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Effect of macronutrients on the growth and yield of Rapeseed/toria (*Brassica campestris*)

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ABSTRACT

A field experiment was planned and conducted during the Rabi season of 2019-20 at agricultural research centre, school of agricultural sciences, SGRRU, Dehradun Uttarakhand, to investigate the "Effect of macronutrients on the growth and yield of Rapeseed/toria". The experiment was laid out in randomized block design with three replication and 8 treatments. Treatments constituted viz. Sulphur (Basal application). Sulphur (Foliar application), Sulphur (Basal+Foliar application), NPK (Basal) + Ca Mg:S (Basal), NPK(Basal) + Ca Mg S(Foliar), NPK(Foliar)+ Ca Mg S (Foliar) .70 kg/ha NPK with the recommended dose of 40:30:30,18 kg/ha Ca, 6kg/ha Mg. 40kg/ha S used in different doses in all treatments. The crop variety PR 2006 (Pant Rai 19) was shown on November 15, 2019 and harvested on March 25, 2020. Observation on various growth parameters, field attributes and yield were recorded. The seed and stover samples at harvest were collected; finally the economics of different treatments were worked out. Fertilizer management treatments significantly influenced various growth parameters, yield attributes and yield of mustard. Plant height, number of branches per plant, number of leaves per plant, number of siliqua/plant, number of seeds/siliquae yield recorded had significantly higher values under treatment T6 (NPK (Foliar) + Ca Mg S (Foliar) followed by T5-NPK (Basal)+ Ca:Mg:S (Foliar application) and T4- NPK (Basal)+Ca Mg:S (Basal) NPK (Foliar)+ Ca: Mg S(Foliar) T6 though recorded maximum seed yield (1875 kg/ha) but was statistical at par with NPK(Basal)+Ca:Mg S (Foliar) (1748kg/ha) and was significantly superior over remaining treatments. The treatment shows significantly high yield and plant growth in which all macronutrients are used as foliar application.

***Key words :** Fertilizer, NPK, Rapeseed, Siliquae, Macronutrients.*

Introduction

Oilseed have qualitative place in Indian agriculture next to cereals. Oilseeds are the most important crops in India both in respect of remunerative return per unit area and wider adaptability under constraint. Agro-climatic conditions. India is world's fourth largest edible oil economy after the US, China and Brazil, and is the second largest importer after China. India accounts for 7% of global oilseed output, 7% of Global Oil Mill production, 6% of Global Oil mill Exports, 6% of global vegetable oil produc-

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tion, 14% of global vegetable oil import and 10% of global edible oil (Shekhawat *et al.,* 2012). India is the largest rapeseed mustard growing country in the world occupying the first position in area and second position in production after China. India mustard output is seen at 80 million tons in 2019-2020 (June-July) 2.6% higher than last year's estimates of 17 market participants (Anonymous, 2017-18). The rapeseed-mustard is usually grown under low input management. The yield of this crop is very low (750 kilogram per hectare). Water and nutrient management are two important aspect of any crop optimum yield is possible, when these components are judicially incorporated in the crop husbandry. The mustard plant is a plant species in the genera *Brassica* and Sinapis in the family Brassicaceae. Mustard seed is used as spice. Grinding and mixing the seeds with water, vinegar, or other liquids creates the yellow condiment known as prepared mustard. The seed can also be pressed to make mustard oil, and the edible leaves can be eaten as mustard greens. Under rained conditions mustard attains poor growth. Due to Limited moisture in the root zone, the basal dose of drought may not be very effective. Foliar supply of nutrients can increase the photosynthetic efficiency by delaying the onset of sense of leaves Application of water macro, micro and beneficial elements through foliar spray can influence some of the plants psychological process and in turn help to minimise the yield reduction due to drought insufficient soil moisture. Beside micro, and beneficial elements all the major nutrients nitrogen phosphorus and potassium play important role in increasing the quality of mustard (Antil and Narwal, 2007). Nitrogen is known to activate most of the metabolic activities and transformation of energy; Phosphorus is essential for cell division and meristematic growth of tissues it also helps seeds and fruits development it and stimulates flowering as well. Effective utilisation of available rainwater also deserves a high priority as the efficient use of nutrients in dry land condition. Increase in water use efficiency due to phosphonis application is more on coarse-textured soils then on fine textured soil this is quite important as it provides extra production support to soils which have low moisture storage capacity. Such result confirm the role of nutrients in promoting extensive and deep root system making the water stored in deeper soil profile accessible to them. This may be very important during the drought periods when the surface soil dries up similarly potassium is also known to improve water use efficiency and help to maintain crop yield under moisture stress and reduce the extent of crop lost. Among the various factor responsible for maximization of this crop application of nitrogen phosphorus along with other micro and beneficial element is most important. For maximizing the yield, it is essential that Indian mustard should not suffer due to inadequate moisture supply and mineral nutrition especially nitrogen. Nitrogen and sulphur have important role in the seed protein and oil synthesis, work so far done indicates positive role of both nutrients in promoting quality of seed of toria, however, the quantum effect varies depending upon agroecosystem occupied by the crop. Sulphur deficiency of late has been widely recognised under light textured soil and especially in areas where intensive agriculture is done. Many alluvial soils where toria is mostly cultivated, contains less than 10 ppm available sulphur is also a key element in mustard rapeseed oil and the deficiency of sulphur course in the reduction of oil content. With this nutrient calcium magnesium and phosphorus potassium are also important for the plant growth these all are macronutrients. Sulphur is required for glucosinate formation and for this reason the sulphur requirement for brassica crop production is much as compared to other oilseed crops. Calcium consistent of middle lamella of call-wall (calcium pectate) which gives turgidity of cell, highly required in telophase for cell plate formation. Its contents in healthy plants range between 0.2-0.1% this is key because well-developed cell walls help resist disease. It is also necessary for metabolism contributes to the green colouring of plants Magnesium constituent of chlorophyll, chromosome polyribosome carrier of P in plants particularly in connection with the formation of seeds. Its content varies from 0.1-0.4% in healthy plants. Phosphorus is responsible for assisting growth of roots and flowers, phosphorus also helps plant with stand environmental stress and Harsh winters K regulate cosmo regulation and stomatal movement. It is a traffic policemen, root booster stalk strenghener food farmer sugar and starch Transporter protein builder. but it is not effective without its co-nutrients nitrogen and phosphorus. In view of these facts a field experiment involving treatments of macronutrients (NPK. Ca, Mg and S).

Materials and Methods

An investigation to study the "Effect of macronutrients on the growth and yield of rapeseed/toria" was carried out during the Rabi season of 2019-20 At the crop research centre Shri Guru Ram Rai University of agricultural science Dehradun. The materials used and the methods employed during investigation are detailed within this chapter. 3.1 Experimental site: The present investigation was laid out at the crop research centre of school of agriculture sciences, SGRRU, Dehradun, and Uttarakhand. It is in the North Western region of Uttarakhand at altitude off 450 m above mean sea level (MSL) and 3088 is square kilometre in size. Geographically, the location of Dehradun is in between 29 degree 58' and 78 degree 18" 30" East longitudes. The field experiment was conducted during Rabi season of 2019-2020. The climate of Dehradun is humid subtropical. Summer temperatures can reach up to 40-44 degree Celsius for a few days. Winter temperatures are usually between 1 and 20 degrees Celsius and fog is is common in winters like planes. Although the temperature in Dehradun can reach below freezing during severe cold snaps during the monsoon season there is often having and protected rainfall agriculture benefits from fertile alluvial soil adequate drainage and plentiful train it was recorded that Dehradun received 950 mm rainfall from the month of July to October in 2019 the maximum and minimum temperature was regarded during the growing season of crop (November 2018 to March 2019). The maximum and minimum temperature was recorded during the growing season of crop (i.e., November 2019 to March 2020) was 26 degrees Celsius and 6 degree Celsius respectively.

Results and Discussion

Plant population/m row length

The plant is stand recorded at initial and harvest stages are presented in the result indicate that both stages the plant population was not affected significantly by different treatment the plant population ranges between 7.24 -9.0 and 6.37-8.98 per square meter at initial and harvest stage, respectively.

Plant height (cm), Number of branches/plant and Number of leaves / plants

Plant height measure of growth was recorded periodically (Table 1) at an interval of 30 daysstarting from 30th day after sowing up to harvest stage. The mean data on plant height and point indicates that it was enhanced by multi-fold with the advancement of plantgrowth till 90 DAS, thereafter Such an increase was slow upto the harvest stage. The plantheight was found to be influenced (shown in Fig. 1) significantly due to different treatments of nutrients level withand without of bio fertilizers at all the growth stages. At 30 DAS, the treatment T4 NPK (Basal) +Ca: Mg: Sulfur (Basal), recorded significantly maximum height 12.62cm. Add 60 DAS, plant height was observed in the range of (95 -135.2) cm under different treatments, maximum plant height (135.2 cm) was observed under T4 -NPK (Basal)+Ca:Mg Sulfur (Basal), followed by TS, and T7 treatments and these treatments showed statisti-

Table 1. Effect of macronutrients on Plant Height, Branche and plant population of Rapeseed/toria (*Brassica campestris*)

Treatments	Plant Population/M Row Length Initial Harvest	Plant Height 30 DAS	60 DAS	90 DAS	Maturity		Branches/Plant 30 DAS	60 DAS	90 DAS	Maturity
T_1 (Sulfur Basal)	7.96	7.84	10.6	117.5	162.2	162.2	3.7	8.07	13.5	13.5
T_2 (Foliar)	8.21	8.00	9.5	125.2	168.5	168.5	3.4	9.82	14.6	14.6
T_3 (Sulfur Basal Foliar)	7.83	7.42	9.13	120.8	163.2	163.2	3.6	9.3	13.5	13.5
T_4 (N P K (B) + Ca:Mg:S(B)	9.00	8.98	12.62	135.2	170	170	4.9	10.8	15.3	15.3
T_5 (N P K (B) + Ca:Mg:S(F)	8.93	8.32	12.5	133	179.1	179.1	4.7	12.1	15.5	15.5
T_6 (N P K (F) + Ca:Mg:S(F)	8.01	8.93	9.3	125	180.1	180.1	3.6	10.4	16	16
T_7 N P K (Basal)	8.67	7.67	10.72	131	164	164	4.1	9.7	13	13
T_8 Control	7.24	6.37	8.73	95	140	140	3.3	8	11	11
SEM	0.39	0.28	0.5	4.36	4.13	4.13	0.36	0.45	0.47	0.47
CD (5%)	NA	NA	2.5	11.73	13.76	13.76	1.00	1.33	2.39	2.39

cally par in the respect of plant height Whereas, minimum height (95 cm) was Noted under control treatment At 90 DAS, and maturity, plant height was recorded in the range of (140 - 180.1 cm) under different treatments. Maximum plant height (180.1 cm) was observed under T6-NPK (foliar) CaMg: Sulfur (foliar), followed by TS, and T4 treatments with the height of 179.1, and these treatments showed statistically add per plant height from each other whereas minimum plant height (140 cm) was Noted under control treatment. Similar finding was also reported by Deka *et al.* (2018). The number of branches per plant was observed at 30,60 and 90 DAS and found significantly influenced due to different treatments are presented in Table 4.3 and depicted in the number of branches per plant was found significantly due to treatments of different nutrients levels with soil and foliar application at all the great growth stages. At 30 DAS, number of branches per plant was observed in range of (3.3-4.9) Under different treatments. Maximum branches 49 was observed under T4 NPK (Basal) + Ca:Mg:S (Basal) treatment followed by T5 and T7 treatments with 4.7 and 4.1 Branches/plant respectively and their treatment showed statistically at par difference from each other. Whereas minimum number of branches per plant were noted under control treatment. At 60 DAS, number of branches per plant was observed in the range of 8-12.1 under different treatments. Maximum branches 12.1 were observed under TS treatment which was significantly higher over all the treatments except T4 treatment, which shows 10.8 statistically at par branches per plant. Whereas minimum number of branches per plant was noted under control treatment. At 90 DAS number of branches per plant observed in the range of 11-16 under different treatments Maximum branches 16 was observed under T6 treatment which was significantly were over all the treatments except T5 and T6 treatments which shows 15.5 and 153 statistical at par branches per plant. Whereas minimum number of branches per plant was noted under control treatment At the maturity number of branches per plant was same as 90 DAS branches per plant. The minimum branches were observed under 16 treatment which was significantly hair over all the treatments and the minimum branches per plant was observed under control treatment. Similar finding was also reported by Deka *et al.* (2018). The number of leaves per plant was observed at 30 60 and 90 DAS and found significantly cod due to different treatments are presented in (Table 2) and depicted in Fig. 3 the er of leaves per plant was found to be significantly due to treatments of different nutrients in30 DAS number of leaves per plant was observed in the range of 5 48-88 under different Mowed by T4, T6 and T7 treatments and these treatments showed statistically at par different Maximum leaves 8.8 were observed under T5- NPK (Basal) Ca Mg S (foliar) ach other Whereas, minimum leaves 5.48 was recorded under control At 60 DAS number of leaves per plant was observed in the range of 12.6-37.2 under different treatments. Maximum leaves 372 was observed under T5- NPK (basal) + Ca Mg S (foliar) followed by T4, 17 and 13 treatments and these treatments showed statistically at per difference from each other. Whereas minimum number of leaves/plant 12.6 was recorded under control treatments. At 90 DAS, number of leaves per plant was observed in the range of 12.3-40.03 under different treatments, maximum leaves 40.03 was observed under T6- NPK (foliar) + Ca: Mg S (foliar) which was significantly higher over rest all

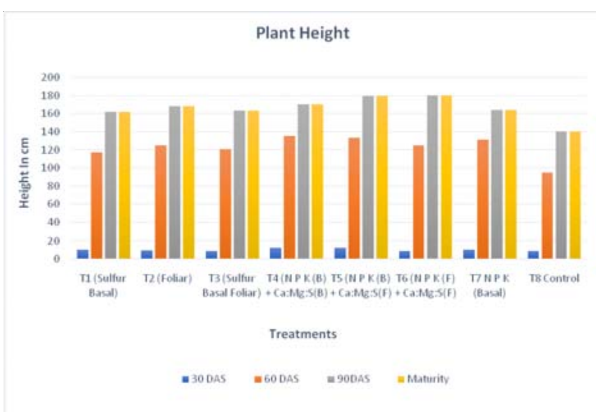

Fig. 1. Effect of macronutrients on plant height of Rapeseed/toria (*Brassica campestris*)

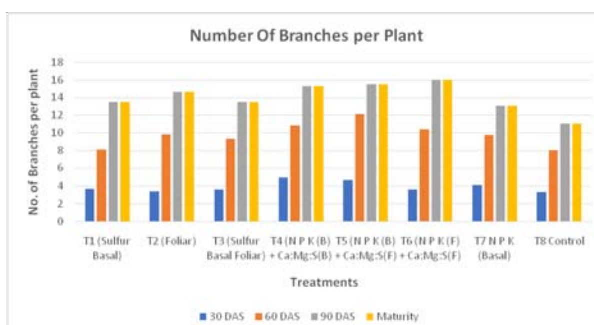

Fig. 2. Effect of macronutrients on Number of branches of Rapeseed/toria (*Brassica campestris*)

the treatments except T5 and T4 treatments and these treatments showed statistically at par difference from each other whereas, minimum 14.30 under control treatment At maturity, number of leaves was observed in the range 12.3-32 under different treatments full stop maximum leaves 32 was observed under T6 -NPK (foliar)+ Ca:MgS (foliar) whereas minimum number of leaves 12.3 was recorded under control treatments.

Yield attributing characters

Number of siliquae per plant and Length of siliqua per plant

The number of siliquae per plant was significantly influenced by different treatments are presented in Table 4.5 and Figure 4.4. The number of siliquae per plant from 73 -303.9 under different treatments and the magnitude of increase in number of silicas per plant due to various treatments was 8.5-320.73 over control. The maximum number of siliquae (303.9/plant) were recorded under treatment 16- NPK (foliar) +Ca:Mg:S (foliar) which was significantly higher over rest all the treatments except T5 -NPK (Basal) +Ca:Mg:S (foliar) and T4 -NPK (Basal)+Ca Mg S(Basal) treatment Whereas minimum number of siliquae per plant (73/plant) was recorded under control plots It is evident from table 4.5, that foliar application of NPK and foliar application of calcium magnesium and sulphur significantly increased number of siliquae per plant over onlybasal application of NPK Ca Mg. S and soil application of NPKC and foliar application of Calcium Magnesium and Sulphur Treatments. (T4 and T5). The treatment of sulphur (Soil +Foliar application, @50kg/ha) produced significantly higher number of siliquae/plant over respective sulphur (soil application)-T1 and Sulphur (foliar application) -T2 applied plots (Singh *et al.*, 2014) and (Thaneswar *et al.*, 2017). It is evident from the data presented in the table 4.5, that there was a significant increase in length of siliqua indifferent treatments compared to control. Length of siliqua was observed in the range of (2.3-3.93) cm under different treatments Maximum length 3.93 cm was observed in T6 -NPK (Foliar) + Ca:Mg:S (foliar) which was significantly higher over rest all the treatments except T5 treatment, which was statistically at par where as minimum length of siliqua was recorded under control T8 (2.30 cm).

Number of seeds/siliquae, 1000 seed weight (g) and Seed weigh/plant (g)

The number of seeds per siliqua was significantly influenced by different treatments are presented in Table 4.5. The number of seeds per siliqua varied from 10.4 -13.69 under different treatments. The maximum seeds 13.69/siliqua was recorded under treatment T6 NPK (Foliar)+ Ca:Mg:S (Foliar) which was significantly higher over all the treatments except TS -NPK (Basal) + Ca Mg:S (Foliar) and T4 -NPK (Basal)+Ca:Mg:S (Basal) which was statistically at par from each other. Whereas minimum value was recorded under control plots (Singh *et al.*, 2017). Produced. It is inferred from the data given in the table 4.5; state the different levels of nutrients It is an important yield attributing character with determines the seed size, quality of seed different combination of macronutrients was able to alter the 1000

Table 2. Effect of macronutrients on number of leaves and yield of Rapeseed/toria (Brassica campestris)"

Treatments	Leaves / Plants				Yield Attributes				
	30 DAS	60 DAS	90 DAS	Maturity	No. of Siliqua/ plant (Cm)	Length of Siliqua/ Plant (Cm)	No. of Seeds/ Siliquae	1000-Seeds Weight (g)	Seed Weight/ Plant (gm)
T_1 (Sulfur Basal)	7.40	30.01	35.3	29.32	243.7	2.93	11.33	4.38	11.23
T_2 (Foliar)	7.52	28.32	32.01	24.08	114	3.00	10.90	4.594	10.09
T_3 (Sulfur Basal Foliar)	7.20	32.9	32.02	28.4	256	3.13	12.07	4.32	11.31
T_4 (N P K (B) + Ca:Mg:S(B)	8.43	36	35.4	31.01	291.8	3.52	13.00	4.61	11.42
T_5 (N P K (B) + Ca:Mg:S(F)	8.8	37.2	39.9	28.32	298.3	3.62	13.03	4.632	11.63
T_6 (N P K (F) + Ca:Mg:S(F)	8.01	30.6	40.03	32	303.3	3.93	13.69	4.69	12.80
T_7 N P K (Basal)	7.93	33.54	35.2	31	181.42	2.8	12.93	3.89	7.8
T_8 Control	5.48	12.6	14.30	12.3	73	2.30	10.40	3.58	2.69
SEM	0.31	2.55	2.68	2.13	10.31	0.48	0.39	0.13	1.07
CD (5%)	1.13	2.53	3.20	2.38	16.02	0.20	0.85	0.280	0.89

seed weight to some extent. A significant increase was noted in thousand seed weight under different treatments compared to the control full stop it was observed in the range of 0.13-4.69 g under different treatments. Maximum weight (4.69 g) obtained in treatment T6 -NPK (Foliar)+Ca:Mg:S (Foliar). However seed weight obtained in this treatment was par with T5. T4 and 12, whereas, minimum test weight (4.69) g was noted in control of treatments (Singh *et al.*, 2014) and (Thaneswar *et al.*, 2017). It is clear from results that foliar application of CMS and NPK significantly increase seed weight/plant over only basal application of NPK and foliar application of Ca Mg-S and only soil application of NPK+Ca Mg S applied treatments. (Singh *et al.*, 2014) and (Thaneswar *et al.*, 2017).

Seed yield (kg/ha) and Stover yield (kg/ha)

Table 4.6, indicated that there was a significant response in seed yield due to different treatments as compared to control. Seed yield varied from (1100-1875) kg/ha under different treatments. Maximum seed yield (1875 kg/ha) was observed under T6 NPK (Foliar)+Ca-Mg-S (foliar) followed by TS-NPK (Basal-CaMg-S (Foliar) and 14 -NPK (Basal)-Ca:Mg-S (Basal) with the yield of 1748 and 1706 kg/ha and these treatments were produce significantly higher yield over rest of the treatments Basal application of NPK with foliar application of Ca, Mg and sulphur recorded significantly higher seed yield. It is evident from the result that soil and foliar application of sulphur significantly increased seed yield over only sulphur application of sulphur or only foliar application of sulphur alone (Chandan *et al.*, 2018). It is clearly evident from the table 4.6, that stover yield was significantly affected by various treatments stover yield varied from 1540-3030 kg/ha Maximum stover yield 3030 kg/ha was observed under T6-

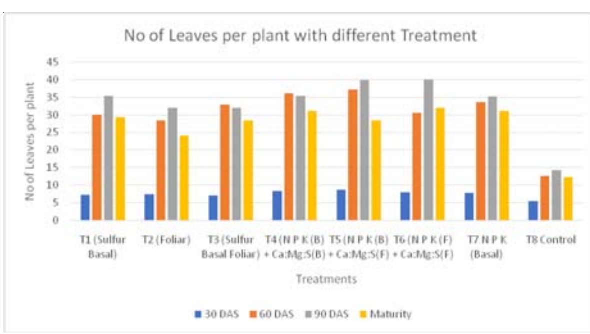

Fig. 3. Effect of macronutrients on number of leaves of Rapeseed/toria (*Brassica campestris*)

NPK (Foliar) + Ca:Mg-S (Foliar)) followed by T5 NPK (Basal) CaMgS (Foliar)) and T4 (NPK (Basal) +Ca:Mg:S (Basal)) with the yield of 2970 & 2901 kg/haIt is evident from the results that foliar application of Calcium magnesium and sulphur and NPK significantly increased the stover yield (Chandan *et al.* 2018). The Seed yield is effect cumulative effect of different growth and guild attributing characters Significant increase in seed yield was recorded with the plot where all maticns are applied in efficient amount 11 is evident from fig. 5.2 that additional application of secondary macronutrients significantly increased seed yield by 16.41 and 16.57% over other treatments applied alone in the plots Maximum seed yield (1875 kg/ha) was observed under T6 NPK (Foliar) Ca MeS (Foliar application) followed by T5 NPK (Basal application) Ca, Mg5 (Foliar) and T4 NPK (Basal)Ca: Mg: S (Basal) with the yield of 1748 and 1706 kg/ha and these treatments were produce significantly higher yield over rest of all other treatments. The probable reason may be that the sufficient amount of major nutrients resulted in greater accumulation of carbohydrates, proteins and their translocation to the productive organs which in turn improved all growth and yield attributing characters resulting more seed yield. Decide this addition of Sulphur, Magnesium and Calcium provided adequate balanced 20 off of Sulphur Magnesium and Calcium to the plants for growth the findings confirm the result of Prashad *et al.* (2003). The seed yield increased significantly due to sulphur T3 foliar basal application at over T Sulfur (Basal application) showing great needs for Sulphur fertilization in these soil as the contribution of sulphur in protein and oil synthesis is well established particularly in rapeseed- mustard crop. moreover our results confirm the findings of Sharma *et al.* (1994), Rathore and Manohar (1990) and Bhat *et al.* (2007). Soil application of NPK showed significantly higher plant growth and seed yield This may bedue to significant improvement in siliqua per plant, length of siliqua per plant and seed weight per plant could be seen with seed treatment with NPK used as a basal application with secondary major nutrients foliar application. Application of increasing levels of nitrogen from 40 to 100 kg per hectare significantly enhanced siliqua/plant seeds/siliqua, siliqua length, test weight, seed yield, NPK uptake by Indian mustard. However significant increase in stover and biological yield Reager *et al.* (2006).

Conclusion

The higher yield of mustard is dependent mainly on the availability of adequate plant nutrients Because of continuous cultivation over centuries and intensification of agriculture in recent there has been progressive and substantial depletion of soil nutrients reserves Secondary and micronutrient deficiencies are also emerging and magnitude of grab responses to these nutrients is increasing. Since the nutrients in the soil are not present in adequate quantities and proportiona as required for the plants to produce maximum yields on sustainable basis, there is a need to add plant nutrients to the soil through mineral fertilizers, organic manures and biofertilizers. Keeping in view the aforesaid facts, the present experiment entitled "Effect of macronutrients on growth and yield of rapeseed/mustard" Was carried out during the Rabi season 2019-20. The foliar application of NPK Ca Mg and sulphur proofed beneficial for the performance of mustard crop. Foliar and basal application of sulphur treatment sowed the good seed yield growth in treatment 13. Conjoint use of calcium, magnesium and sulphur along with NPK improved the fertility status of soil. The soil applied NPK proved beneficial for the performance of each plant of mustard. The foliar application gives supplementary nutrients to the plants for growth. All macronutrients are important for the plant growth and other parameters viz., Plant height, leaves/plant, branches/plant, siliqua/plant seeds/siliqua 1000 seed weight. Seed yield, stover yield and other economics parameters. All the macronutrients treatment increases the seed yield of mustard significantly over other treatments. The most effective treatment for crop growth in mustard was found to be Foliar application of NPK with Calcium Magnesium and Sulphur together increased the seed yield.

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