International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2019; 7(1): 1553-1556

Received: 09-11-2018
Accepted: 13-12-2018

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Optimization basal and foliar application of nitrogen for enhancing productivity of mustard [*Brassica juncea* (L) Czern and Coss]

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Abstract
A field experiment was conducted during *rabi* season of 2014-15 at the Agriculture Farm of MGCGVV Chitrakoot, Satna (M.P.) to optimize the doses of basal and foliar feritization The 12 treatments comprising 03 basal (50, 75, and 100%N) and 03 foliar application of N with supplying chemicals like KNO_3, Urea and Ca $(NO_3)_{2a}$ and their combination along with 100% NPK and a control were tested in 3 replication in randomized block design. Growth parameters plant height (c.m), leaves/plant, dry matter/plant (g), root length (cm), spread(cm), dry weight (g), yield attributes No. of siliqua per plant No. of seeds per siliqua Seed weight/plant (g) Seed yield (kg/ha) Stover yield (kg/ha) Harvest index (%) and seed yield and stover yield were significantly uncreased with 75% basal N+2sprays of 1%KNO_3 or 2% urea. However gowther parameaters, yieldattibutis and grain and strower yield were found significantly higher under 100% NPK+2%ws but these value were registered significantly at par with 75%basal N+2 spray of !%KNO_3 or urea. Net returns and benifical cost ratio was also significantly higher under basal application of 75% N basal + 2%urea, 75% Nbasal +1% KNO3 +75% N basal+1% Ca$(NO_3)_2$. The fertility level at 75 % of recommended dose of fertilizers as basal application with two foliar sprays of T_{10}:75% basal N +2 spray of 2% urea or 1% KNO_3 at 30 and 45 days after sowing was the best treatment combination with regard to the seed yield and net returns in mustard underrainfed condition.

Keywords: mustard, basal, foliar, fertilization, nitrogen

1. Introduction
Rapeseed and mustard is an important oil seed crop contributingupto 18% of the domestic edible oil production. It can becultivated in a variety of soils but a fertile soil with a clayloamtexture is best for producing higher yields. Generally, soil nutrition management is one of the most significant points in terms of crop breeding. Of all the essential nutrients, the mustard in its largest quantity requires nitrogen as an important limiting factor in crop productivity. Nitrogen supports the plant with rapid growth, increasing seed and fruit production and enhancing quality of leaf and oil seed crops (Allen & Morgan, 2009) [1]. Nitrogen is one of the most important nutrient elements for crop growth and protein synthesis, cell size, protoplasm, and photosynthetic activity. When compared to cereals, canola is classified as nutrient exhaustive crop with clearly higher critical nitrogen demand and under arid conditions. This demand may enhance depending upon the interaction of severe abiotic and biotic stresses (Rathke *et al.*, 2005) [10]. 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. Nitrogen management is crucial in cropping systems incorporating mustard; itis often difficult to strike between levels sufficient fornormal plant growth and those that are acceptable forhuman consumption (Maereka *et al.*, 2007) [6]. Keeping these points in consideration, the present investigation was undertaken to study the effect of basal and foliar fertilization of nitrogen on mustard productivity.

2. Materials and Methods
The field investigation was conducted at Mahatma Gandhi Chitrakoot Gramodaya Vishwa Vidhyalaya Chitrakoot Satna, Madhya Pradesh in winter (*rabi*) season during the year 2014-15. The soil of experimental field was sandy loam in texture, slightly alkaline in nature and

poor in fertility. The crop received 27.3 mm rainfall during October, 2014 to March, 2015. October was the hottest month with maximum temperature of 33.6^{0}C while, January was the coldest month of the year with lowest minimum temperature of 5.9^{0}C.

The 12 treatments comprising 03 basal (50,75, and 100%N) and 03 foliar application of N with supplying chemicals like KNO_3, Urea and $Ca(NO_3)_{2a}$ and their combination along with 100% NPK and a control were tested in 3 replication in randomized block design. The combinations were 100% basal N + 2 water sprays; 100% basal NPK +2 water sprays; 2 sprays of 2% urea; 2 sprays of 1% KNO_3; 2 sprays of 1% $Ca(NO_3)_2$; 50% basal N + 2 sprays of 2% urea; ; 50% basal N + 2 sprays of 1% KNO_3; 50% basal N + 2 sprays of 1% $Ca(NO_3)_2$; 75% basal N + 2 sprays of 2% urea, 75% basal N + 2 sprays of 1% KNO_3 and 75% basal N + 2 sprays of 1% $Ca(NO_3)_2$. Recommended dose of NPK were used as 60 kg N+ 40 kg P_2O_5+ 20 kg K_2O/ha. The mustard variety Pusa Mahak was sown on 18/10/2014 and harvested on10/03/2015.The plant population was maintained by thining of plants at 15 days after sowing with maintaining 45 cm×15cm plant geometry. The weeds of crop field was remove by adopting 02 hand weeding at 07-11-2014 and 28-11-2014 days after sowing. The insect pest and disease was control by 02 spray each of, respectively. All the observation were taken at standandprocedcce. The data collected in the experiment were analyzed by the analysis of various technique as suggested by Panse, V.G and Sukhatme, P.V (1967) [9].

3. Result and Discussion

3.1 Shoot and root Growth

Growth parameters viz. plant height, number of leaves, dry matter accumulation per plant and, root length, root spread root dry weight per plant were increased significantly up to 75% basal N with foliar feeding of KNO3, 75% nitrogen level with Al thought The treatment with 100% basal NPK +2 water sprays gave higher values due to complete supply of all the primary nutrients (NPK), however the alone application of N was also proved better in terms of the producing these parameters. It may be due to more availability and uptake of nitrogen in crop plant at higher fertility levels, which increased the growth parameters. These results corroborate to the findings of Khatun *et al.* (2011) [3]. Foliar spray of 1% KNO_3 gave higher values of these parameters as compared to 1% $Ca(NO_3)_2$ and2% urea alone. The reason may be behind this, that the 1% KNO_3 also supplies K, which is a major element lacks in other two fertilizers ($Ca(NO_3)_2$ and urea. Effect of KNO_3were also reported by Kumar *et al.* (2015) [4]. Better root growth may be explained that nitrogen stimulates early root development and their growth. Foliar fertilization increased root characteristics significantly over control.

3.2 Yield and Yield attributes

Yield attributes like no. of siliqua per plant, no. of seeds per siliqua, seed weight per plant, seed and straw yields were increased significantly with increasing levels of basal nitrogen up to 75% N with foliar sprays of 1% KNO_3, and 2% urea. Basal application of 100% NPK +2 water sprays produced highest values of the parameters followed by 75% basal N + 2 sprays of 1% KNO_3, 75% basal N + 2 sprays of 2% urea and 75% basal N + 2 sprays of 1% $Ca(NO_3)_2$ being at par with each other. The seed yield recorded under Basal application of full dose of NPK without any foliar spray of fertilizers was produced 13.82 per cent higher seed yield as compared to the control but at par with 75% basal N+1% KNO_3,or 2%urea spray. Pande and Bose (2006) [7] were also reported similar findings with KNO_3 and $Ca(NO_3)_2$ treatments and the effects of KNO_3 on yield attributes were also noticed by Kumar *et al.* (2005) [4]. The possible reasons for treatments effect on seed yield per plant have already been discussed earlier. Trivedi *et al.* (2013) [15] reported the beneficial effects of NPK application on seed yield. It indicates that foliar fertilization was effective when basal application of nitrogen was done at lower level of 75%. Sharma and Jain (2003) [11] found the same results with foliar application of urea, while Trawczynski (2014) [14] registered the higher stover yield with nitrogen application. The harvest index of mustard was not differed significantly. The ratio of increase in seed and biological yield was almost same, which resulted into the non-significant differences in harvest index.

3.3 Economics

Cost of cultivation varied under different treatments and recorded maximum with 100% basal NPK +2 water sprays followed by 75% basal N + 2 sprays of 1% KNO_3. Gross returns was recorded significantly higher under treatment 100% basal NPK +2 water sprays, and 75% basal N + 2 sprays of 1% KNO_3 however, it was recorded statistically at par under the treatment 75% basal N + 2 sprays of 2% urea, 75% basal N + 2 sprays of 1% $Ca(NO_3)_2$, 50% basal N + 2 sprays of 1% $Ca(NO_3)_2$, 50% basal N + 2 sprays of 1% KNO_3, 50% basal N + 2 sprays of 2% urea and 2 sprays of 1% $Ca(NO_3)_2$. While, the highest net returns was recorded under 75% basal N + 2 sprays of 2% urea followed by the net returns under 2 sprays of 2% urea. Significant increase in net returns of mustard at recommended level of fertility has also been reported by Sharma and Jain (2003) [11] with KNO_3; by Sumeria (2003) [12] with nitrogen alone and by Jana *et al.* (2009) [2] with the use of NPK. The benefit: cost ratio was found maximum in 2 sprays of 2% urea, 2 sprays of 1% KNO_3.Almost similar results have also been reported by Sumeriya (2000) [13] with nitrogen application, Premi *et al.* (2012) [8] the use of urea spray, however Trivedi *et al.* (2013) reported the highest benefit: cost ratio with NPK application.

Table 1: Effect of various treatment combination on Growth parameters of mustard.

Treatments	Growth parameters at harvest stage					
	Plant height (cm)	Number of leaves/plant	Dry matter accumulation per plant (g)	Root length (cm)	Root spreading (cm)	Root dry weight (g)
Control	103.55	22.20	3.00	17.80	10.85	1.40
100% basal N + 2 water sprays	103.56	24.67	3.02	18.38	11.63	1.27
100% basal NPK +2 water sprays	108.41	25.40	3.70	21.67	13.63	1.62
2% urea (2 sprays)	105.09	24.47	3.13	18.90	12.53	1.53
1% KNO_3 (2 sprays)	105.93	24.93	3.03	18.60	11.90	1.41
1% $Ca(NO_3)_2$ (2 sprays)	106.35	24.87	3.13	19.49	12.62	1.43
50% basal N + 2% urea (2 sprays)	106.44	23.77	3.23	18.81	11.87	1.53
50% basal N + 1% KNO_3 (2 sprays)	104.19	19.13	3.17	18.55	11.73	1.40

50% basal N + 1% $Ca(NO_3)_2$ (2 sprays)	106.41	23.53	3.20	19.69	12.08	1.50
75% basal N + 2% urea (2 sprays)	107.11	23.73	3.43	20.97	12.95	1.55
75% basal N + 1% KNO_3 (2 sprays)	107.34	25.13	3.63	21.65	13.09	1.57
75% basal N + 1% $Ca(NO_3)_2$ (2 sprays)	106.77	25.00	3.37	20.79	12.73	1.43
SEm±	0.97	0.82	0.14	0.83	0.45	0.06
CD (P=0.05)	2.84	2.24	0.41	2.24	1.31	0.18

Table 2: Effect of various treatment combination on Yield and yield attribute of mustard.

Treatments	Yield attributes					
	No. of siliqua per plant	No. of seeds per siliqua	Seed weight/plant (g)	Seed yield (kg/ha)	Stover yield (kg/ha)	Harvest index (%)
Control	350.13	12.37	13.60	475.03	1651.33	22.34
100% basal N + 2 water sprays	346.20	12.00	12.47	488.80	1651.00	22.82
100% basal NPK +2 water sprays	394.13	13.33	15.73	540.70	1789.67	23.20
2% urea (2 sprays)	357.53	12.13	10.47	504.57	1660.67	23.31
1% KNO_3 (2 sprays)	360.87	12.60	13.47	492.83	1669.00	22.82
1% $Ca(NO_3)_2$ (2 sprays)	365.00	13.20	13.37	505.00	1715.33	22.76
50% basal N + 2% urea (2 sprays)	373.40	13.27	13.87	516.17	1718.00	23.11
50% basal N + 1% KNO_3(2 sprays)	353.93	12.73	13.20	510.97	1707.67	23.06
50% basal N + 1% $Ca(NO_3)_2$ (2 sprays)	362.87	13.27	13.73	509.10	1712.67	22.92
75% basal N + 2% urea (2 sprays)	379.27	13.00	14.67	529.40	1743.67	23.29
75% basal N + 1% KNO_3 (2 sprays)	382.93	13.20	14.80	533.27	1754.00	23.32
75% basal N + 1% $Ca(NO_3)_2$ (2 sprays)	378.73	13.40	14.13	521.33	1742.33	23.03
SEm±	9.52	0.42	0.81	12.63	27.33	0.53
CD (P=0.05)	27.92	NS	2.37	37.04	80.15	NS

Table 3: Economics of mustard cultivation under different treatments

Treatments	Economics			
	Cost of cultivation (Rs/ha)	Gross income (Rs/ha)	Net return (Rs/ha)	B: C ratio
Control	12262	19929	7667	1.625
100% basal N + 2 water sprays	13424	20410	6986	1.520
100% basal NPK +2 water sprays	16169	22504	6335	1.392
2% urea (2 sprays)	12277	20981	8704	1.709
1% KNO_3 (2 sprays)	12732	20587	7855	1.617
1% $Ca(NO_3)_2$ (2 sprays)	12423	21106	8683	1.699
50% basal N + 2% urea (2 sprays)	12862	21502	8640	1.672
50% basal N + 1% KNO_3 (2 sprays)	13317	21299	7983	1.599
50% basal N + 1% $Ca(NO_3)_2$ (2 sprays)	13008	21244	8236	1.633
75% basal N + 2% urea (2 sprays)	13151	22016	8865	1.674
75% basal N + 1% KNO_3 (2 sprays)	13606	22172	8567	1.630
75% basal N + 1% $Ca(NO_3)_2$ (2 sprays)	13296	21731	8435	1.634
SEm±	-	445	444.5	0.03
CD (P=0.05)	-	1304	13035	0.10

4. Conclusion

Basal application of 100% NPK with two foliar sprays of water was the best combination for getting more growth and productivity, but, it was not found the best treatment as the profitability is concerned. It was not differed statistically with the 25 % reduced basal application of alone N with 2 sprays of 1% KNO_3 or 2% urea or 1% $Ca(NO_3)_2$. Thus the foliar application of nitrogen may be recommended for better yield and cost saving purposes. Basal application of 100% NPK or 25 % reduced basal application of alone N with 2 sprays of 1% KNO_3 or 2% urea or 1% $Ca(NO_3)_2$ were found the appropriate dose of basal and foliar application of nitrogen for higher productivty of mustard. Finally it can be concluded from the results of this study that the fertility level at 75 % of recommended dose of fertilizers as basal application with two foliar sprays of 1% KNO_3 or 2% urea or 1% $Ca(NO_3)_2$ at 30 and 45days after sowing was the best treatment combination with regard to the seed yield and net return in mustard under rainfed condition

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