Eco. Env. & Cons. 29 (1) : 2023; pp. (412-419)
Copyright@ EM International
ISSN 0971–765X

DOI No.: http://doi.org/10.53550/EEC.2023.v29i01.061

Effect of graded levels of fertilizer on growth and yield of niger varieties under rainfed condition of Assam

[1]Nikita Kaman, [1]Nayanjyoti Ojha, [1]Rinjumoni Dutta, [2]Anjali Basumatary, [3]Ranjan Das and [4]Priyanka Das

[1]Department of Agronomy, [2]Department of Soil Science, [3]Department of Crop Physiology, [4]Department of Agricultural Biochemistry and Agricultural Chemistry, Assam Agricultural University, Jorhat, Assam, India

(Received 27 July, 2022; Accepted 21 October, 2022)

ABSTRACT

During the *rabi* season of 2019-20, a field experiment entitled "Effect of graded levels of fertilizer on growth and yield of niger varieties under rainfed condition of Assam" was conducted at Instructional-cum-Research (ICR) Farm, Assam Agricultural University, Jorhat with a view to assess the influence of graded levels of NPK and varieties on growth and yield of niger. With three replications, the experiment was laid out in a Randomized Block Design (Factorial). The treatments comprised of four grades of NPK viz., F_1: 10-5-5 kg N-P_2O_5-K_2O/ha, F_2: 20-10-10 kg N-P_2O_5-K_2O/ha, F_3: 30-15-15 kg N-P_2O_5-K_2O/ha and F_4: 40-20-20 kg N-P_2O_5-K_2O/ha and four varieties viz., V_1: NG-1, V_2: GA-10, V_3: JNS-9 and V_4: NB-1. Experimental findings revealed that application of 40-20-20 kg N-P_2O_5-K_2O/ha, 30-15-15 kg N-P_2O_5-K_2O/ha and 20-10-10 kg N-P_2O_5-K_2O/ha gave statistically at par values in respect of all growth parameters studied viz., plant height, number of leaves per plant, leaf area index, number of branches per plant, dry matter production per plant and chlorophyll content of leaves. Application of 40-20-20 kg N-P_2O_5-K_2O/ha proved superior in terms of yield attributing characters like capitula per plant, number of seeds per capitulum, seed (534.15 kg/ha) and stover yield (2981.05 kg/ha) and oil yield (204.12 kg/ha). No treatment differences were observed in respect of 1000-seed weight and harvest index. Among the varieties, NB-1 gave significantly higher values in almost all the growth characters (*viz.,* plant height, number of leaves per plant, leaf area index, number of branches per plant and dry matter production per plant) under study except chlorophyll content of leaves, which was higher in the variety GA-10. On the other hand, the variety GA-10 gave significantly higher values in respect of yield attributing characters like number of capitula per plant, number of seeds per capitulum and 1000-seed weight which were at par with JNS-9. Significantly higher seed yield was obtained in GA-10 (491.87 kg/ha) which was at par with JNS-9 (470.24 kg/ha), whereas, the stover yield was the highest in NB-1 (2866.84 kg/ha). Harvest index was significantly higher in GA-10 (16.44%) and was at par with JNS-9 (15.90%) and NG-1 (15.50%). The variety GA-10 also produced significantly oil yield (191.96 kg/ha). The highest interaction effect was recorded under the treatment combination- V_2F_4 (40-20-20 kg N-P_2O_5-K_2O /ha was applied to GA-10) in respect of number of capitula per plant (35.64), seed yield (623.90 kg/ha).

Key words: *Niger, Seed yield, Oil yield*

Introduction

Oilseed crops have been considered as an important group of commercial crops because of their higher economic and nutritional value. Oilseed is the 2nd largest agricultural commodity in India next to cere-

als and also edible oils are India's largest agricultural imports. Although oilseed production has been enhanced in the past few years in India, still there is shortfall to meet country's self-sufficiency. The Solvent Extractors' Association (SEA) of India has reported that the import of both edible and non edible oil has increased by 32% during April, 2021 in India. Therefore, the prices of edible oil have increased alarmingly and thus negatively influencing the Indian agricultural economy. So, there is need to increase the area under oilseed crops with improved agronomic practices. India's diverse and rich agro-ecological condition favours growing of nine annual oilseed crops and among them niger is one the most important edible minor oilseed crop. Niger is although a minor oilseed crop but its seeds contain 37-47% oil and higher amount of unsaturated fatty acid (oleic acid 38% and linoleic acid 51.6%) which is free from toxins and fit for human diet (Gogoi, 2019). Niger oil is of utmost importance in human nutrition as it contains high essential unsaturated fatty acid, linoleic acid (85%); high amount of cysteine and has great ability to reduce blood cholesterol level (Ramdan, 2012). The oil is also of great commercial importance, it is used for manufacturing soaps, paints, perfumes, varnish, grease and cosmetics. Beside these, the oil is also used for lighting, and other culinary purposes. After extraction of oil, the oilcake is used as manure and also as feed, especially for milch cattle it is proved to be a valuable feed. The whole niger plant can also be used as green manuring crop before blooming.

India ranks first in respect to area and production with a contribution of more than 50% of world niger. It is cultivated in 1.36 lakh hectare area of the country with a production of 0.41 lakh tones and productivity of 303 kg/ha (Anon., 2019-20a). The productivity of niger is low, as it is mainly grown in tribal pockets with the use of minimum agro inputs, particularly fertilizers leading to very low productivity (Sharma, 1993). Proper management of NPK is crucial for crop growth and yield.

Nitrogen being an integral part of chlorophyll influences the process of photosynthesis. The utilization of phosphorus, potassium and other elements is greatly governed by availability of nitrogen. Deficiency in nitrogen induces growth retardation, decreased leaf number and leaf area in niger (Nasim *et al*., 2011). Phosphorus helps in energy storage and transfer and also plays crucial role in flower and seed formation. Phosphorus management is of great importance due to insufficiency of phosphatic fertilizers and for the need to sustain productivity (Nambaiar and Abrol, 1989). Potassium is one of the essential elements which is important for growth and development of plants. It plays vital role in improving the yield and quality of crops through its effect on photosynthesis, water use efficiency and plant tolerance to diseases, drought and cold as well and thereby make the balance between protein and carbohydrates (Singh *et al*., 2010). Until niger was brought under the All India Coordinated Research Project (AICRP) there was no research input for crop improvement and production technology of niger (Ranganatha *et al*., 2014).

In Assam, niger is cultivated in an area of 5.72 thousand hectare with a production of 3.19 thousand tones and its productivity is 558 kg/ha (Anon., 2019-20b). The low productivity of niger in Assam is may be due to the fact that there is only a few recommended varieties for Assam and also it is grown with poor fertilizer management. The reasons for low yield are poor soil fertility management, inadequate use of fertilizer and traditional crop management practices. Niger crop can tolerate streams of weather fluctuations and also less susceptible to damages caused by other biotic and abiotic factors (Sharma and Kewat, 1998). Hence, growing promising niger varieties with proper fertilizer management under Assam condition can boost the productivity of niger in the state.

Materials and Methods

The field experiment was conducted during *rabi* season of 2019-20 at the Instructional-cum-Research (ICR) farm, Assam Agricultural University, Jorhat-13. With an altitude of 87 meter above the mean sea level, the site is situated at 26°46' N latitude and 94°13' E longitude. As a whole the climatic condition of Jorhat is sub-tropical humid with warm summers and cold winters. Normally, the pre-monsoon showers start from mid March to April and the monsoon start from the month of June and extend up to the month of September-October. The rainfall intensity decreases progressively from mid October and reaches minimum during December- January. The maximum temperature generally ranges between 34-37 °C during summer and the minimum temperature ranges between 8-10 °C during winter. The meteorological data recorded during standard meteorological weeks (SMWs) of the crop growing sea-

son were obtained from meteorological observatory of the university. During the entire crop season (2019-20) a total of 49.5 mm rainfall was received in 14 spells. The highest rainfall of 20.7 mm was received in SMW number 5. There was no rainfall at all during SMW number 46, 47, 49, 50, 51, 52 and 2. The total weekly evaporation ranged from 6.0 mm to 12.3 mm. The total evaporation during the crop growing season was 143.7 mm. The mean weekly maximum temperature ranged from 20.7 °C to 29.0 °C and the mean weekly minimum temperature ranged from 8.4 °C to 19.5 °C. During the experimental period the mean relative humidity was 94.70 to 100 per cent in morning and 55.70 to 80.75 per cent in the evening. The mean maximum bright sunshine hours/day during the crop season reached as high as 8.2 hours/day and the lowest being 1.8 hours/day. The soil of the experimental site was sandy loam in texture, acidic in reaction (pH 5.43), medium in organic matter content (0.56%), medium in available N (283.14 kg/ha), low in available P (18.65 kg/ha) and medium in available K (156.55 kg/ha). The treatment comprised of four levels of NPK *viz.*, F_1:10-5-5, F_2:20-10-10, F_3:30-15-15 and F_4:40-20-20 N-P_2O_5- K_2O kg/ha and four varieties *viz.*, NG-1, GA-10, JNS-9 and NB-1, respectively. The experiment was laid out in Randomized Block Design (Factorial) with individual plot size having dimension of 4m x 3m. Well decomposed FYM @ 2 tones/ha was uniformly broadcasted over the experimental area and incorporated with soil at the time of final land preparation. As per treatment, the fertilizers were applied to the plots one day before sowing as urea, SSP and MOP. The fertilizers were applied following broadcasting method of application and incorporated into the soil by light hoeing. Sowing was done in lines on 8th November, 2019 manually at a spacing of 25 cm x 10 cm and depth 3-4 cm with seed rate of 8 kg/ha.

Observations on growth and yield attributing characters were recorded at 20 days interval after sowing. Ten representative plants from individual plots were selected randomly at 20 days interval from sowing till harvest and respective plant height was measured in centimeter (cm) from the ground level to the tip of the plant and the average of the recorded data was calculated for statistical analysis. Numbers of leaves were counted from already selected and tagged ten representative plants from each experimental plot and average of the recorded data was calculated at 20 days interval. From already labelled ten plants the number of branches per plant was counted at 20 days interval from 40 DAS and the average was calculated. Leaf Area Index is the total leaf area per unit ground surface area (Watson, 1952). Five plant samples were collected from net plot area at 20 days interval and were analyzed for LAI. Leaf area index was calculated by the following formula as prescribed by Watson (1952):

$$\text{Leaf area index (LAI)} = \frac{\text{Total leaf area}}{\text{Ground area}}$$

At 20 days interval five plants were randomly collected from the rows outside net plot area leaving the border rows to obtain the dry matter production per plant. Then the samples were first shade dried for 24 hours and later oven dried at 60 °C till constant weight was obtained. Their dry weights were averaged and expressed as g per plant. Chlorophyll content of leaves was measured by Minolta SPAD-502 meter (spectral absorbance data) as per the method described by Markwell *et al.* (1995). Total number of capitulum per plant was counted from ten already labelled representative plants from each plot and calculated for average value. Ten numbers of capitulum were taken from each selected plants from each plot and the total number of seeds in those capitulum were counted and the average value was calculated to determine the number of seeds per capitulum. From each plot 1000 healthy seeds were taken and counted carefully, dried to 12% moisture and weights were recorded in gram to obtain the 1000-seed weight. Seed yield (kg/ha) was recorded after cleaning and drying properly and the weight of the threshed seeds were recorded for each plot in gram and was converted into kg/ha. The weights of the sun dried bundles were recorded for each net plot before threshing and the weight of the seeds obtained per plot after threshing was subtracted from the total weight of the bundles, which gave the weight of the stover and the stover weight was then expressed in kg/ha. The oil yield was worked out using the formula:

Oil yield (kg/ha) = Oil content x seed yield (kg/ha)

Harvest index is the ratio of economic yield to total biological yield expressed in percentage. The harvest index for niger was worked out using the following formula:

$$\text{Harvestindex}(\%) = \frac{\text{Economicyield}}{\text{Totalbiologicalyield}} \times 100$$

Results and Discussion

Growth characters

The growth attributing characters, *viz.,* plant height, number of leaves per plant, leaf area index, and chlorophyll content of leaves at 80 DAS and number of branches per plant and dry matter production per plant at harvest were found to be higher with application of 40-20-20 kg N-P_2O_5-K_2O/ha and was at par with 30-15-15 kg N-P_2O_5-K_2O/ha and 20-10-10 kg N-P_2O_5-K_2O/ha (Table 1). Significantly higher plant height, number of leaves and number of branches per plant were recorded under higher fertility levels. This might be due to adequate availability of nitrogen, phosphorus and potassium which attributed to better nutritional environment for absorption and their beneficial effect for causing accelerated rate of photosynthesis, assimilation, sufficient formation of photosynthates, which promoted the metabolic activities, cell division, formation of meristematic tissues and ultimately resulted in an increased plant height, enhanced the number of branches and number of leaves per plant. Moreover, adequate supply of nitrogen favoured the nitrogen content and nutrient utilization towards protein which favoured vertical (plant height) and lateral (branching) growth of the plant and ultimately increased in growth of plants with successive increments in the number of branches per plant. The higher dry matter production of the crop with higher fertility levels could be attributed to better nutrition to plants resulted in increased plant height, leaf area index , number of leaves and branches per plant which resulted in better light interception and accumulation of more photosynthates. This result corroborates the findings of Singh *et al*. (2017a) and Raghuvanshi *et al.* (2018) in mustard and Pati and Acharya (2009) in *toria*. Chlorophyll content of leaves significantly increased with increasing levels of NPK. Nitrogen fertilization activates the enzyme associated with chlorophyll formation and thus results in higher concentration of chlorophyll (Hokmalipour and Darbandi, 2011). Bjaili *et al.* (2019) has also reported increasing concentration of chlorophyll at higher N rate in sunflower.

Significantly higher values in almost all the growth characters, *viz.,* plant height, number of leaves per plant and leaf area index at 80 DAS and number of branches per plant and dry matter production per plant at harvest were recorded with variety NB-1 except chlorophyll content of leaves, which was higher in the variety GA-10 (Table 1).

Table 1. Effect of varieties and levels of NPK on growth characters

Treatments	Plant height (cm) at harvest	No. of leaves/ plant at 80 DAS	LAI at 80 DAS	No. of branches/ plant at harvest	Dry matter production/ plant (g) at harvest	Chlorophyll content of leaves (SPAD values) at 80 DAS
Varieties						
V_1: NG-1	74.68	32.88	1.57	9.50	11.48	37.04
V_2: GA-10	80.91	35.57	3.36	10.47	12.39	40.56
V_3: JNS-9	76.66	33.99	1.61	10.07	11.81	37.13
V_4: NB-1	88.64	39.05	3.69	11.64	15.77	33.14
S.Em (±)	2.37	0.95	0.10	0.35	0.42	1.24
CD (5%)	6.85	2.74	0.30	1.02	1.23	3.59
Levels of NPK (N-P_2O_5-K_2O kg /ha)						
F_1: 10-5-5	70.81	32.16	2.21	9.12	10.65	32.98
F_2: 20-10-10	79.63	35.09	2.62	10.45	12.94	37.29
F_3:30-15-15	84.16	36.74	2.66	10.95	13.74	37.85
F_4: 40-20-20	86.29	37.50	2.74	11.16	14.13	39.74
S.Em (±)	2.37	0.95	0.10	0.35	0.42	1.24
CD (5%)	6.85	2.74	0.30	1.02	1.23	3.59
Interaction (VxF)	NS	NS	NS	NS		NS
NS						

NS=Non-significant
DAS=Days after sowing

The probable reason may be attributed to genetic characteristics of variety NB-1 which has higher capacity to utilize photosynthates more efficiently for rapid formation of leaves, branches and eventually the dry matter production. Similar results were reported by Singh *et al*. (2017a) and Raghuvanshi *et al.* (2018) in mustard, Nem *et al.* (2020) in *toria* and Gupta *et al*. (2017) in linseed. The chlorophyll content of leaves varied significantly among the varieties at all the stages of crop growth except at 20 DAS and the variety GA-10 recorded the highest value at all the stages which was at par with JNS-9 and NG-1 at all the stages. This might be due to genetic ability of GA-10 to influence enzymatic reactions for chlorophyll formation.

Yield attributes

Yield attributing characters *viz.*, number of capitula per plant (32.65) and number of seeds per capitulum (22.99) were found to be significantly higher with application 40-20-20 kg N-P_2O_5-K_2O /ha (F_4) which was at par with 30-15-15 kg N-P_2O_5-K_2O /ha (F_3). However, 1000-seed weight which did not differed significantly due to graded levels of NPK (Table 2). This may be due to optimal supply of nutrients to the crop which helped in translocation of more photo synthates to the sink resulting in more number of seeds per capitulum. The positive response of higher level of fertilizers on above yield attributes to be ascribed to overall improvement in crop growth, which enabled the plant to absorb more nutrient and moisture that empowered the plant to manufacture more quantity of photosynthetic accumulate there in sink. The similar findings were also reported by Sandeep and Kubsad (2017) in niger, Singh *et al*. (2017a) in mustard, Pati and Acharya (2009) in *toria*, Gupta *et al*. (2017) and Gaikwad *et al.* (2005) in linseed.

Among the varieties, significantly higher values for number of capitulum per plant (32.47), number of seeds per capitulum (22.71) and 1000-seed weight (3.81g) were recorded in the variety GA-10 which was at par with JNS-9 (Table 2). This might be due to genetic characters of this variety which promoted better translocation of photosynthates from source to sink. Similar findings, indicating the varietal differences for various yield attributes have also been reported by Shaikh *et al.* (2019) in niger, Pati and Acharya (2009) in *toria*, Singh *et al*. (2017a) and Raghuvanshi *et al.* (2018) in mustard. It should be noted here that though the variety NB-1 produced significantly higher growth parameters as compared to other varieties, but failed to reflect it in yield attributing characters. This is due to genetic characteristics of this variety which had poor translocation efficiency of food materials from source to sink. Kumar *et al.* (2019) also found in case of linseed variety Ruchi in which despite having maximum plant height produced significantly lower yield attributes.

Table 2. Effect of varieties and levels of NPK on different yield attributes of niger

Treatments	Number of capitula/ plant	Number of seeds/ capitulum	1000-seed weight (g)
Varieties			
V_1: NG-1	28.58	18.93	3.42
V_2: GA-10	32.47	22.71	3.81
V_3: JNS-9	30.03	20.99	3.56
V_4: NB-1	24.96	16.56	3.41
S.Em (±)	0.85	0.81	0.10
CD (5%)	2.46	2.34	0.30
Levels of NPK (N-P_2O_5-K_2O kg /ha)			
F_1: 10-5-5	24.20	15.12	3.38
F_2: 20-10-10	27.73	18.94	3.43
F_3:30-15-15	31.45	22.13	3.63
F_4: 40-20-20	32.65	22.99	3.76
S.Em (±)	0.85	0.81	0.10
CD (5%)	2.46	2.34	NS
Interaction (VxF)	*	NS	NS

NS=Non-significant
* = Significant

A significant interaction effect was found between varieties and levels of NPK on number of capitula per plant (Table-3). The highest number of capitula per plant (35.64) was obtained when 40-20-20 kg N-P_2O_5-K_2O /ha (F_4) was applied to the variety GA-10 (V_2). The probable reason may be attributed to genetic characteristics of GA-10 and adequate supply of nutrients for which there was improvement in nutritional environment in root zone, which encouraged better root growth and proliferation, thereby, facilitating more withdrawal of water and nutrients from larger areas and greater depths which resulted in better development of crop plant for improved growth and higher number of capitula per plant.

Seed, stover and oil yield

The seed and stover yield improved with corresponding increase of NPK levels up to highest level. This was due to favorable effect of increasing fertilizer levels on yield attributing characters which fi-

nally reflected in higher seed yield and stover yield. Significantly higher seed yield (534.15 kg/ha) was obtained with 40-20-20 kg N-P_2O_5-K_2O /ha (F_4) (Table 4). The increase in seed yield under adequate nutrient supply might be ascribed, mainly due to the combined effect of all the three major nutrients. The optimum availability of nutrients has favoured the growth and development of better root system, which helped in better uptake of nutrients. Further, it might have improved the rate of photosynthesis and better translocation of photosynthates to reproductive parts as indicated by higher values of yield components that resulted in better seed yield of niger. The stover yield was significantly higher with 40-20-20 kg N-P_2O_5-K_2O /ha (F_4) (Table 4). Increase in stover yield at higher NPK levels might be due to increase in plant height, number of leaves/plant, number of branches/plant and dry matter yield, respectively, at final stage due to application of 40-20-20 kg N-P_2O_5-K_2O /ha (F_4). Positive response of seed and stover yield with increasing levels of fertilizer has been reported by many researchers. This finding corroborates the findings of Sandeep and Kubsad (2017) in niger, Singh *et al*. (2017a) and Raghuvanshi *et al.* (2018) in mustard, Deka *et al.* (2018) in *toria* and Singh *et al.* (2013) and Gaikwad *et al.* (2020) in linseed. The increase in seed yield due to 40-20-20 kg N-P_2O_5-K_2O/ha and 30-15-15 kg N-P_2O_5-K_2O /ha over recommended dose of fertilizer (20-10-10 kg N-P_2O_5-K_2O /ha) was 21.93% and 5.16%, respectively. However, the seed yield decreased by 15.53% due 10-5-5 kg N-P_2O_5-K_2O /ha compared to RDF.

Among the varieties, GA-10 produced the highest seed yield (491.87 kg/ha) which was at par with JNS-9 (470.24 kg/ha) (Table 4). Harvest index was also highest in GA-10 (16.44%) which was at par with JNS-9 (15.90%) and NG-1(15.50%) (Table 4). The higher seed yield of GA-10 and JNS-9 could be

Table 3. Interaction effect of Varieties and levels of NPK on number of capitula per plant

Varieties	Levels of NPK (N-P_2O_5-K_2O kg /ha)			
	F_1: 10-5-5	F_2: 20-10-10	F_3:30-15-15	F_4: 40-20-20
V_1: NG-1	22.76	26.59	32.39	32.58
V_2: GA-10	28.95	32.57	32.72	35.64
V_3: JNS-9	28.08	30.27	30.45	31.31
V_4: NB-1	17.03	21.50	30.24	31.07
S.Em (±)	0.98			
CD (5%)	2.83			

Table 4. Effect of varieties and levels of NPK on yield parameters of niger

Treatments	Seed Yield (Kg/ha)	Stover Yield (Kg/ha)	Harvest Index (%)	Oil Yield (Kg/ha)
Varieties				
V_1: NG-1	443.22	2464.88	15.50	165.43
V_2: GA-10	491.87	2512.71	16.44	191.96
V_3: JNS-9	470.24	2509.55	15.90	178.28
V_4: NB-1	397.61	2866.84	12.15	134.73
S.Em (±)	13.07	102.77	0.63	5.27
Levels of NPK (N-P_2O_5-K_2O kg /ha)				
CD (5%)	37.75	296.79	1.83	15.22
F_1: 10-5-5	370.02	2217.82	14.79	122.41
F_2: 20-10-10	438.07	2530.51	14.85	162.04
F_3:30-15-15	460.70	2624.61	15.09	181.82
F_4: 40-20-20	534.15	2981.05	15.25	204.12
S.Em (±)	13.07	102.77	0.63	5.27
CD (5%)	37.75	296.79	NS	15.22
Interaction (VxF)	*	NS	NS	
NS				

NS=Non-significant; DAS=Days after sowing

Table 5. Interaction effect of varieties and levels of NPK on seed yield (kg/ha)

Varieties	Levels of NPK (N-P_2O_5-K_2O kg /ha)			
	F_1: 10-5-5	F_2: 20-10-10	F_3:30-15-15	F_4: 40-20-20
V_1: NG-1	351.86	470.71	471.47	478.85
V_2: GA-10	421.12	450.59	471.85	623.90
V_3: JNS-9	396.24	437.04	456.99	590.69
V_4: NB-1	310.86	393.94	442.47	443.14
S.Em (±)	15.09			
CD (5%)	43.59			

attributed to cumulative effect of significantly more number of capitula per plant, seeds per capitulum and higher 1000-seed weight. Similar trend in seed yield was reported by Banga *et al.* (2013), Raghuvanshi *et al.* (2018) and Singh *et al*. (2017a) in mustard, Pati and Acharya (2009) in *toria*. The stover yield, on the other hand, was significantly higher in the variety NB-1 (2866.84 kg/ha) which was due to significantly higher growth parameters obtained in this variety at final stage of crop growth. However, the same variety NB-1 recorded the lowest seed yield. That means in spite of being a tall and highly branched variety having more number of leaves as well as more dry matter yield, it failed to express higher yield attributes for production of higher seed yield. This may be due to genetic characters of the variety which led to poor translocation of photosynthates and ultimately resulted in the shortfall of photosynthates in the sink from the source. Kumar *et al.* (2019) also recorded the same result in case of linseed variety Ruchi in which despite having maximum plant height produced the lowest seed yield. The per cent increase in seed yield was 10.97% and 6.09% with GA-10 and JNS-9, respectively over the recommended variety NG-1. However, the seed yield decreased by 10.29% in NB-1 compared to NG-1.

A significant interaction effect was found between varieties and levels of NPK on seed yield of niger (Table 5).

The highest oil yield of 204.12 kg/ha was obtained due to application of 40-20-20 kg N-P_2O_5-K_2O /ha (F_4). Higher oil yield at higher fertility level may be attributed to higher seed yield (534.17 kg/ha) obtained at higher doses of NPK. Since oil yield per hectare is the product of per cent oil content in seed and seed yield/ha. Similar results were reported by Kumar (2015) in *toria*, Banga *et al.* (2013) in mustard and Singh *et al.* (2013) and Gaikwad *et al.* (2005) in linseed.

The oil yield was significantly higher in the variety GA-10(191.96 kg/ha) which was at par with JNS-9 (178.28 kg/ha) (Table 4). The higher oil yield of GA-10 and JNS-9 may be attributed to higher seed yield (491.87 and 470.24 kg/ha, respectively) of the variety as oil yield is a product of per cent oil content and seed yield which is generally influenced by genetic structure of different genotypes. This information was in corroboration with the findings of Kumar (2015) in *toria*, Banga *et al.* (2013) in mustard and Singh *et al.* (2013) in linseed.

Conclusion

From this experiment we can conclude that if we apply 40-20-20 kg N-P_2O_5- K_2O/ ha to niger variety GA-10 gives higher productivity in terms of seed yield, oil yield as well as economic indices.

Conflict of Interest

All the authors declared that there is no conflicts of interest in publishing the research article in your esteemed journal.

References

Anonymous, 2019-20a. Directorate of Economics and Statistic, Government of India.

Anonymous, 2019-20b. Directorate of Economics and Statistic, Government of Assam.

Banga, R. S., Dhawan, K. and Singh, D. 2013. Quality and yield of Indian mustard genotypes as influenced by different fertility levels. Oilseeds Section, Department of Plant Breeding, CCS Haryana Agricultural. University, Hisar (India).

Bjaili, A.A., Al-Solaimani, S.G. and EL-Nakhlawy, F.S. 2019. Growth and Seed Quality of Sunflower (*Helianthus annuus* L.) Cultivars as Affected by Nitrogen Fertilizer and Defoliation Rates. *International Journal of Engineering Research & Technology.* **8**(1): 161-167.

Deka, P., Pathak, K., Begum, M., Sarma, A. and Dutta, P.K. 2018. Seed yield and nutrient uptake in late sown

toria (*Brassica campestries* var. toria) as influenced by different irrigation and fertilizer levels. *Agricultural Science Digest-A Research Journal.* 38(2): 127-130.

Gaikwad, S.R., Suryavanshi, V.P., Bhusari, S.A. and Misal, A.M. 2005. Effect of fertilizers on growth and yield of linseed (*Linum usitatissimum* L.) varieties. *The Pharma Innovation Journal*. 9(10): 127-131.

Gogoi, B. 2019. Rabi niger crop (*Guizotia abyssinica* L.) fits well under Assam condition. *Dimorian Review.* 6(5).

Gupta, M., Sarabdeep, K., Vikas, G., Rajeev, B. and Charu, S. 2017. Effect of different doses of fertilizers on yield and NPK uptake of linseed (*Linum usitatissimum* L.). *Bangladesh Journal of Botany.* 46(2): 575-581.

Hokmalipour, S. and Darbandi, M.H. 2011. Effects of nitrogen fertilizer on chlorophyll content and other leaf indicate in three cultivars of maize (*Zea mays* L.). *World Applied Sciences Journal.* 15(12): 1780-1785.

Kumar, P., Singh, R., Kumar, R. R., Kumar, D., Sohane, R. K., Singh, A. K. and Mehta, S. 2019. Varietal Evaluation of Different Genotypes of Linseed for Yield Performance in Aurangabad District of Bihar. *Current Journal of Applied Science and Technology*, pp. 1-4.

Kumar, R. 2015. 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. *Bangladesh Journal of Botany*. 44(4): 521-528.

Markwell, J., Ostermann, J. C. and Mitchell, J. L. 1995. Calibration of the Minolta SPAD-502 leaf chlorophyll meter. *Photosynthetic Research*. 46: 467-471.

Nambaiar, K.K.M. and Abrol, I.P. 1989. Long term fertilizer experimrnts in India- An over view. *Fertilizer News.* 34(4) : 11-20 and 26.

Nasim, W., Ahmad, A., Wajid, A., Akhtar, J. and Muhammad, D. 2011. Nitrogen effects on growth and development of sunflower hybrids under agroclimatic conditions of Multan. *Pakistan Journal of Botany.* 43(4) : 2083-2092.

Nem, T., Sharma, P., Devadas, V.S., Hazarika, G.N. and Monlai, S. 2020. Performance of Toria (*Brassica campestris* L.) Varieties under Namsai Conditions. *International Journal of Current Microbiology and Applied Sciences.* 9(10): 2101-2103.

Pati, P. and Acharya, N.N. 2009. Response of toria varieties to fertilizer levels. *Agricultural Science Digest*. 29(2): 63-65.

Raghuvanshi, N., Kumar, V. and Dev, J. 2018. Effect of nitrogen levels on mustard (*Brassica juncea* (L.) Cuzern and Coss.) varieties under late sown condition. *Current Journal of Applied Science and Technology.* 30(2): 1-8.

Ramdan, M.F. 2012. Functional properties, nutritional value and industrial applications of niger oilseeds (*Guizotia abyssinica* Cass.). *Critical Reviews in Food Science and Nutrition.* 52 : 1-8.

Ranganatha, A.R.G., Panse, R.K., Panday, A.K. and Deshmukh, M.R. 2014. Strategies for Maximizing Sesame and Niger Production. In: *Recent Advances in Weed Management organized at Directorate of Weed Science Research* (ICAR), Jabalpur.

Sandeep, K. R. and Kubsad, V. S. 2017. Growth and yield of niger (*Guizotia abyssinica* Cass.) as influenced by planting geometry, fertilizer levels and cycocel spray. *Journal of Farm Sciences.* 30(2): 172-176.

Shaikh, M. F., Mirza, I.A.B. and Shaikh, S. N. 2019. Performance of niger *(Guizotia abyssinica lf. Cass)* varieties under varied weather condition marathwada region. *Indian Journal of Pure and Applied Biosciences*. 7(4): 473-477.

Sharma, R.S. and Kewat, M.L. 1998. Niger does well under farming situation constraints. *Indian Farming.* 47(11): 15- 24.

Sharma, S.M. 1993. Status and strategies of sesame and niger research in India. *National Seminar on Oilseeds Research and Development in India, held at Hyderabad.* Aug 2 to 5 : 60-69.

Singh, S. P., Singh, R. A., Yadav, V. R., Chaudhary, S. and Kumar, A. 2017a. Effect of Different Nutrient Combinations on Yield and Quality of Mustard Varieties (*Brassica juncea* L.). *International Journal of Current Microbiology and Applied Sciences.* 6(2): 1343-1347.

Singh, D.N., Bohra, J. S. and Singh, J.K. 2013. Influence of NPK, S and variety on growth, yield and quality of irrigated linseed (*Linum usitatissimum*). *Indian Journal of Agricultural Sciences.* 83(4): 456-458.

Singh, C., Singh, P. and Rajbir, S. 2010. *Oil Crops of Mustard (Brassica juncea L.) Genaral Introduction Modern Techniques of Raising Field Crops*. Oxford and IBH publishing Company Pvt. Ltd., New Delhi. pp. 273-291.

Watson, D.J. 1952. The physiological basis of variation in yield. *Advance in Agronomy.* 4: 101-145.