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Effects of Different Levels of NPK and Sulphur on Growth and Yield Attributes of Rapeseed (*Brassica campestris* var. toria)

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A B S T R A C T

The field experiment was carried out at Research field of Department of Agronomy, Allahabad school of Agriculture, during *rabi* season of 2016. The experiment was laid out in 3×3 factorial randomized block design with 9 treatments in three replications. It was observed that the best yield attributes characters in treatment T_8-(@120:60:40 kg NPK ha^{-1} + 40 kg Sulphur ha^{-1}) in respect to different days intervals i.e. 30, 60, 90 and 120 days after sowing (DAS). Plant height was 20.61, 122.45, 169.67 and 171.91 cm found to be significant at 120 DAS but non-significant at 30, 60 and 90 DAS. Number of leaves $plant^{-1}$ were 8.00, 14.22, 17.56 and 8.30 found to be non-significant at 60 and 90 DAS but significant at 30 and 120 DAS. Number of branches $plant^{-1}$ was 9.33, 11.44 and 11.94 found to be significant at 120 but non-significant at 60 and 90 DAS. Highest number of siliqua $plant^{-1}$, Number of seeds $siliqua^{-1}$, fresh weight $plant^{-1}$ (g), dry weight $plant^{-1}$ (g), test weight (g), seed yield (t ha^{-1}), straw yield (t ha^{-1}) and oil content(%) was found in T_8-(@120:60:40 kg NPK ha^{-1} + 40 kg Sulphur ha^{-1}) which was 301.00, 16.20, 104.44, 37.45, 3.96, 22.00, 45.12 and 37.67 was found to be significant. Highest B:C ratio (1:2.36) was recorded in T_3-(@ 60:30:20 kg NPK ha^{-1} + 0 kg Sulphur ha^{-1}). However, since these findings are based on one year experiment and therefore, further research may be conducted to substantiate it under Allahabad agro climatic conditions.

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. Rapeseed-mustard is an important group of edible oil seed crops and contributes around 26.1% of the total oil seed production and contributes about 85% of the total rapeseed–mustard produced in India (Meena *et al.*, 2011). The first position in area and second position in Production after China (Anonymous, 2009). Rapeseed and mustard crops are being cultivated in 53 countries

spreading over the six continents across the globe covering an area of 24.2 million hectare. Indians contribution to world hectare and production is 28.3 and 19.8 percent respectively.

In India, Toria is cultivated on 6.86 million hectares in Rabi season. Rapeseed-Mustard is the most important oil seed crop accounting around production 6.31(million tonnes) of total oilseed production in India (Directorate of Economics and Statistics, Department of Agriculture 2015). Nitrogen is the most important nutrient, which determines the growth of the mustard crop and increases the amount of protein and the yield.

Rapeseed is rich in minerals like calcium, manganese, copper, iron, selenium, zinc, vitamin A, B, C and proteins. 100g mustard seed contains 508 kcal energy, 28.09g carbohydrates, 26.08g proteins, 26.08 g total fat and 12.2g dietary fiber. Nitrogen is the most important nutrient, which determines the growth of the Rapeseed crop and increases the amount of protein and the yield. Phosphorus and potash are known to be efficiently utilized in the presence of nitrogen. It promotes flowering, setting of siliqua and in increase the size of siliqua and yield. Sulphur is also an important nutrient and plays an important role in physiological functions like synthesis of cystein, methionine, chlorophyll and oil content of oil seed crops. It is also responsible for synthesis of certain vitamins (B, biotin and thiamine), metabolism of carbohydrates, proteins and oil formation of flavored compounds in crucifers. *Brassica* has the highest sulphur requirement owing to the presence of sulphur rich glucosinolates (Bharose *et al.,* 2010). Potassium is one of the seventeen elements which are essential for growth and development of plants. It's for improving the yield and quality of different crops because of its effect on photosynthesis, water use efficiency and plant tolerance to diseases, drought and cold as well for making the balance between protein and carbohydrates. (Singh *et al.,* 2010)

The technology mission in oilseed initiated in 1986 paved the way to meet different challenges and complexities in the oilseed sector. There was five times increase in oilseed production during the period revising 1950-2004 under predominantly rainfed agro-ecological conditions. These were higher than even the corresponding production increase in total food grains during 2003-2004. Even with a record oilseed production of 25.1 million tones, India imported 51 lakh tones of vegetable oils costing more than Rs. 11000 crores. The country's demand for vegetable oils is expected to increase from the current level of 13 millions tones to 14.8, 18.3 and 21.8 million tons by 2010, 2015 and 2020 respectively (Hedge,2007). In Uttar Pradesh, mustard occupies an area of 0.781 million hectares and production of 0.957 million tones (Hedge, 2007). Nearly 76% oilseeds area is rainfed which is often subjected to erratic monsoon.

The oil content of the yellow mustard seeds ranges from 41-47 % and 20-40 % protein. The seed and oil are used as condiments in the preparation of pickles and for flavoring curries and vegetables. The oil cake is mostly used as a cattle feed and the leaves of young plants are used as green vegetables. The use of mustard oil for industrial purposes is rather limited on account of its high cost. Apart from this yellow mustard cake is also used as organic manure for the soil.

The crop requires relatively cool temperate, a fair sunny and moist weather during the growing period and dry weather during harvest period. Above all the major drawback in the low yield is that is generally grown as a mixed crop potato, sugarcane and gram without the additional application of essential

plant nutrient like nitrogen, phosphorus, potash and sulphur.

Materials and Methods

The experiment was conducted during *rabi* season of 2016-17 at Crop research farm Department of Agronomy Allahabad School of Agriculture SHUATS Allahabad. The experimental site is located in the sub – tropical region with 25^0 27^1 N latitude 81^0 51^1 E longitudes and 98 meter the sea level *altitudes*. The experiment was laid out in a 3×3 RBD factorial design with three levels of NPK and Sulphur with nine treatments, each consisting of three replicates. The total number of plots was 27. Rapeseed (*Brassica campestris* L.) was sown in rabi season plots of size 4.0 x 2.5 m with row spacing 30 cm and plant to plant distance 10 cm. The Soil of experimental area falls in order of inceptisol.The soil of the experimental field is alluvial in nature, both the mechanical and chemical analysis of soil was done before the starting the experiment to ascertain the initial fertility of the soil. The soil samples were randomly collected from 0-15 cm depths at randomly prior to tillage operations. The samples were mixed depth viz. and its weight was reducing by air drying, conning, quartering and passing it through 2mm sieve. To obtain composite soil sample in respective to different depth viz. the soil was stored for mechanical chemical analyzed. The treatment consisted of nine combination of inorganic source of fertilizers T_0-(@ 0:0:0 kg NPK ha^{-1} + 0 kg Sulphur ha^{-1}), T_1-(@ 0:0:0 kg NPK ha^{-1} + 20 kg Sulphur ha^{-1}), T_2-(@ 0:0:0 kg NPK ha^{-1} + 40 kg Sulphur ha^{-1}), T_3-(@60:40:20 kg NPK ha^{-1} + 0 kg Sulphur ha^{-1}), T_4-(@60:30:20 kg NPK ha^{-1} + 20 kg Sulphur ha^{-1}), T_5-(@60:30:20 kg NPK ha^{-1} + 40 kg Sulphur ha^{-1}), T_6-(@120:60:40 kg NPK ha^{-1} + 0 kg Sulphur ha^{-1}), T_7-(@120:60:40 kg NPK ha^{-1} + 20 kg Sulphur ha^{-1}), T_8-(@120:60:40 kg NPK ha^{-1} + 40 kg Sulphur ha^{-1}). The source of NPK and Sulphur Urea, DAP, MOP and Zinc sulphate respectively.

Physical and chemical analysis of soil samples (pre-sowing) (Table 1 and 2).

Results and Discussion

Growth parameters

Table 3 shows the interaction effect of different levels of NPK and Sulphur the important growth parameters of Rapeseed crop.

Plant height (cm)

Increase in plant height due to increasing of NPK and Sulphur may be due to adequate nutrients which are turns help in vigorous vegetative growth of plants and subsequently increase the plant height through cell elongation cell division photosynthesis and turbidity of plant cell. The maximum height recorded as 20.61, 122.45, 169.67 and 171.91 respectively at 30, 60, 90 and 120 DAS in treatment T_8Similar results have also been recorded by Tripathi *et al.*, (2011).

Number of leaves $plant^{-1}$

The effect of different levels of NPK and Sulphur on no. of leaves $plant^{-1}$ was found significant at 30, and 120 DAS, whereas found non-significant at 60 and 90 DAS. The maximum number of leaves $plant^{-1}$ was recorded as 8.00, 14.22, 17.56 and 8.30 respectively at 30, 60, 90 and 120 DAS in treatment T_8 Similar results have also been recorded by Tripathi *et al.*, (2011).

Number of branches $plant^{-1}$

The effect of different levels of NPK and Sulphur on number of branches $plant^{-1}$ was found to be significant. The maximum

number of plant^{-1} was recorded as 9.33, 11.44 and 11.94 respectively at 60, 90 and120 in treatment T_8 Similar results have also been recorded by Tripathi *et al.*, (2011).

Table 4 shows the interaction effect of different levels of NPK and Sulphur the important plant yield attributes parameters of Rapeseed crop.

Table.1 Physical analysis of soil

Particulars	Method employed	Results
Sand (%)	Bouyoucous Hydrometer	60.00
Silt (%)	method Bouyoucous (1927)	20.12
Clay (%)		19.88
Textural class	Core method	Sandy loam
Bulk density (g cm^{-3})	Graduated measuring cylinder Black (1965)	1.30
Particle density (g cm^{-3})	Graduated measuring cylinder Black (1965)	2.47
Pore Space (%)	Graduated measuring cylinder Black (1965)	56.95

Table.2 Chemical analysis of soil

Particulars	Method employed	Results
pH (1:2)	Digital pH meter (Jackson, 1958)	7.80
EC (dSm^{-1})	EC meter (Digital Conductivity Meter) (Wilcox, 1950)	0.28
Organic Carbon (%)	(Walkley and Black's method, 1947)	0.33
Available Nitrogen (kg ha^{-1})	Alkaline potassium permanganate method (Subbaih and Asija, 1956).	352.08
Available Phosphorus (kg ha^{-1})	Colorimetric method (Olsen *et al*. 1954)	20.78
Available Potassium (kg ha^{-1})	Flame photometric method (Toth and Prince, 1949)	228.12
Available Sulphur (kg ha^{-1})	Turbidemetric (Chesnin & Yien, 1950)	25.83

Table.3 Plant growth parameter

Treatment	Plant height (cm)				Number of leaves plant^{-1}				Number of branches plant^{-1}		
	30 DAS	60 DAS	90 DAS	120 DAS	30 DAS	60 DAS	90 DAS	120 DAS	60 DAS	90 DAS	120 DAS
T_0	14.14	64.6	103.44	105.32	5.78	11	13.56	5.3	6.33	7.78	8.28
T_1	15.22	79.44	117.44	118.5	6.33	11.33	14.22	5.5	6.66	8.44	8.94
T_2	15.09	81.11	119	121	6.67	12	15.11	5.63	7.67	9.22	9.72
T_3	15.85	92.66	139.44	140.72	6.67	11.89	15.67	5.73	7.87	9.22	9.72
T_4	16.52	100.33	151.33	153.39	6.78	11.89	15.89	6.2	8.33	9.56	10.06
T_5	17.29	104.66	156.78	158.16	6.89	13.22	16.11	6.87	8.44	10.56	11.06
T_6	16.33	117	162.22	163	7.33	13.22	16.78	6.1	8.67	10.67	11.17
T_7	17.97	12233	166.22	167.89	7.44	14.22	17.11	7.17	9.11	10.78	11.28
T_8	20.61	122.44	169.67	171.91	8	14.22	17.56	8.3	9.33	11.44	11.94
F-test	NS	NS	NS	S	S	NS	NS	S	NS	NS	S
S.Ed. (±)	1.424	5.857	6.809	1.978	0.175	0.359	0.314	0.108	0.249	0.265	0.155
C.D. (at 5%)	3.02	12.417	14.435	4.193	370	0.76	0.665	0.229	0.528	0.562	0.329

Table.4 Plant yield attributes parameter

Treatment	Siliqua plant^{-1}	Seeds siliqua^{-1}	Fresh weight (g)	Dry weight (g)	Test weight (g/1000 seeds)	Total grain yield (t ha^{-1})	Stover yield (t ha$^{-1)}$	Oil content (%)	B:C ratio
T_0	116.12	14.40	15.78	4.89	3.78	1.36	2.83	29.87	1.93
T_1	152.90	14.40	21.78	7.00	3.79	1.43	2.97	31.03	1.88
T_2	172.01	14.50	30.11	9.55	3.85	1.55	3.22	32.80	1.89
T_3	134.80	15.10	46.67	13.11	3.86	1.86	3.84	32.53	2.36
T_4	158.00	15.20	65.89	19.67	3.88	1.98	4.07	34.17	2.33
T_5	175.23	16.10	76.56	23.11	3.90	2.08	4.27	34.93	2.29
T_6	208.22	15.30	90.11	30.56	3.93	2.00	4.12	35.53	2.28
T_7	241.56	16.30	96.22	33.21	3.95	2.12	4.35	36.50	2.26
T_8	301.00	16.20	104.44	37.45	3.96	2.20	4.51	37.67	2.21
F-test	NS	S	S	S	S	S	S	S	
S.Ed. (±)	27.362	1.015	2.826	1.028	0.006	0.094	0.189	0.181	
C.D. (at 5%)	58.007	2.152	5.990	2.179	0.013	0.200	0.400	0.384	

Higher yield response in comparison of NPK and Sulphur alone was recorded with balanced application of NPK and Sulphur. The maximum number of siliqua plant^{-1} was recorded as 301.00 in treatment T_8 and minimum number of siliqua plant^{-1} was recorded as 116.12 in treatment T_0 and were found to be significant. The maximum fresh weight of plant recorded as 104.44 in treatment T_8 and minimum fresh weight of plant was recorded as 15.78 in treatment T_0 were found to be significant, The maximum dry weight of plant was recorded as 37.35 in treatment T_8 and minimum dry weight of plant was recorded as 4.89 in treatment T_0 and were found to be significant. The maximum test weight of seeds 3.96 g was recorded in T_8 and minimum test weight of seeds was 3.78 g recorded in T_0 and were found to be significant. The maximum seed yield 2.20 t ha^{-1} was recorded in T_8 and minimum seed yield 1.36 t ha^{-1} was recorded in T_0 and were found to be significant. The maximum stover yield 4.51tha^{-1} was recorded in T_8 and minimum stover yield 2.83 t ha^{-1} was recorded in T_0 which were found to be non-significant. Among the different treatments studied with respect of maximum Oil Content in seeds (%), The maximum Oil Content in seeds (%) was recorded in T_8 (37.67) and the minimum was recorded T_0 (29.87) Among the different treatments studied with respect of maximum B:C ratio, The maximum B:C ratio was recorded (2.36) in T_3 and the minimum was recorded in T_1 (1.88).

It is concluded that the best yield attributes characters in treatment T_8 in respect to different days intervals i.e. 30, 60, 90 and 120 days after sowing (DAS). Plant height was 20.61, 122.44, 169.67 and 171.91cm found to be significant at 120 DAS but non-significant at 30, 60 and 90 DAS, number of leaves plant^{-1} were 8.00, 14.22, 17.56 and 8.30 found to be significant at 30 and 120 DAS but non-significant at 60, and 90 DAS, number of branches plant^{-1} was 3.33,9.44 and 9.94 found to be at 120 DAS significant and at 60 and 90 DAS non-significant. Highest number of siliqua plant^{-1} was 301.00 found to be non-significant. Highest fresh weight(g), dry weight (g), test weight (g), seed yield (t), stover yield (t), and oil content(%)which was 16.20, 104.44, 37.45, 3.96, 2.20, 4.51, 37.67 found to be significant. T_8 which was found to be significant. Highest B:C ratio (2.36) was recorded in (T_3).

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