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RESEARCH PAPER

Response of niger (*Guizotia abyssinica*) to different levels of nitrogen, phosphorus, potassium and sulphur

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Abstract : A field experiment was conducted at Instructional-cum-Research (ICR) Farm, Assam Agricultural University, Jorhat during *Rabi* seasons of 2016-17 and 2017-18 to study the response of niger to different levels of nitrogen, phosphorus and potassium as well as sulphur on growth, yield and oil content of niger. The experiment was laid out in Factorial Randomized Block Design with three replications. The treatments comprised of three NPK levels *viz*., F_1 (20-10-10 kg N-P_2O_5-K_2O ha^{-1}), F_2 (25-12.5-12.5 kg N-P_2O_5-K_2O ha^{-1}), F_3 (30-15-15 kg N-P_2O_5-K_2O ha^{-1}) and three S levels *viz*., S_1 (no sulphur), S_2 (10 kg S ha^{-1}), S_3 (20 kg S ha^{-1}). Application of F_3 (30-15-15 kg N-P_2O_5-K_2O ha^{-1}) and S_3 (20 kg S ha^{-1}) recorded maximum and significantly higher seed yield (q ha^{-1}), oil content (%), oil yield (q ha^{-1}) as well as growth and yield attributing parameters *viz.,* plant height, number of leaves $plant^{-1}$, number of branches $plant^{-1}$, number of capitulum $plant^{-1}$ and number of seeds $capitulum^{-1}$ during both the years. Test weight was not influenced significantly during both the years. Interaction effects of NPK (F) and sulphur (S) were found to be not significant in respect of growth and yield attributing characters in both the years. In case of seed yield (q ha^{-1}) and oil yield (q ha^{-1}) interaction effect were found to be significant in both the years.The highest gross return (Rs. 23,905.00 in 2016-17 and Rs. 22,400.00 in 2017-18) and net return (Rs. 11,184.86 in 2016-17 and Rs. 9679.86 in 2017-18) were recorded by F_3S_3 in both the years. In case of benefit-cost ratio, the higher value (1.88 and 1.76, respectively) was recorded with F_3S_3 during 2016-17 and 2017-18.

Key Words : Niger, Sulphur, Growth, Yield, Oil content

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INTRODUCTION

Oilseeds constitute an important group of commercial crops in India. It is the second largest agricultural commodity next to cereal. Oilseeds are rich sources of energy and nutrition and also provide superior quality protein, essential fatty acids, vitamins and minerals. The diverse agro-ecological conditions in the country are suitable for growing nine annual oilseed crops, which includes seven edible oilseed crops and two non-edible oilseed crops. Among them niger is one of the important edible oilseed crop. Niger belongs to *Asteracea* family. The seeds of niger contain a considerable quantity of edible oil (38-43%), protein

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(20%), sugar (12%) and minerals essential for human and animal meals. The oil is used for culinary purposes, in paints, soap manufacturing, perfume industry, lubrication and cosmetics. Its cake obtained after extraction of oil is valuable cattle feed, particularly for milch cattle and the low grade oil-cakes are also used as concentrated organic manures. India is the chief producer of niger and ranks second and fourth in the world for its acerage and annual production, respectively (Dalei *et al*., 2014). In India, niger is grown in an area of 4.2 lakh ha with a production of 1.12 lakh tonnes (Surve *et al*., 2013). The productivity of niger in India is 320 kg ha^{-1} (Jagtap *et al*., 2015). Niger can be grown successfully under varying agro-ecosystems and it has tolerance to streams of weather fluctuations with less susceptibility to damages by animals, birds, insects and diseases. Requirement of low levels of management in crop production, cultivation in poor lands, resistance to drought are the important features in favouring niger crop for its cultivation by the farming community. It gives sustained seed yield even under unfavourable situations. In Assam, area occupied by this oilseed crop is 5.29 thousand hectares and productivity is 619 kg ha^{-1} which is more than the national average productivity (Anonymous, 2019). Niger is grown under *Rainfed* condition hence its performance depends upon amount and distribution of rainfall in the state. Proper fertility management may be another factor for further improvement of productivity of the crop in the state of Assam. Nitrogen, phosphorus and potassium are major nutrients required for crop growth and yield. Moreover, the fourth major nutrient sulphur help in increasing seed yield as well as oil content. Keeping all the above points in view the present experiment has been conducted with the objective to study the response of niger to different levels of nitrogen, phosphorus, potassium and sulphur on growth, yield and oil content of niger.

Material and Methods

The field experiment was carried out at the Instructional-Cum-Research (ICR) Farm, Assam Agricultural University, Jorhat-13 during *Rabi* seasons of the year 2016-17 and 2017-18. The farm is situated at 26º45'N latitude, 94º12'E longitude and at an altitude of 87.0 meter from the mean sea level. The climatic condition of Jorhat is sub-tropical humid with hot summer and cold winter. During the crop seasons of 2016-17 and 2017-18 a total rainfall of 99.5 mm and 41.8 mm, respectively was received. The experiment was laid out in Factorial Randomized Block Design with three replications. The treatments comprised of three NPK levels *viz*., F_1 (20-10-10 kg N-P_2O_5-K_2O ha^{-1}), F_2 (25-12.5-12.5 kg N-P_2O_5-K_2O ha^{-1}), F_3 (30-15-15 kg N-P_2O_5-K_2O ha^{-1}) and three S levels *viz*., S_1 (no sulphur), S_2 (10 kg S ha^{-1}), S_3 (20 kg S ha^{-1}). The soils of the experimental site were sandy loam in texture, acidic in reaction, medium in organic carbon (0.68% and 0.70%), medium in available N (285.10 kg ha^{-1} and 274.42 kg ha^{-1}), available P_2O_5 (24.45 kg ha^{-1} and 25.40 kg ha^{-1}), and available K_2O (158.32 kg ha^{-1} and 150.58 kg ha^{-1}) and low in available S (17.94 kg ha^{-1} and 16.40 kg ha^{-1}) for the year, 2016-17 and 2017-18.

The crop variety used in the experiment was 'NG-1'. The sowing was done in the furrows of 3-5 cm depth opened at 25 cm apart. The fertilizers were incorporated into the soil one day before sowing of the crop by light hoeing. The seeds were sown on 4th November and harvested on 25th February in both the years. In order to represent the plot, five plants of niger from each plot were selected randomly for various biometric observations on growth and post harvest studies. Seed and stover yields $hectare^{-1}$ were worked out based on yield records in each plot. Seed oil content was determined with the help of "Soc-Plus" apparatus as per method described by AOAC (1960) and the oil yield (q ha^{-1}) was determined for each plot by multiplying the oil content with mean seed yield of corresponding treatment. Other observations were recorded following standard procedures.

Results and Discussion

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Effect on growth parameters of niger :

Data on different growth parameters of niger are presented in Table 1.

Effect of levels of NPK (F) :

The growth parameters like plant height, number of leaves $plant^{-1}$ and number of branches $plant^{-1}$ increased with the increase in the NPK levels at 30 and 60 DAS. All the parameters were significantly highest under F_3 (30-15-15 kg N-P_2O_5-K_2O ha^{-1}) than other levels of fertilizers in both the years. The increase in plant height

may be due to better availability of nitrogen at active growth stages of the crop which increased cell division and cell elongation. Secondly, more availability of NPK increases metabolic and meristematic activities which led to increase in plant height. The increase in number of leaves may be due to increase in NPK levels which increases cell division and differentiation, enhanced meristematic activity and also better chlorophyll synthesis. The increase in number of branches might be due to availability of more nutrients which improve photosynthesis, cell multiplication and activation of plant enzymes. Similar results were also obtained by Paul *et al*. (1993), who reported that growth parameters of niger were significantly highest at 30-15-15 kg N-P_2O_5-K_2O ha^{-1} and was found to be optimum and remunerative fertilizer dose for niger under *Rainfed* conditions in sandy loam soils at Gossaigaon (Assam).

Effect of levels of sulphur (S) :

The growth parameters were also increased with increasing levels of sulphur. All these parameters were significantly highest under S_3 (20 kg S ha^{-1}) than those of S_2 and S_1 in both the years. Increase in plant height might be due to multiple role of sulphur in protein and carbon metabolism of plants by activating a number of enzymes which participate in dark reaction of photosynthesis. Secondly, it might be due to more synthesis of amino acids, increase in chlorophyll content in growing region and improving the photosynthetic activity, ultimately enhancing cell division and differentiation. Increase in number of leaves might be due to the role of sulphur which enhances the cell division, cell expansion and chlorophyll synthesis. Secondly, sulphur is important in the activity of meristematic tissue and development of shoots. Increase in number of branches $plant^{-1}$ might be due to the role of sulphur in cell elongation, cell division and setting of cell structure. The results are in line with the findings of Jagtap *et al*. (2003), who reported that application of sulphur with increasing levels of up to 30 kg ha^{-1} significantly enhanced plant height over control in linseed. Similarly, Singh *et al*. (2013) reported that application of sulphur with increasing

Table 1: Effect of levels of NPK and sulphur (S) on growth and yield attributing parameters of niger

Treatments	Plant height (cm)				Number of leaves $plant^{-1}$				Number of branches $plant^{-1}$		Number of capitulum $plant^{-1}$		Number of seeds $capitulum^{-1}$		Test weight (g)	
	30 DAS		60DAS		30 DAS		60 DAS		30 DAS	60 DAS						
	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18
Levels of NPK (F)																
F_1 = (20-10-10 kg N-P_2O_5-K_2O ha^{-1})	23.17	22.66	62.43	59.42	12.87	11.20	22.52	19.57	9.31	8.20	17.22	15.51	28.89	27.22	3.30	3.24
F_2 = (25-12.5-12.5 kg N-P_2O_5-K_2O ha^{-1})	25.67	24.40	66.54	62.70	14.33	12.83	24.99	21.96	10.64	9.00	19.33	17.51	31.49	29.24	3.36	3.30
F_3 = (30-15-15 kg N-P_2O_5-K_2O ha^{-1})	27.96	26.66	70.53	65.96	15.86	13.97	27.76	23.90	11.83	10.31	21.61	20.40	34.78	31.29	3.45	3.33
S.E. ±	0.68	0.57	1.08	1.05	0.45	0.32	0.77	0.63	0.37	0.22	0.65	0.53	0.85	0.66	0.88	0.05
C.D. (P=0.05)	2.04	1.72	3.26	3.15	1.37	0.98	2.30	1.89	1.11	0.67	1.94	1.61	2.55	2.00	NS	NS
Levels of S (S)																
S_1 = (0 kg S ha^{-1})	23.18	22.60	63.53	59.40	12.89	11.34	22.73	19.71	9.40	8.42	17.33	15.80	28.82	27.07	3.30	3.20
S_2 = (10 kg ha^{-1})	25.72	24.54	66.88	62.73	14.37	12.78	25.10	21.83	10.70	9.16	19.38	17.93	31.77	29.28	3.38	3.32
S_3 = (20 kg S ha^{-1})	27.88	26.56	69.10	65.94	15.80	13.86	27.43	23.87	11.88	9.92	21.44	19.68	34.55	31.38	3.43	3.35
S.E.±	0.68	0.57	1.08	1.05	0.45	0.32	0.77	0.63	0.37	0.22	0.65	0.53	0.85	0.66	0.88	0.05
C.D. (P=0.05)	2.04	1.72	3.26	3.15	1.37	0.98	2.30	1.89	1.11	0.67	1.94	1.61	2.55	2.00	NS	NS
Interaction (F x S)																
S.E. ±	1.18	0.99	2.20	1.82	0.80	0.57	1.33	1.09	0.64	0.38	1.12	0.93	1.47	1.15	0.15	0.10
C.D. (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

NS= Non-significant

level upto 40 kg ha^{-1} significantly enhanced number of branches plant^{-1} over control in linseed.

Interaction effect (FxS) :

The interaction effect of levels of NPK and S on plant height, number of leaves and number of branches plant^{-1} were found to be non-significant in both the years.

Effect on yield attributing characters of niger :

Data on different yield attributing characters of niger are presented in Table 1.

Effect of levels of NPK (F) :

Increase in the levels of NPK increased the yield attributing characters like number of capitulum plant^{-1} and number of seeds capitulum^{-1} and test weight (g). The values for all these parameters were significantly highest under F_3 (30-15-15 Kg N-P_2O_5-K_2O ha^{-1}) in both the years. This might be due to rich soil environment which promote reproductive growth processes and due to adequate supply of these nutrients resulted in higher production of photosynthates and their translocation to sink. Similar observations were recorded by Thakuria and Gogoi (1991), who reported that with increase in the NPK levels upto 40:20:20 kg ha^{-1} increases number of capitulum plant^{-1} and number of seeds capitulum^{-1} of niger under *Rainfed* condition in Jorhat (Assam).

Effect of levels of sulphur (S) :

The yield attributing characters like number of capitulum plant^{-1}, number of seeds capitulum^{-1} and test weight (g) were increased with increasing levels of sulphur. The values for all these parameters were significantly highest under S_3 (20 kg S ha^{-1}) followed by S_2 and the lowest values were recorded under S_1. Increase in number of capitulum plant^{-1} might be because of better absorption of applied nutrients led to cell multiplication due to availability of sulphur. Increase in number of seeds capitulum^{-1} might be due to improved nutritional environment as a result of increased sulphur supply which might favourably increased the carbohydrate metabolism. The favourable effect led to increased translocation of photosynthates towards sink. Moreover, application of sulphur enhanced photosynthates assimilation to help in net export of carbohydrate to sink and thus increased the number of seeds capitulum^{-1}. Thentu *et al*. (2014) also reported that yield attributing characters were increased with increase in the levels of sulphur upto 40 kg ha^{-1}.

Interaction effect (FxS) :

Interaction effects were not significant.

Effect on seed yield and stover yield of niger :

Data regarding seed and stover yield (q ha^{-1}) as

Table 2 : Effect of levels of NPK and S on yield, harvest index as well as seed oil content and oil yield of niger

Treatments	Seed yield (q ha^{-1})		Stover yield (q ha^{-1})		Harvest index (%)		Seed oil content (%)		Oil yield (q ha^{-1})	
	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18
Levels of NPK (F)										
F_1 = (20-10-10 kg N-P_2O_5-K_2O ha^{-1})	4.38	4.07	27.83	26.78	13.80	13.19	36.22	34.96	1.61	1.43
F_2 = (25-12.5-12.5 kg N-P_2O_5-K_2O ha^{-1})	4.89	4.64	29.38	28.49	14.25	13.98	37.71	35.52	1.85	1.66
F_3 = (30-15-15 kg N-P_2O_5-K_2O ha^{-1})	5.81	5.38	31.17	30.70	15.69	14.84	38.88	36.82	2.27	1.99
S.E. ±	0.13	0.12	0.50	0.47	0.56	0.51	0.50	0.43	0.05	0.05
C.D. (P=0.05)	0.41	0.37	1.50	1.43	NS	NS	1.50	1.30	0.15	0.15
Levels of S (S)										
S_1 = (0 kg S ha^{-1})	4.32	4.01	27.76	26.97	13.47	13.00	36.03	34.04	1.55	1.36
S_2 = (10 kg ha^{-1})	5.06	4.70	29.33	28.60	14.65	14.07	37.54	35.93	1.92	1.69
S_3 = (20 kg S ha^{-1})	5.69	5.37	31.28	30.38	15.61	14.92	39.23	37.32	2.24	2.01
S.E.±	0.13	0.12	0.50	0.47	0.56	0.51	0.50	0.43	0.05	0.05
C.D. (P=0.05)	0.41	0.37	1.50	1.43	NS	NS	1.50	1.30	0.15	0.15
Interaction (F x S)										
S.E.±	0.24	0.22	0.87	0.82	0.97	0.88	0.87	0.75	0.09	0.08
C.D. (P=0.05)	S	S	NS	NS	NS	NS	NS	NS	S	S

NS= Non-significant

well as harvest index (%) of niger are presented in Table 2.

Effect of levels of NPK (F) :

The seed as well as stover yield were increased with the increase in levels of NPK. Among different levels of NPK the highest seed yield of 5.81 q ha^{-1} in 2016-17 and 5.38 q ha^{-1} in 2017-18 and stover yield of 5.69 q ha^{-1} in 2016-17 and 5.37 q ha^{-1} in 2017-18 were recorded under F_3 (30-15-15 kg N-P_2O_5-K_2O ha^{-1}) which were significantly higher than those of F_2 and F_1 in both the years. Application of F_3 resulted in increase in seed yield by 15.81 and 24.61 per cent in 2016-17, 13.75 and 24.34 per cent in 2017-18 over F_2 and F_1, respectively. Similarly, stover yield increased by 6 and 10.71 per cent in 2016-17, 7.1 and 12.76 per cent in 2017-18 under F_3 over F_2 and F_1, respectively. The increase in seed yield may be attributed to increase in growth and yield attributing characters like number of branches $plant^{-1}$, number of capitulum $plant^{-1}$ and number of seeds $capitulum^{-1}$. Secondly, it could be due to optimum availability of nutrients which favoured the growth and development of crop and helped in increased uptake of nutrients. Further, increase in levels of NPK increased leaf area which might have resulted in higher photosynthesis which leads to dry matter accumulation and its translocation to reproductive parts as indicated by higher values of growth and yield components that resulted in higher seed yield of niger. The increase in stover yield might be due to better vegetative growth of the crop in terms of more branching and taller plants. Baishya and Thakur (1997) also reported that application of 30-15-15 kg N-P_2O_5-K_2O ha^{-1} recorded maximum and significantly increased seed yield of niger and was economically viable under *Rainfed* condition of north bank plains agro-climatic zone of Assam.

Effect of levels of sulphur (S):

The seed and stover yield increased significantly with the increase in levels of sulphur in both the years. The highest seed yield of 5.69 q ha^{-1} in 2016-17 and 5.37 q ha^{-1} in 2017-18 and stover yield of 31.28 q ha^{-1} in 2016-17 and 30.38 q ha^{-1} in 2017-18 were recorded under S_3 (20 kg S ha^{-1}) which were significantly higher than the values of S_2 and S_1 in both the years. The seed yield of niger increased upto the extent of 11.22 and 24.21 per cent in 2016-17, 13.75 and 25.32 per cent in 2017-18 under S_3 over S_2 and S_1, respectively. Similarly, stover yield increased by 6.23 and 11.25 per cent in 2016-17, 5.8 and 11.22 per cent in 2017-18 under S_3 over S_2 and S_1, respectively. The increased seed yield is mainly due to increase in yield attributing characters like number of capitulum $plant^{-1}$, number of seeds $capitulum^{-1}$. Secondly, it might be due to the balanced nutritional environment, efficient and greater partitioning of metabolites and adequate translocation of nutrients towards reproductive site. Thirdly, more accumulation of amino acids, amide substances and their translocation to the reproductive organs influenced growth and yield of crop. The increase in stover yield might be due to the increase in vegetative growth which resulted in increased photosynthesis and assimilation rates, cell division, cell elongation and activation of enzymes. Debnath and Basu (2013) also found that the application of 20 kg S ha^{-1} proved to be optimum dose for yield maximization of safflower in Nadia (West Bengal). Similarly, Tomar (2012) reported that highest seed and stover yield in linseed was recorded with 20 kg S ha^{-1} which were significantly higher over 10 kg S ha^{-1} and further increase in sulphur level upto 30 kg ha^{-1} there was no response.

Interaction effect (FxS) :

Interaction effect of levels of NPK and S was found to be significant in respect of seed yield in both the years

Table 3: Interaction effect of levels of NPK and S on seed yield (q ha^{-1}) and oil yield (q ha^{-1})

Levels of S (S)	Levels of NPK (F)											
	Seed yield (q ha^{-1})						Oil yield (q ha^{-1})					
	2016-17			2017-18			2016-17			2017-18		
Treatments	F_1	F_2	F_3	F_1	F_2	F_3	F_1	F_2	F_3	F_1	F_2	F_3
S_1	4.07	4.30	4.60	3.80	3.93	4.30	1.43	1.56	1.66	1.27	1.34	1.49
S_2	4.38	4.80	6.00	4.00	4.67	5.43	1.64	1.80	2.34	1.42	1.65	2.00
S_3	4.68	5.57	6.83	4.40	5.33	6.40	1.75	2.18	2.82	1.59	1.98	2.48
S.E.±		0.24			0.22			0.09			0.08	
C.D. (P= 0.05)		0.72			0.65			0.27			0.25	

(Table 3). It might be due to the additive effect of NPK and sulphur which resulted in more availability of nutrients and ultimately increased yield. Secondly, NPK fertilizers likely to make the crop more responsive to sulphur by increasing the vegetative growth of the crop which increased yield of niger. Moreover, addition of sulphur with NPK fertilizers may maintain a favourable balance between the applied nutrients in the plant for its optimum growth. These findings are in conformity with those by Parmar *et al*. (2010), who reported that interaction effect of fertilizers and sulphur was significant in case of seed yield of mustard.

Effect on seed oil content (%) and oil yield (q ha^{-1}) of niger:

Data pertaining to the oil content (%) and oil yield (q ha^{-1}) of niger are presented in Table 2.

Effect of levels of NPK (F):

The seed oil content increased with increasing levels of NPK. The highest seed oil content was recorded by F_3 (30-15-15 kg N-P_2O_5-K_2O ha^{-1}). It could be due to effect of phosphorus and potassium. Although nitrogen does not affect seed oil content but when applied in combination with phosphorus and potassium, it increased oil content of crop. The increase in oil content with phosphorus application could be due to the fact that phosphorus help in synthesis of fatty acids and their esterification by accelerating biochemical reaction in glyoxylate cycle in respect of oil content and potassium plays major role in enzymatic system that control metabolism of photosynthates and their conversion to oil.

Effect of levels of sulphur (S):

Application of S_3 (20 kg S ha^{-1}) increased the seed oil content by 4.30 and 8.15 per cent in 2016-17, 3.72 and 8.7 per cent in 2017-18 than S_2 and S_1, respectively. This could be attributed to the influence of sulphur in rapid conversion of nitrogen to crude protein and finally to oil. Secondly, the acetic thiosulphate, a sulphur based enzyme in the presence of sulphur convert acetyl Co-A to melonyl Co-A rapidly resulted in higher oil content in seed .Similar trend was reported by Bainade *et al*. (2019), who found that seed oil content of linseed increased with increase in the levels of sulphur upto 25 kg ha^{-1}.

Interaction effect (FxS):

Interaction effect between NPK (F) and sulphur (S) was found to be non-significant.

Effect of levels of NPK (F):

The oil yield increased significantly with the increasing levels of NPK. Oil yield was recorded highest (2.27 q ha^{-1} in 2016-17 and 1.99 q ha^{-1} in 2017-18) under F_3 (30-15-15kg N-P_2O_5-K_2O ha^{-1}). This is due to increase in seed yield as well as oil content in niger.

Effect of levels of sulphur (S):

The oil yield increased significantly with increasing levels of sulphur. Oil yield was recorded highest (2.24 q ha^{-1} in 2016-17 and 2.01 q ha^{-1} in 2017-18) under S_3. This was due to increase in seed yield as well as oil content in niger. Sharma and Bansal (1998) also observed that the oil content of safflower seeds was increased with the application of sulphur upto 30 kg ha^{-1}.

Table 4: Comparative economics of different treatment combinations during the years 2016-17 and 2017-18

Treatments	2016-17				2017-18			
	Cost of cultivation (Rs. ha^{-1})	Gross return (Rs. ha^{-1})	Net return (Rs. ha^{-1})	Benefit-cost ratio	Cost of cultivation (Rs. ha^{-1})	Gross return (Rs. ha^{-1})	Net return (Rs. ha^{-1})	Benefit-cost ratio
F_1S_1	8613.31	14245	5631.69	1.65	8613.31	13300	4686.69	1.54
F_1S_2	10313.31	15330	5016.69	1.48	10313.31	14000	3686.69	1.35
F_1S_3	12013.31	16380	4366.69	1.36	12013.31	15400	3386.69	1.28
F_2S_1	8966.70	15050	6083.30	1.67	8966.70	13755	4788.30	1.53
F_2S_2	10666.70	16800	6133.30	1.57	10666.70	16345	5678.30	1.53
F_2S_3	12366.70	19495	7128.30	1.58	12366.70	18655	6288.30	1.50
F_3S_1	9320.14	16100	6779.86	1.73	9320.14	15050	5729.86	1.61
F_3S_2	11020.14	21000	9979.86	1.90	11020.14	19005	7984.86	1.72
F_3S_3	12720.14	23905	11184.86	1.88	12720.14	22400	9679.86	1.76

Price of output: Selling price of niger seed = Rs. 35 kg^{-1}

Interaction effect (FxS):

The interaction effect of levels of NPK and S was found to be significant in respect of oil yield in both the years (Table 3). This might be due to combined effect of NPK and S on seed yield and oil content which ultimately increased oil yield.

Effect on economics :

Economic comparison of the treatments was done on the basis of gross return, net return and benefit-cost ratio (Table 4). The highest gross return (Rs. 23905.00 in 2016-17 and Rs. 22400.00 in 2017-18) and net return (Rs.11184.86 in 2016-17 and Rs. 9679.86 in 2017-18) were recorded by F_3S_3 in both the years which were because of the highest yield obtained under this treatment. In case of benefit-cost ratio, the highest value (1.90) was recorded by F_3S_2 which was slightly higher than F_3S_3 (1.88) during 2016-17. But, during 2017-18 the highest value (1.76) was recorded by F_3S_3. Paul *et al*. (1993) also recorded the highest net return from niger cultivation with the application of 30-15-15kg N-P_2O_5-K_2O ha^{-1} at Gossaigaon (Assam).

REFERENCES

A.O.A.C. (1960). *Official method of analysis*. 10th Edn. Association of Official.

Anonymous (2019). *Directorate of Economics and Statistics,* Statistical Handbook Assam-2019. (des.assam.gov.in).

Bainade, S. P., Parlawar, N. D., Korade, S. B. and Hivare, V. S. (2019). Effect of sulphur on growth, yield and quality parameters of linseed (*Linum usitatissium*). *J. Soils & Crops,* **29**(1): 136-139.

Baishya, A. and Thakur, A. C. (1997). Effect of graded levels of NPK fertilizers on the yield of niger under *Rainfed* condition of north bank plain zone of Assam. *J. agric. Sci. Soc. North East India,* **10**(1): 116-117.

Dalei, B. B., Kheroar, S., Mohapatra, P. M., Panda, S. and Deshmukh, R. M. (2014). Effect of foliar sprays on seed yield and economics of niger [*Guizotia abyssinica* (L.f.) Cass]. *J. Agril. Sci*., **6**(6): 143-147.

Debnath, S. and Basu, A.K. (2013). Effect of sulphur on seed yield and oil content in safflower. *J. Crop & Weed*, **9**(2): 113-114.

Jagtap, A.G. (2003). Effect of different sources and levels of sulphur on growth and yield of linseed. *Indian J. Agric. Sci.,* **74** (1) : 40-42.

Jagtap, P. K., Sandipan, P. B., Patel, K. M. and Patel, M. C. (2015). Growth and yield attributes in niger as influence by sowing time. *J. Agric. Sci.,* **6**(1): 12-15.

Parmar, R. M., Parmar, J. K. and Patel, M. K. (2010). Effect of nitrogen and sulphur on yield and yield attributes of mustard under the loamy sand soil of North Gujarat. *An Asian J. Soil Sci.,* **5**(2): 295-299.

Paul, S. K., Suhrawardy, J. and Gupta, B. (1993). Response of niger to NPK fertilization under *Rainfed* condition in Assam. *Madras Agril. J.,* **80**(5): 289-290.

Sharma, U. K. and Bansal, K.N. (1998). Influence of different levels and sources of sulphur on yield and nutrient uptake by safflower grow on alluvial soils. *Crop Res.,* **16**(3): 306-308.

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

Surve, V., Patel, C. L., Patil, P. R., Pisal, R. R., Patel, R. and Patel, D. (2013). Performance of *Rabi* niger [*Guizotia abyssinica* (L.) Cass] Influenced by phosphorus management. *Internat. J. Forestry & Crop Improv.,* **4** (1): 40-43.

Thakuria, K. and Gogoi, P. K. (1991). Nutrient requirement of niger (*Guizotia abyssinica* Cass) under *Rainfed* condition. *Indian J. Agron.,* **37**(3): 608-610.

Thentu, T. L., Nawlakhe, S. M., Mankar, D. D., Shrinivasrao, M. and Bhonde, G. V. (2014). Growth, yield and quality of summer sesame as influenced by the fertilizer and sulphur levels. *J. Soils & Crops,* **24**(1): 143-147.

Tomar, R. S. (2012). Response of linseed (*Linum usitatissium*) to sources and doses of sulphur in alluvial soils of Madya Pradesh. *Crop Res.,* **43**(1-3) : 39-41.