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Response of mustard to different doses of nitrogen with or without GA_3

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ABSTRACT

Effect of different doses of nitrogen with or without GA_3 application on plant height, nutrient uptake (N,P,K and S). Yield parameters in NDR-8501 *Brassica juncea* cultivar in year 2013-14. Field experiment was conducted at Instructional Farm of N.D.U.A.&T., Kumarganj, Faizabad (U.P.) during *Rabi* season, mustard seeds were grown under different treatments. Three doses of nitrogen (90, 120 and 150 kg ha^{-1}) and GA_3 (50 ppm) spraying at 30 and 60 DAS, nutrient uptake, siliquae $plant^{-1}$, seed $siliquae^{-1}$, seed yield increases at 120 kg N ha^{-1} with spraying of GA_3 at 30 DAS as compared to without GA_3 spraying GA_3 at 60 DAS spraying increase the observed parameters but it was low in comparison of 30 DAS. The optimum dose of nitrogen of recommended dose of fertilizer along with spraying of 50 ppm GA_3 at 30 DAS can be used as optimum recommended source for improving mustard seed yield under local agro climatic conditions.

Introduction

Rapeseed-mustard is the third important oilseed crop in the world after soyabean (Glycine max) and palm oil (*Elaeis guineensis* Jag.). India is the fourth largest oilseed economy in the world. Among the seven edible oilseeds cultivated in India. Rapeseed mustard contributes 28.6% in the total oilseeds production and ranks second after groundnut showing 27.8% in the India's oilseed economy. The share of oilseeds is 14.1% out of the total cropped area in India. Rapeseed-mustard accounts for 3% of it. Rapeseed-mustard occupy an important position among oilseed. In world the total area under rapeseed-mustard during 2012-13, was 34.19 M ha with the production of 63 MT and productivity was 1850 kg ha^{-1}. In India the total area under rapeseed-mustard during 2012-13 was 6.3 M ha with the production of 7.4 MT and productivity was 1176 kg ha^{-1}.

Nitrogen is an integral part of many compounds such as chlorophyll, enzymes essential for plant growth processes, nucleic acids and proteins (Marschner, 2002). Nitrogen plays an important role in improving yield and nutrient uptake (Marshed *et al.*, 2008). Gibberellins (GA_3) are generally involved in growth and development. They control seed germination, leaf expansion, stem elongation and flowering (Magomue *et al.*, 2004). Several factors either endogenous or environmental contribute to sink strength, but sink activity can mainly be enhanced by gibberellins (Kuper, 1993). Keeping in view of the above facts the field experiment was carried out to find out the suitable dose of nitrogen with GA_3 spraying schedule to obtain the maximum yield of mustard. Plant height increased in case of nitrogen @ 120 kg N ha^{-1} and foliar spray of GA_3 at 30 DAS as compared to other treatments.

Materials And Method

A field experiment was conducted at the Instructional Farm of Narendra Deva University of Agriculture & Technology, Kumarganj, Faizabad (U.P.) during *Rabi* season of year 2013-14 and 2014-15 using mustard cultivar NDR-8501 (Narendra Rai). The experiment was laid out in randomized block design (factorial) with nine treatment; each treatments replicated three times. The nine treatments comprises different doses of nitrogen @ 90, 120 and 150 kg N ha^{-1} i.e. nitrogen 90 kg N ha^{-1} and 50 ppm GA_3 at 30 DAS, 120 kg ha^{-1} and 50 ppm GA_3 at 30 DAS and 150 kg N ha^{-1} with GA_3 at 30 DAS, 90 kg N ha^{-1} with GA_3 at 60 DAS, 120 kg N ha^{-1} with 50 ppm GA_3 at 60 DAS, 150 kg N ha^{-1} with 50 ppm GA_3 at 60 DAS. The experimental soils was sandy loam in texture having pH 7.8, organic carbon 0.32% and available nitrogen, phosphorus, potassium and sulphur contents were 136.5, 17.5, 235.15 and 16.95 kg ha^{-1} respectively. The plot sizes were 2 x 2.25 m, the field was properly leveled followed by preparation irrigation afterward at optimum tilth, the field was ploughed. Mustard seeds sown @ 4.5 kg ha^{-1} in row space 45 cm with the help of Kudali. Half dose of nitrogen and full doses of P, K and S (60, 60, 40 kg ha^{-1}) was applied as basal at the time of sowing the remaining dose of nitrogen was applied as top dressing. Weed removal was done wherever necessary to keep plants healthy. Plants of similar size were tagged for recording various data. Plant height were recorded at 30, 60, 90 DAS and maturity. The plants were collected at maturity from each plot and of siliquae $plant^{-1}$, No. of seed $siliqua^{-1}$, seed yield $plant^{-1}$, biological $yield^{-1}$, seed yield (q ha^{-1}) and harvest index was determined. The nitrogen and phosphorus uptake was determined separately using colorimetric method of Linder (1944). The potassium uptake was determined separately using flame photometer. Sulphur was analysed by Turbidimetric method (Chesnied and Ziew, 1951). Oil content was estimated by the conventional Soxhlet method (AOAC, 1970). Data was subjected to analysis of variance (Anova).

Results and Discussion

Perusal of the results presented in Table-1 show that spraying of GA_3 at two stages of plant (30 and 60 DAS) in association with different levels of nitrogen illustrated a significant increase in plant height.

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But the maximum increase in plant height was recorded when GA_3 was applied at 30 DAS as compared to spraying at 60 DAS. The optimal dose of nitrogen (120 kg N ha^{-1}) produced taller plant as compared to rest of the doses of nitrogen at all the stages of observations. Increase in plant height of treated plants can be explained on the basis of the role of N which plays a critical role in regulation of various growth related and morphogenetic aspects of plant development by serving as major limiting factor for carbohydrate metabolism (Mcintyre 2001). Carbohydrates serve as primary messenger due to their essential role in plant growth, development, metabolic activities and physiological processes (Rolland *et al.*, 2002).

Treatment with GA_3 causes microtubule reorientation favouring axial elongation (Shibaoka, 1994). The enzyme Xyloglucan, Endotransglycolase (XET) catalyzes the breaking and reforming of bonds between Xyloglucan residues then permitting transient increase in wall extensibility increase in XET activity is correlated with GA enhanced elongation in number of plant species (Potter and Fry, 1994). Possibly all these factors contributed for the increase in plant height due to GA_3 treatment. GA_3 is also known to promote growth through increasing absorption of nutrients (Singh *et al.*, 2005), nitrogen use efficiency (Khan *et al.*, 2002), cell expansion by stimulating the destruction of growth-repressing proteins (Achard *et al.*, 2009). In the present study, exogenous application of GA_3 and different levels of nitrogen played an important role in the development of taller plants.

Table 1. Effect of nutrients and spraying of Gibberellic acid on plant height at different growth stages of mustard.

Treatments	**Plant height (cm)**			
	30 DAS	**60 DAS**	**90 DAS**	**At Maturity**
T_1 (N_{90},P_{60},K_{60}, S_{60} kg ha^{-1})	12.53	82.10	119.86	141.28
T_2 (N_{120},P_{60},K_{60}, S_{60} kg ha^{-1})	15.2	89.90	125.75	148.70
T_3 (N_{150},P_{60},K_{60}, S_{60} kg ha^{-1})	15.36	88.65	128.92	150.60
T_4 (N_{90},P_{60},K_{60}, S_{60} kg ha^{-1}) + 50 ppm GA_3 at 30 DAS	11.43	92.50	154.72	165.10
T_5 (N_{120},P_{60},K_{60}, S_{60} kg ha^{-1}) + 50 ppm GA_3 at 30 DAS	16.5	104.35	160.91	172.10
T_6 (N_{150},P_{60},K_{60}, S_{60} kg ha^{-1}) + 50 ppm GA_3 at 30 DAS	18.2	102.45	157.56	170.90
T_7 (N_{90},P_{60},K_{60}, S_{60} kg ha^{-1}) + 50 ppm GA_3 at 60 DAS	14.96	83.85	134.96	155.00
T_8 (N_{120},P_{60},K_{60}, S_{60} kg ha^{-1}) + 50 ppm GA_3 at 60 DAS	15.86	86.30	141.52	162.25
T_9 (N_{150},P_{60},K_{60}, S_{60} kg ha^{-1}) + 50 ppm GA_3 at 60 DAS	18.36	91.00	138.72	159.56
SEm±	0.35	1.69	2.76	3.56
CD at 5%	1.06	5.07	8.29	10.68

Total N,P,K and sulphur content in mustard increased significantly when nitrogen applied at 120 kg N ha^{-1} and 150 kg N ha^{-1} as compared to 90 kg N ha^{-1}. The spraying of 50 ppm GA_3 at 30 DAS was more effective than other treatments in uptake of N, P, K and sulphur with all the nitrogen doses. The maximum response was observed with 120 kg N ha^{-1}. Spraying of GA_3 at 60 DAS also increase uptake of N, P,K and S but the effect was found significant in presented in table 2. The maximum uptake was observed in 120 kg N ha^{-1}, however, the value of 150 kg N ha^{-1} was at par (Table-2). Availability of nutrients and their uptake from soil and then distribution in different plant parts affect the final growth and development of plant. These events are mainly regulated by plant supply of crop demand. In present study the uptake of nutrients (N,P,K and S) in mustard maximally increased with N fertilization @ 120 kg N ha^{-1} alone or combined with GA_3 (Table 2). Highest seed yield by foliar application of 50 ppm GA_3 was observed by Akter *et al.* (2007). The effect of different doses of nitrogen and foliar spray of GA_3 was not much more. The effect was non-significant on oil content. Similar results were observed by Sant Prasad (1991), Arthamwar *et al.* (1996), Das *et al.* (2009).

Table 2. Effect of nutrients and spraying of gibberellic acid at 30 and 60 DAS on N, P, K and S uptake at maturity of mustard.

Treatments	**N (kg ha^{-1})**	**P (kg ha^{-1})**	**K (kg ha^{-1})**	**S (kg ha^{-1})**
T_1 (N_{90},P_{60},K_{60}, S_{60} kg ha^{-1})	68.38	29.51	79.23	17.72
T_2 (N_{120},P_{60},K_{60}, S_{60} kg ha^{-1})	90.44	35.03	93.80	19.52
T_3 (N_{150},P_{60},K_{60}, S_{60} kg ha^{-1})	91.29	33.20	89.00	20.60
T_4 (N_{90},P_{60},K_{60}, S_{60} kg ha^{-1}) + 50 ppm GA_3 at 30 DAS	92.98	39.78	100.40	23.35
T_5 (N_{120},P_{60},K_{60}, S_{60} kg ha^{-1}) + 50 ppm GA_3 at 30 DAS	115.98	48.27	106.70	28.32
T_6 (N_{150},P_{60},K_{60}, S_{60} kg ha^{-1}) + 50 ppm GA_3 at 30 DAS	110.32	48.04	104.02	28.27
T_7 (N_{90},P_{60},K_{60}, S_{60} kg ha^{-1}) + 50 ppm GA_3 at 60 DAS	82.49	35.48	95.20	20.81
T_8 (N_{120},P_{60},K_{60}, S_{60} kg ha^{-1}) + 50 ppm GA_3 at 60 DAS	101.37	42.71	100.70	25.07
T_9 (N_{150},P_{60},K_{60}, S_{60} kg ha^{-1}) + 50 ppm GA_3 at 60 DAS	100.64	39.96	99.10	23.42
SEm±	0.76	0.81	0.75	0.45
CD at 5%	2.28	2.43	2.25	1.36

Availability of nutrient and their uptake from soil and then distribution in different plant parts affect the final growth and development of a plot. These events are mainly regulated by nutrient supply or crop demand. In the present study, the uptake of nutrients (N, P, K and S) in mustard maximally increased with N fertilizer @ 120 kg N ha^{-1} alone or combined with GA_3. Highest seed yield by foliar application of 50 ppm GA_3 was observed by Akhter *et al.* (2007).

The increase in number of siliquae $plant^{-1}$ presented in table 3. was 6.8, 12.6 and 10.06 % and 3.4, 3.5 and 3.7% at sub optimal, optimal and super optimal dose of nitrogen along with the one spraying of GA_3 at 30 and 60 DAS, respectively in comparison to control where only nitrogen was applied in presented in table 3. These results are in accordance with the findings of Shah and Samiullah (2006, 2007), Shah and Tak (2011) and Haq et al.(2013) in black cumin, Shah and Samiullah (2007) and Mobeen et al.(2007) in mustard and Surendar et al.(2013) in black gram.

The increase in number of seeds $siliqua^{-1}$ was 28.3, 19.5 and 19.9 % and 22.1, 11.2 and 11.1 % at sub optimal, optimal and super optimal dose of nitrogen along with the one spraying of GA_3 at 30 and 60 DAS, respectively in comparison to control where only nitrogen was applied in presented in table 3.. Similar findings were also reported by Shah and Tak (2011) and Haq et al.(2013) in black cumin, Shah and Samiullah (2007) and Mobeen et al.(2007) in mustard and Surendar et al.(2013) in black gram.

Table 3.Effect of nutrients and spraying of gibberellic acid at 30 and 60 DAS on Number of siliquae plant^{-1}, Number of seed siliqua^{-1} and Seed yield plant^{-1} of mustard.

Treatments	No. of siliquae plant^{-1}	No.of seed siliqua^{-1}	Seed yield plant^{-1} (g)
T_1 (N_{90},P_{60},K_{60}, S_{60} kg ha^{-1})	254.40	10.14	12.35
T_2 (N_{120},P_{60},K_{60}, S_{60} kg ha^{-1})	274.95	11.95	14.50
T_3 (N_{150},P_{60},K_{60}, S_{60} kg ha^{-1})	267.65	11.72	13.90
T_4 (N_{90},P_{60},K_{60}, S_{60} kg ha^{-1}) + 50 ppm GA_3 at 30 DAS	271.70	13.01	17.00
T_5 (N_{120},P_{60},K_{60}, S_{60} kg ha^{-1}) + 50 ppm GA_3 at 30 DAS	309.72	14.29	20.90
T_6 (N_{150},P_{60},K_{60}, S_{60} kg ha^{-1}) + 50 ppm GA_3 at 30 DAS	294.58	14.06	19.40
T_7 (N_{90},P_{60},K_{60}, S_{60} kg ha^{-1}) + 50 ppm GA_3 at 60 DAS	263.00	12.38	14.90
T_8 (N_{120},P_{60},K_{60}, S_{60} kg ha^{-1}) + 50 ppm GA_3 at 60 DAS	283.25	13.29	18.40
T_9 (N_{150},P_{60},K_{60}, S_{60} kg ha^{-1}) + 50 ppm GA_3 at 60 DAS	277.75	13.03	17.80
SEm±	5.96	0.29	0.33
CD at 5%	17.87	0.87	0.99

The increase in seed yield plant^{-1} was 6.8, 12.6 and 10.06 % and 3.4, 3.5 and 3.7% at sub optimal, optimal and super optimal dose of nitrogen along with the one spraying of GA_3 at 30 and 60 DAS, respectively in comparison to control where only nitrogen was applied presented in table 4. Similar increases in seed yield due to exogenous application of GA_3 have been observed by several workers Shah and Tak (2011) and Haq et al.(2013) in black cumin, Shah and Samiullah (2007) and Mobeen et al.(2007) in mustard, Islam et al.(2009) ,Surendar et al.(2013) in black gram and Bibi et al. (2013).

Table 4.Effect of nutrients and spraying of gibberellic acid at 30 and 60 DAS on Seed yield, Stover yield and Harvest index of mustard.

Treatments	Seed yield (q ha^{-1})	Stover yield (q ha^{-1})	Harvest index (%)
T_1 (N_{90},P_{60},K_{60}, S_{60} kg ha^{-1})	16.50	53.40	23.04
T_2 (N_{120},P_{60},K_{60}, S_{60} kg ha^{-1})	18.60	58.60	24.09
T_3 (N_{150},P_{60},K_{60}, S_{60} kg ha^{-1})	18.30	61.10	23.60
T_4 (N_{90},P_{60},K_{60}, S_{60} kg ha^{-1}) + 50 ppm GA_3 at 30 DAS	19.60	63.20	23.67
T_5 (N_{120},P_{60},K_{60}, S_{60} kg ha^{-1}) + 50 ppm GA_3 at 30 DAS	21.85	68.10	24.29
T_6 (N_{150},P_{60},K_{60}, S_{60} kg ha^{-1}) + 50 ppm GA_3 at 30 DAS	20.70	65.90	23.90
T_7 (N_{90},P_{60},K_{60}, S_{60} kg ha^{-1}) + 50 ppm GA_3 at 60 DAS	18.40	59.20	23.58
T_8 (N_{120},P_{60},K_{60}, S_{60} kg ha^{-1}) + 50 ppm GA_3 at 60 DAS	20.50	66.20	23.71
T_9 (N_{150},P_{60},K_{60}, S_{60} kg ha^{-1}) + 50 ppm GA_3 at 60 DAS	20.10	64.80	23.67
SEm±	0.14	0.43	-
CD at 5%	0.41	1.28	-

The increase in seed yield ha^{-1} was 18.7, 17.5 and 13.1 % and 11.5, 10.2 and 9.8 % at sub optimal, optimal and super optimal dose of nitrogen along with the one spraying of GA_3 at 30 and 60 DAS, respectively in comparison to control presented in table 4. where only nitrogen was applied.As revealed from the data of growth parameters, the application of GA_3 improved plant height which enabled the plants to have more branches to bear more siliquae. GA_3 is known to play an important role in differentiation (Huttly and Phillips, 1995; Afrozet *et al.*, 2005), cell division and cell enlargment (Liu and Loy, 1976, Moore, 1989, Huttly and Phillips, 1995, Arteca, 1996, Marschner, 2002). Ample availability of the photosynthates subsequently leads to enhance the filling and culminates into increasing seed yield (Sarkar *et al.*, 1992).these results are corroborated with findings of Shah and Tak (2011) and Haq et al.(2013) in black cumin, Shah and Samiullah (2007) and Mobin et al.(2007) in mustard, Islam et al.(2009) and Surendar et al.(2013) in black gram.

The increase in stover yield ha^{-1} was 18.3, 16.2 and 7.8 % and 10.8, 12.9 and 6.0 % at sub optimal, optimal and super optimal dose of nitrogen along with the one spraying of GA_3 at 30 and 60 DAS, respectively in comparison to control presented in table 4. where only nitrogen was applied. Shah and Tak (2011) and Haq et al.(2013) in black cumin, Shah and Samiullah (2007) and Mobeen et al.(2007) in mustard and Surendar et al.(2013) in black gram.

Maximum increase in HI was noted presented in table 4. with optimal dose of nitrogen and spraying of GA_3 at 30 DAS than spraying of GA, at 60 DAS. The increase in biological yield and harvest index owe much to the production of enough leaves due to GA, with improved radiation interception efficiency which ultimately resulted in higher translocation of photoassimilates towards seeds.

The data presented in table 4. show that the benefit: cost ratio was higher with the application of optimal dose of nitrogen along with spraying of GA3 at 50 ppm at 30 DAS (2.8) followed by superoptimal dose (2.6) and minimum were recorded where only nitrogen various doses of nitrogen (120 kg N ha^{-1} (2.5) 150 kg N ha^{-1} (2.4) and 90 kg N ha^{-1} (2.2) were used.

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