.24	36.51	0.57
F-Test		S	S	S
C.D. at 5%		0.129	0.405	0.026
S.Ed (±)		0.063	0.119	0.013

Table 2: Mean performance of light intensity and different levels of Nitrogen on weight of plant (g), fresh leaf weight (g), yield per plot (kg).

Treatment	Weight of plant (g)	Fresh leaf weight (g)	Yield per plot (kg)
T_0	919.33	61.82	3.94
T_1	872.33	61.78	3.75
T_2	858.67	62.70	3.54
T_3	817.33	61.47	3.32
T_4	768.67	60.57	3.17
T_5	746.33	60.46	3.20
T_6	732.67	60.33	3.13
T_7	683.67	59.47	2.66
T_8	639.33	59.15	2.77
T_9	613.33	58.33	2.35
T_{10}	1558.33	65.83	6.84
T_{11}	1556.33	65.51	6.78
T_{12}	1535.67	65.40	6.14
T_{13}	1478.33	64.25	5.87
T_{14}	1449.33	63.84	5.74
T_{15}	1416.00	63.35	5.58
T_{16}	1386.33	63.19	5.29
T_{17}	1353.00	62.48	4.83
T_{18}	1324.33	62.39	4.68
F-Test	S	S	S
C.D. at 5%	17.889	0.883	0.238
S.Ed (±)	8.803	0.443	0.118

The results are in agreement with the finding of Mina *et al*., (2003); Kumar *et al.,* (2011) and Shankar *et al*., **(**2002), in mustard. The data pertaining to these parameters are given in Table 2.

C. Photosynthetic and climatic parameters

The photosynthetic and climatic parameter of giant mustard viz. light intensity (lux) at 25%, light intensity (lux) at 50%, atmospheric temperature (°C), Precipitation (mm). The maximum light intensity 25% (9916.00 lux) was observed in the treatment combination of T_{10} NPK (55:40:40) +50% Shade (Green Net)] and the minimum light intensity 25% (8454.00 lux) was found with treatment combination T_9 NPK (65:40:40) + 25% Shade (Green Net). The maximum light intensity 50% (8002.33 lux) was observed in the treatment combination of T_{10} NPK (55:40:40) + 50% Shade (Green Net)] and the minimum light intensity 50% (4981.00 lux) was found with treatment combination T_9 NPK (65:40:40) + 25% Shade (Green Net). The maximum atmospheric temperature (34.14°C) was observed in the treatment combination of T_{11} NPK (50:40:40) + 50% Shade (Green Net) and the minimum atmospheric temperature **(**23.12°C) was found with treatment combination T_9 NPK (65:40:40) + 25% Shade (Green Net). The maximum precipitation (1.76 mm) was observed in the treatment combination of T_{11} NPK (50:40:40) + 50% Shade (Green Net) and the minimum precipitation **(**1.09mm) was found with treatment combination T_9 NPK (65:40:40) + 25% Shade (Green Net). The results are in agreement with the findings of Demsar *et al*., (2004); McKenzie *et al*., (2003) and Jenkins *et al*., (2007).

A significant interaction of light intensity and nitrogen supply for regulating giant mustard growth and nutritional quality was observed. The combination of NPK (55:40:40) + 50% Shade (Green Net) nitrogen enhanced the photosynthesis and the yield of giant mustard. However, the light/nitrogen combination for sustainable giant mustard production considering both yield and nutrition needs further investigation.

Table 3: Mean performance of light intensity and different levels of Nitrogen on light intensity (lux) 25%, light intensity (lux) 50%, atmospheric temperature (°C) and precipitation (mm).

Treatment	Light Intensity (lux) 25%	Light Intensity (lux)50%	Atmospheric temperature (°C)	Precipitation (mm)
T_0	8786.00	6292.67	24.80	1.31
T_1	8705.00	6280.33	24.47	1.28
T_2	8644.00	6246.67	24.17	1.24
T_3	8634.00	6238.00	24.05	1.22
T_4	8597.00	6079.67	23.80	1.19
T_5	8586.00	6047.33	23.60	1.16
T_6	8584.00	5879.67	23.48	1.14
T_7	8544.00	5000.00	23.40	1.14
T_8	8487.00	4991.33	23.19	1.12
T_9	8454.00	4981.00	23.12	1.09
T_{10}	9916.00	8002.33	33.83	1.62
T_{11}	9895.00	8000.67	34.14	1.76
T_{12}	9894.00	7991.00	33.18	1.71
T_{13}	9882.00	7980.67	32.42	1.64
T_{14}	9864.00	7975.00	31.64	1.63
T_{15}	9854.00	6789.33	32.18	1.57
T_{16}	9794.00	6591.00	32.14	1.53
T_{17}	9787.00	6547.33	31.44	1.46
T_{18}	9780.00	6538.67	31.30	1.43
F-Test	S	S	S	S
C.D. at 5%	1.659	0.445	0.415	0.158
S.Ed (±)	0.816	1.406	0.204	0.061

CONCLUSION

It is concluded from the experiment that treatment combination T_{10} i.e. NPK (55:40:40) +50% Shade (Green Net) was found superior for application of nitrogen @ 55 kg ha^{-1} in blend with light intensity 50% suitable for enhancing growth, yield and photosynthetic characteristics of giant mustard.

Level of NPK 55:40:40 and level of shade 50% recorded significantly higher values for growth and yield attributing characters, viz., number of leaves highest observed in treatment T_{10} [NPK (55:40:40) +50% Shade (Green Net)] was 15.55, plant height 43.10cm, Weight of plant 1558.33g, yield per plot 6.84 kg, Leaf thickness 0.79 mm, Fresh leaf weight 65.83g, Light Intensity (lux) 25% 9916.00 lux, Light Intensity

(lux) 50% 8002.33 lux in comparsion with other treatments. Level of NPK (55:40:40) +50% Shade (Green Net) treatment also, shows at par results when compared to other treatments.

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Conflict of Interest. Nil.

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