Growth and Yield Response of Mustard, *Brassica juncea* L. to Soil and Foliar Nitrogen Application

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ABSTRACT

To evaluate the present investigation **"Growth and yield response of mustard, (*Brassica juncea* L.) to soil and foliar application of nitrogen"** was carried out at the research farm of School of Agricultural Sciences, GD Goenka University, Gurugram (Haryana) during *rabi* season of 2019-20 to study the growth and yield response of mustard to soil and foliar nitrogen application. The experiment was laid out in split plot design with four nitrogen levels viz. 4/3rd recommended dose of nitrogen (RDN) 120 kg ha^{-1}, 90 Kg of the RDN, 2/3rd RDN (60 kg ha^{-1}), 1/3rd of the RDN (30 kg ha^{-1}) and control in main plots; with four foliar sprays viz. single spray of water, single foliar spray of 2% urea solution at 15 days after germination (DAG), two foliar sprays of 2% urea solution at 15 and 30 DAG and three foliar sprays of 2% urea solution at 15, 30 and 45 DAG in subplots replicated thrice. The results revealed that the soil application of 90 kg of the RDN was found significantly superior over rest of the soil application treatments as in all the growth indices and yield attributing characters like plant height, dry matter accumulation, number of functional green leaves plant^{-1}, chlorophyll content, number of siliquae plant^{-1}, 1000 seed weight, harvest index, stover yield and it has given higher seed yield (934.67 kg ha^{-1}). Among the foliar sprays, two foliar sprays of 2% urea solution at 15 and 30 DAG proved superior over rest of the foliar applications and recorded highest seed yield (936.3 kg ha^{-1}). These results indicate that the nitrogen management have significant effects on the growth, development, and yield enhancement of agricultural crops especially in mustard. This experimental data can be used to optimize dose and time of nitrogen application for profitable production of mustard in India.

Keywords: Foliar sprays, soil application, 2 % urea solution, days after germination

INTRODUCTION

Oil seeds have prestigious 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 constrained Agri- climatic conditions. India is world's fourth largest edible oil economy after the U.S., China and Brazil, and is the second largest importer after China.India is the largest rapeseed-mustard growing country in the world occupying the first position in area and second position in production after China. Indian mustard (*Brassica juncea* L.) commonly known as raya, rai or laha is an important oilseed crop, among the *brassica* group of oilseeds in India. It is the third important oilseed crop in the world after soybean (*Glycine max*) and palm (*Elaeisguineensis* J.).The area, production and productivity of mustard in India is 5.96 million ha, 8.32 million tons and 1397 kg ha, respectively (Anonymous, 2019).Indian mustard is predominantly cultivated in Rajasthan, Uttar Pradesh, Haryana, Madhya Pradesh and Gujarat, also grown under some non-traditional areas of South India including Karnataka, Tamil Nadu and Andhra Pradesh. However, Indian mustard occupies the largest area in Uttar Pradesh (Awasthi *et al*. 2007).

Amongst the agronomic factors known to augment crop production, fertilizer stands first and is considered as one of the most productive inputs in agriculture. Of the major elements, nitrogen which is insufficient in most of the Indian soils plays an appreciably important role in *Brassica* crops (Kumar, 1986).Nutrients play a pivotal role in increasing the seed yield in mustard.Of all the essential nutrients, the mustard in its largest quantity requires nitrogen as an important limiting factor in crop productivity.Nitrogen is the most energy intensive element and various losses in form of volatilization, leaching and fixation are more often with this than any other nutrient element.About 50% of the applied nitrogen to the soil remains unavailable to a crop because of combinationof leaching, fixation and volatilization. However, the wastage of nutrients can be reduced by foliar applications of dilute solutions of nutrients to supplement the basal applications (Jamal and Chaudhary, 2007).Since its first recorded use in the early 19th century, foliar fertilization has been the subject of considerable controlled environment, and field research and has become widely adopted as a standard practice for many crops.The rationales for the use of foliar fertilizers include, when soil conditions limit availability of soil applied nutrients, conditions when high loss rates of soil applied nutrients may occur, the stage of plant growth, the internal plant demand and the environmental conditions interact to limit the delivery of nutrients to critical plant organs.Furthermore, foliar fertilization is theoretically more environmentally friendly, immediate and target-oriented than the soil fertilization as the nutrients can be directly delivered to the plant tissues during critical stages of plant growth (Fernandez, *et al*. 2013). Foliar application is highly efficient in terms of absorption as nutrients are not subjected to various losses that occur with soil application. If dose of nitrogen could be reduced by foliar application, it would curtail the cost of cultivation significantly and would be an economically viable technology.Therefore, choice of fertilizer become critical depending upon its source, rate of application, method of application, time of application and crop growth stage of application. Choosing the correct rate, timing and method of nitrogenous fertilizer application is one of the most important aspects of successful canola growth and yield production.

MATERIAL AND METHODS

A field experiment was conducted to study the **"Growth and yield response of mustard (*Brassica juncea* L.) to soil and foliar application"** during rabi season of 2019-20 at the research farm of School of Agricultural Sciences, GD GOENKA University, Gurugram, Haryana. The soil of the experimental site was silty loam in texture with pH 7.9.

The experiment was laid out in split plot design containing three nitrogen levels viz. 4/3rd of recommended dose of nitrogen (120 kg ha^{-1}), recommended dose of nitrogen (90 kg ha^{-1}), 2/3rd of recommended dose of nitrogen (60 kg ha^{-1}), and 1/3rd of recommended dose of nitrogen (30 kg ha^{-1}) in main plots, with foliar sprays viz. single spray of water, single foliar spray of 2% urea solution at 15 days after germination (DAG), two foliar sprays of 2% urea solution at 15 and 30 DAG and three foliar sprays of 2% urea solution at 15, 30 and 45 DAG in sub plots. Variety PM-30 of the crop was sown on 15 November, 2019 with crop geometry 45×15cm and harvested on 24 March 2020.

A uniform basal application of whole amount of phosphorous in the form of single super phosphate and whole amount of potassium as muriate of potash and one third of nitrogen in the form of urea as per treatment will be applied. Remaining quantity of nitrogen will be top dressed twice, 25 and 50 days after germination.

There will be 16 treatments with each treatment replicated thrice.

1. 4/3rd of recommended dose of nitrogen with single spray of water regarded as control

2. 4/3rd of recommended dose of nitrogen with one foliar spray at 15 DAG
3. 4/3rd of recommended dose of nitrogen with two foliar sprays at 15 and 30 DAG
4. 4/3rd of recommended dose of nitrogen with three foliar sprays at 15, 30 and 45 DAG
5. Recommended dose of nitrogen with single spray of water regarded as control
6. Recommended dose of nitrogen with one foliar spray at 15 DAG
7. Recommended dose of nitrogen with two foliar sprays at 15 and 30 DAG
8. Recommended dose of nitrogen with three foliar sprays at 15, 30 and 45 DAG
9. 2/3rd of recommended dose of nitrogen with single spray of water regarded as control
10. 2/3rd of recommended dose of nitrogen with one foliar spray at 15 DAG
11. 2/3rd of recommended dose of nitrogen with two foliar sprays at 15 and 30 DAG
12. 2/3rd of recommended dose of nitrogen with three foliar sprays at 15, 30 and 45 DAG
13. 1/3rd of recommended dose of nitrogen with single spray of water regarded as control
14. 1/3rd of recommended dose of nitrogen with one foliar spray at 15 DAG
15. 1/3rd of recommended dose of nitrogen with two foliar sprays at 15 and 30 DAG
16. 1/3rd of recommended dose of nitrogen with three foliar sprays at 15, 30 and 45 DAG

RESULTS AND DISCUSSION

Growth Attributes

Plant height

A consistent increase in plant height was found with advancement of crop growth. Among various levels of nitrogen, application of nitrogen with 90 kg ha^{-1} recorded highest plant height as compared to other nitrogen levels. The minimum value was recorded in control. The effect of nitrogen application was pronounced when it was increased from 60 to kg ha^{-1}. However, further increase in nitrogen levels decreased the plant height. Among foliar sprays, two sprays of 2% urea solution resulted in higher plant height as compared to water spray regarded as control. Foliar sprays increased plant height up to two sprays. Further application of urea solution as foliar could not increase plant height. Cell division and cell expansion are the two key physiological processes responsible for growth. For these two, nitrogen is of prime requirement. Probably nitrogen supplementation through foliar application resulted in better growth. Similar results were proposed by Dongarker *et al*. (2005), Dawson *et al*. (2009), Kumar *et al*. (2010).

Dry matter accumulation

The dry matter increased with advancement of the growth stage and was recorded maximum at harvest. Various nitrogen levels and foliar sprays significantly influenced the dry matter accumulation of plants. Treatment with 90 kg ha^{-1} RDN recorded significantly highest dry matter accumulation followed by 120 Kg ha^{-1} RDN and 60 kg ha^{-1} RDN. Twice the spraying of 2% urea has recorded high dry matter accumulation.Similar observation was also made by Kumar *et al*. (2010) and Zimik *et al*. (2010). Dry matter accumulation is function of metabolic activities required for growth and development. Nitrogen is required for these activities to occur in plant system. Kumar *et al*. (2010) observed that increasing levels of nitrogen up to 80 kg ha^{-1} appreciably improved the growth characters (plant height, branches/plant and dry matter accumulation).

Yield Attributes

Among various yield attributes, nitrogen levels influenced significantly total number of siliquae /plant only. It was found highest for 90 kg N/ha. Foliar sprays of 2% urea solution influenced the yield attributes significantly. The yield attributes *viz*., number of siliquae/plant, 1000 seed weight, seed yield and stover yield was found maximum for two foliar sprays, however they remained at par with three foliar sprays. It might be because two foliar sprays would have sufficed the supply of nitrogen to the plants for production of enough photosynthatates to put forth more branches which lead to production of more number of siliquae/plant. The result confirms the finding of Keivanrad and Zandi (2012). 1000 Seed weight is the function of metabolic activities and sink-source balance of the plant. Two foliar sprays supplemented plants with nitrogen and also proved efficient to maintain sink-source relationship. Control and single foliar spray could not supply the plant with sufficient nitrogen for development of seed therefore, resulted in relatively lower values for 1000 seed weight. Positive effect of nitrogen levels on 1000 seed weight has also been reported by Khan (1996). Reddy, *et al*. (1989) found similar results in groundnut with foliar application of phosphorus.

Seed Yield

Different nitrogen levels significantly influenced the seed yield. Seed yield was found maximum for 90 kg N/ha, however it remained on par with 120 kg N/ha. Among the foliar sprays, two sprays of 2% urea solution resulted in maximum seed yield. Seed yield is a function of yield attributes of the plant. All the yield attributes were recorded higher with 90 kg ha^{-1} recommended dose of nitrogen. Among foliar sprays, two sprays of 2% urea solution proved better. Halvey *et al*. (1987) also found significant increase in yield of peanut with foliar application of nitrogen, phosphorus, potassium and sulphur. Khan *et al*. (1993) reported similar findings in mustard with foliar application of nitrogen and phosphorus. Maximum stover yield obtained in treatment with 90 kg ha^{-1} RDN recorded significantly higher straw yield. Among different foliar application treatments, treatment with foliar spray of 2% urea solution twice recorded significantly higher stover yield which is on par with foliar sprays. Singh *et al*. (2004) working at Varanasi reported that seed and stover yield, net return of *B. juncea* were increased up to 80 kg N/ha.

Table 1: Effect of growth parameters at different nitrogen levels and foliar sprays

Treatment	Plant height (cm)	Dry matter accumulation ($g\ plant^{-1}$)
120 Kg ha^{-1} RDN (4/3rd)	189.8	93.8
90 kg ha^{-1} RDN	194.83	101.53
60 kg ha^{-1} RDN (2/3rd)	181.83	78.92
30 Kg ha^{-1} RDN (1/3rd)	167.67	73.83
Control	158	66.03
SE(m)	2.40	1.15
C.D	6.85	3.28
Single spray of water of 2% urea solution	185.9	93.1
One foliar spray of 2% urea solution	195.1	102.5
Two foliar sprays of 2% urea solution	196.2	103.3
Three foliar sprays of 2% urea solution	195.02	102.9
SE(m)	2.49	1.49
C.D	7.2	2.31

Table 2: Effect of yield parameters at different nitrogen levels and foliar sprays

Treatments	Number of siliquae $plant^{-1}$	1000 Seed weight (g)	Seed yield (kg/ha)	Stover yield (kg/ha)
120 Kg ha^{-1} RDN (4/3rd)	341	4.27	921.67	3652.67
90 kg ha^{-1} RDN	348.67	5.17	934.67	3731.67
60 kg ha^{-1} RDN (2/3rd)	316.67	3.87	859.67	2640.67
30 Kg ha^{-1} RDN (1/3rd)	284.33	3.27	771	2184.67
Control	207.33	3.1	654.33	1673.67
SE(m)	4.71	0.07	11.65	37.44
C.D	13.43	0.21	33.19	106.70
Foliar sprays				
Single spray of water	340.4	4.2	919.2	3534
One foliar spray of 2% urea solution	349.1	5.2	935.9	3792.4
Two foliar sprays of 2% urea solution	350.4	5.31	936.3	3923
Three foliar sprays of 2% urea solution	349.4	5.29	935.1	3897
SE(m)	0.39	0.41	1.9	38.3
C.D	1.51	1.01	0.75	112.6

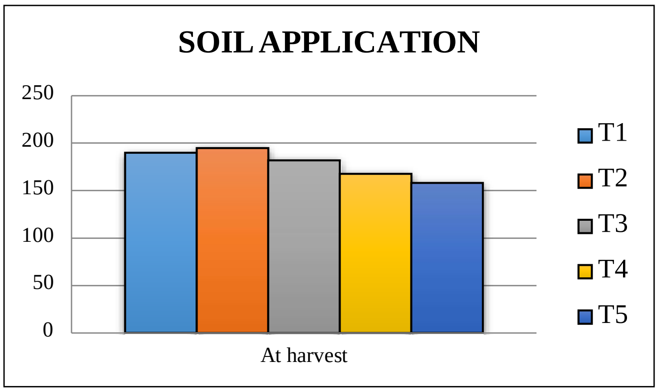

Fig 1: Effect of nitrogen levels on plant height

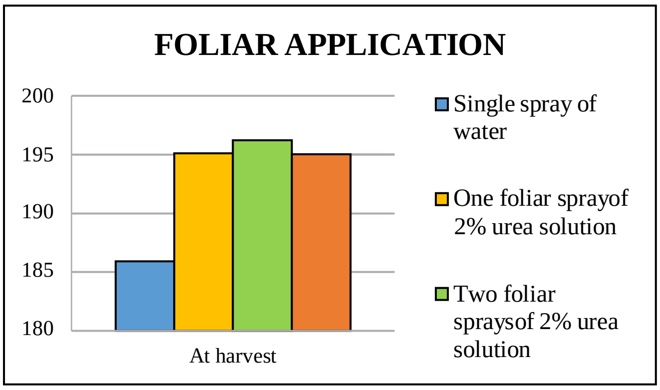

Fig 2: Effect of foliar sprays on plant height

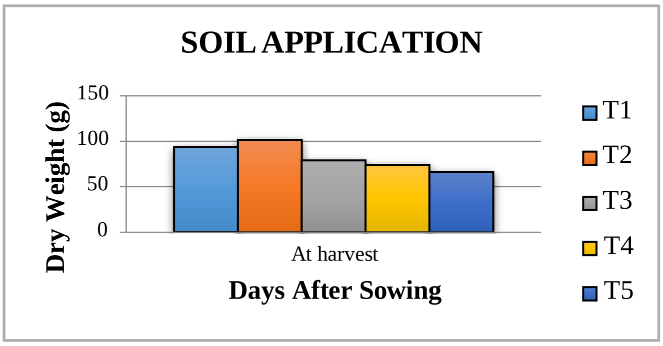

Fig 3: Effect of nitrogen levels on dry matter accumulation

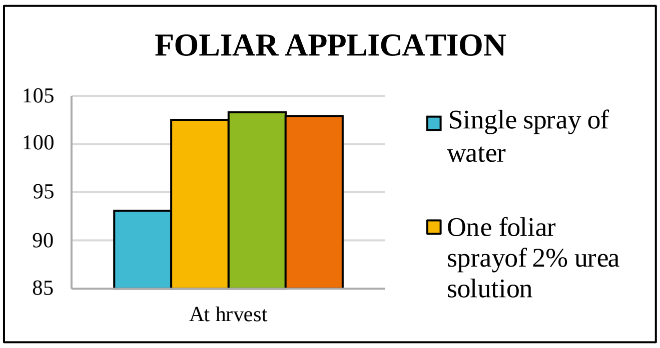

Fig 4: Effect of foliar sprays on dry matter accumulation

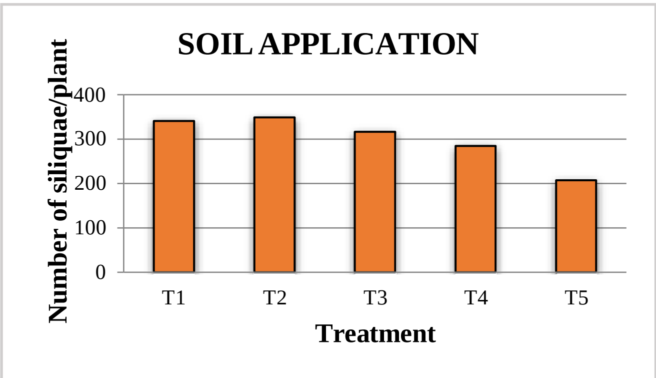

Fig 5: Effect of nitrogen levels on number of siliquae/plant

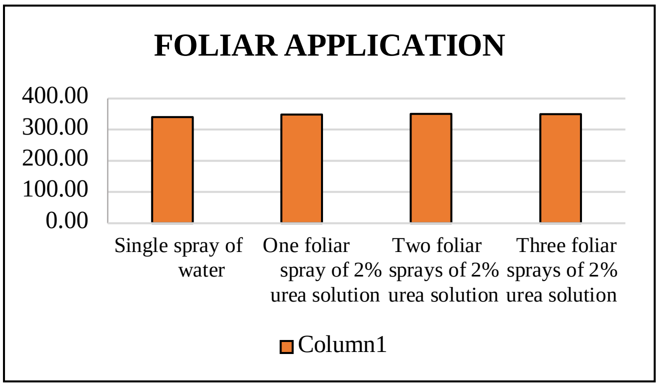

Fig 6: Effect of foliar sprays on number of siliquae/plant

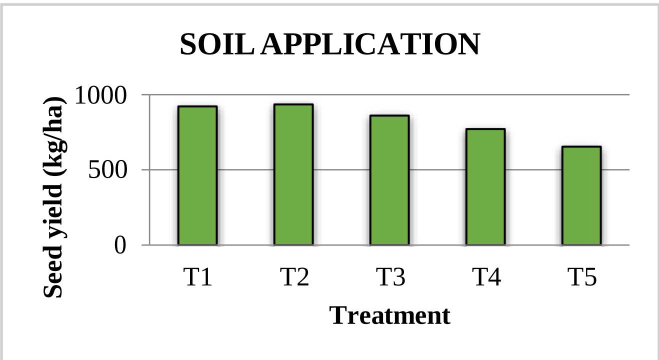

Fig 7: Effect of nitrogen levels on Seed yield

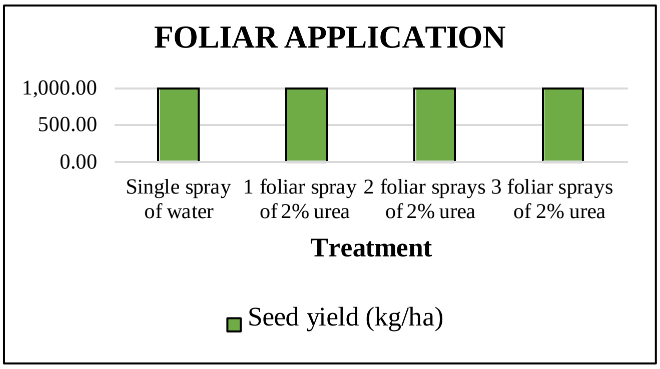

Fig 8: Effect of foliar sprays on Seed yield

CONCLUSION

Among different nitrogen levels, treatment with 90 kg ha^{-1} RDN and treatment with two foliar sprays of 2% urea solution were recorded maximum growth and yield attributes. Large quantity of soil nitrogen application (120 kg ha^{-1} RDN) has no additional benefit. So recommended dose of 90 kg ha^{-1} RDN is sufficient for good results and the next best treatment is 60 kg ha^{-1} RDN.The treatments with control recorded lowest grain yield. This was due to less availability of nutrients in control.The results do not justify the foliar application of N alone enhanced highest yields. However, under certain conditions where nutrients supply to plants become a limiting factor because of soil properties, foliar spray can serve a useful purpose by supplementing the soil to ensure optimal supply of nutrients to plants.Thus, to enhance food production and elevating the nutritional aspects mustard, such green agricultural practice be adopted. However, further research work needs to be undertaken to clarify the role foliar application in mustard.

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