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Study on Nitrogen Levels and Varieties on Yield Contributing Characters, Quality and Economics of Mustard (*Brassica juncea* Curzen and Cross.) Varieties under Late Sown Condition

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ABSTRACT

Keywords

Nitrogen, Yield attributes, Seed, Stover, Quality, Economics Mustard, NDR-8501, Vardan, Maya

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A field experiment was conducted during the winter (*rabi*) season of 2015-16 to Study on the nitrogen levels and varieties on yield contributing characters, quality and Economics of mustard (*Brassica juncea* Curzen and Cross.) varieties under late sown condition at Main Agronomy Research Station, Narendra Deva University of Agriculture and Technology, Faizabad (Uttar Pradesh). Testing the experiment near alkaline in pH, low EC, Organic carbon and available N, medium in available P and medium available K. The experiment was laid out in Factorial randomized block design with five Nitrogen levels viz. 0, 40, 60,120 and 160 kg ha^{-1} and three varieties Vardan, NDRI-8501 and Maya with three replication. The plants without treatments were served as control. Seed yield and its components were significantly increased in all the treatments over control. The maximum grain yield was noted with 120 kg Nitrogen and variety NDRI-8501. An increase in the grain yield at the abovementioned treatments was may be due to the increase of number of siliqua, length of siliqua, number of seed siliqua^{-1}, test weight. Under different treatment combinations (interactions) the maximum net return of Rs. 54807 ha^{-1} and B:C ratio (2.67) was obtained from 120 kg ha-1 and NDRI-8501 combination.

Introduction

Crop production largely depends on cultivation of high yielding varieties and need based application of nutrients. Nitrogen (N) is the most important nutrient, and being a constituent of protoplasm and protein, it is involved in several metabolic processes that strongly influence growth, productivity and quality of crops (Reddy and Reddy 1998, Kumar *et al.,* 2000). The N fertilizer application accounts for significant crop production cost. Rapeseed-mustard group of crops have relatively high demand for N than many other crops owing to larger N content in seeds and plant tissues (Laine *et al.,* 1993, Malagoli *et al.,* 2005). Yield increases in Indian mustard at various locations in India have been reported with application of N as high as 150 kg ha^{-1} or more (Tomar *et al.,* 1997, Deekshutulu *et al.,* 1998, Singh *et al.,* 2010). A significant part of the unused N is lost to environment causing pollution and contamination of water bodies (Malagoli *et al.,* 2005) or gets converted to greenhouse gases such as oxides of N. Furthermore, N efficiency decreases with increase in N application (Chamoro *et al.,* 2002). Increasing N application also reduces oil content (Dubey *et al.,* 1994, Singh and Singh 2005 and Singh *et al.,* 2008). Since N fertilizers are costly, poor nitrogen use efficiency is of great concern and therefore, attempts are needed to improve the contribution of applied N to production of grain and this approach will reduce the environmental and production costs in agriculture. Almost all investigations showed that nitrogen fertilizers gave substantial seed yield increase even in diverse and contradicting conditions (Siadat *et al.,* 2010). However, nitrogen fertilizer's requirements can differ very much according to soil type, climate, management practice, timing of nitrogen application, cultivars, etc Bani-saeedi (2001). The quality of oil primarily depends on its fatty acid composition. Traditional cultivars of rapeseed-mustard contain high proportion of long chain fatty acids such as eicosenoic and erucic acid (more than 45%) and low proportion of oleic acid (15-20%) in oil. These long chain fatty acids are reported to cause thickening of arteries and increase blood cholesterol leading to heart ailments in human beings (Zhao *et al.,* 1993).

Differences in N concentration in various plant parts of oilseed rape (*Brassica napus*L.) suggest that N uptake and distribution is an inherited character (Grami and La Croix 1977). Spring oilseed rape cultivars producing lowest yields at lowest level of N application generally responded more markedly to increased N application rates than cultivars with higher yield at high N application (Yau and Thurling, 1987a, b). Since N fertilizers are costly, poor NUE is of great concern and therefore, attempts are needed to improve the contribution of applied N to production of grain and this approach will reduce the environmental and production costs in agriculture but such information is not available for Eastern Uttar Pradesh mustard. Considering that the information on yield and quality of mustard with respect to nitrogen and varieties under late sown condition is still not available in this region, the present study aims to generate more information concerning the Study on the nitrogen levels and varieties on yield contributing characters, quality and Economics of mustard (*Brassica juncea* Curzen and Cross.) varieties under late sown condition of Uttar Pradesh, India.

Materials and Methods

The field experiment was carried out during winter season of 2015- 16 at Main Agronomy Research Station, Narendra Deva University of Agricultural and Technology, Faizabad (Uttar Pradesh) during the *rabi* season of 2015-16. The farm is located at 42 km away from Faizabad city on Faizabad- Raebareily road at 26.47˚ N latitude, 82.12˚ E longitude and an altitude of about 113 metres above the mean sea level. Faizabad (Uttar Pradesh) is characterized by sub-tropical, semi-arid type of climate with hot and dry summer during April to June followed by hot and humid period during July to September and cold winter during December and January. The mean maximum and minimum temperatures show considerable variations during different months of the year. Temperature often exceeds 42ºC during summer and sometimes touches above 45ºC with dry spells during

May and June. Minimum temperature falls below 5oC with some frosty spells during the winter months of December and January. The meteorological data recorded during standard meteorological weeks (SMWs) of the crop growing season (*rabi*2015-16) obtained from meteorological observatory of the university, which is located at a distance of 900 meters from the experimental site. The mean temperature recorded during first week of November (45th SMW) 2015 to fourth week of March (12th SMW) 2016 ranged between 5.2oC to 33.4oC. The mean relative humidity varied from 42.7 to 78.8 per cent during crop growth period. A rainfall of 4.8 mm was recorded in the month of March, 2016.The evaporation rate varied from 1.7 mm to 5.8 in the month of November and March, respectively. Daily mean sunshine hours ranged from 2.7 hours in 3_{rd} SMW to 8.1 hours in 9th SMW. The soil of the experimental field belongs to the major group of Indo- Gangetic which is silt loam up to 15 cm depth (Table 1).

Experimental details of the research field

The cropping sequence of the experimental field for the preceding 5 years was rice, blackgram and sorghum followed by mustard, chickpea wheat. The experiment was laid out in Randomized Block Design (RBD), keeping the three varieties viz. vardan, NDRI - 8501 and maya were laid out with five nitrogen levels 0, 40, 80, 120 and 160 kg ha^{-1}respectively, with thee replication. The crop was fertilized with a uniform dose of phosphorus and potassium at the rate of 60 kg and 40 kg ha^{-1}, respectively. Nitrogen was applied as per treatments Urea, DAP and Murate of potash were used as the source of nitrogen, phosphorus and potassium. The full dose of phosphorus and potassium and half dose of nitrogen was applied as basal dose and remaining half dose of nitrogen was given in two equal splits as top dressing each after first and second irrigations. Two irrigations were given in the mustard crop. First irrigation was done at (25 DAS) and second irrigation was done at siliqua formation stage (55 DAS) of the crop. Land preparation was done after harvesting of kharif crop. One ploughing was done by disc plough followed by two ploughings by tractor drawn cultivator and planking was done invariably after each ploughing to get the fine seed bed. Layout was done carefully as per technical programme of the experiment. Thinning was done in two phases. In the first phase dense emerging seedlings were uprooted after 10 days of sowing. Second phase of thinning was completed 25 DAS by maintaining plant to plant and row to row distance as 45 cm and 15 cm, respectively. Mustard seeds were sown in lines at the distance of 45 cm and 15 cm plant to plant with the help of seed drill. The seed rate was used 5 kg ha^{-1}. The crop was harvested at complete maturity as judged by visual observation. The border rows from both the sides and 45 cm from each side width wise were harvested first and kept aside. Thereafter, crop of each net plot was harvested separately and brought to threshing floor after proper tagging. The produce of net plot was weighed individually and recorded before threshing. Threshing was done by wooden sticks and seed weight was recorded for net plot after winnowing the produce. To obtain stover yield the seed weight was subtracted from total biomass recorded from each plot.

Estimation of traits

At maturity, ten random samples were hand harvested from each experimental unit and the following parameters were determined: plant height (cm), number of seeds $siliqua^{-1}$, leangth of siliqua (cm) and number of siliquae $plant^{-1}$. Main stem length was measured as the plant height. Numbers of siliquae $plant^{-1}$ and seeds $siliqua^{-1}$ were counted from 30 randomly selected siliquae after hand threshing. The seed yield was measured by harvesting net plot area of each plot at crop full maturity (physiological maturity). After harvesting, the plants were left in the field for sun drying to their constant weight (12% moisture content). Then, the total above ground plant weight after removal seed was computed (stover yield) by a precise scale (0.001 g) and expressed as kg ha^{-1}. Eight samples of 100 seeds were taken from each seed lot of the experimental units and they were weighed afterwards. Then, the average multiplied by 10 recorded as 1000-seed weight (TSW). Harvest index (HI) was calculated as ratio of seed yield to biological yield. The seed oil contents were determined with the Soxhlet apparatus at the laboratory of university.

Oil yield was computed by multiplying seed yield and oil content.

Statistical analysis

The data was analysed statistically according to Factorial Randomized Block design. The significance of the overall differences among the treatments was determined by using the 'F' test. Conclusion was drawn at 5 per cent probability level. When 'F' value in the analysis of variance table was found to be significant, the critical difference (CD) was computed to test the significance of the difference between two treatment means (Fisher and Yates, 1963).

Results and Discussion

Effect of nitrogen

Application of nitrogen increased all the yield contributing characters viz., length of siliqua. Number of seed $siliqua^{-1}$, 1000-seed weight significantly upto 160 kg ha^{-1} of N except number of siliqua $plant^{-1}$ significantly higher up to 120 kg ha^{-1} of N. Application of 40 kg ha^{-1} of N resulted in significantly higher all the yield contributing characters over the control (0 kg ha^{-1} N). This might be due to the fact that nitrogen application increased the root development which enhanced the absorption of nutrients from soil which resulted in better development of source capacity i.e. leaf area, which ultimately enhanced photosynthesis efficiency and its utilization towards yield contributing characters. Similar results have also been reported by several workers viz., Bhari *et al.*, (2000), Bhaleroo *et al.*, (2001), Tripathi and Tripathi (2003), Shelly and Virender (2010).

Nitrogen fertilization enhanced the stover yield with increase in the dose of nitrogen up to 160 kg ha^{-1}. This might be due to the fact that nitrogen application increased all the growth contributing characters viz. plant height (cm), branches $plant^{-1}$ and leaf area index which enhanced the Stover production. The beneficial effect of nitrogen fertilization on stover yield of mustard has also been reported by Bhari *et al.*, (2000), Bhaleroo *et al.*, (2001).

The highest seed yield (16.44 q ha^{-1}) and least seed yield (9.91 q ha^{-1}) were belonged to the plot which received 120 kg ha^{-1} N and control (0 kg ha^{-1} N), respectively. The seed yield significantly increase with every increasing dose of nitrogen up to 120 kg N $ha^{-1.}$ The highest yield of 16.44 q ha^{-1} was recorded with 120 kg N ha^{-1} which remained at par with 160 kg N ha^{-1} (16.41 q ha^{-1}). The increase seed yield was associated with increase in all yield contributing characters viz. siliquae $plant^{-1}$, length of siliqua, seed $siliqua^{-1}$, and test weight. Adequate supply of nitrogen facilitated better growth and development of crop plant, enhanced nutrient content and resulted significant increase in yield attributes. Similar results have also been reported by Butter and Aulakh (1989), verma *et al.*, (2014) (Table 2).

Nitrogen application resulted in significant increase in protein content with progressive increase in the dose of nitrogen. The higher protein content of 24.54% was obtained with 120 kg N ha^{-1} which remained at par with 160 kg N ha^{-1} (24.43%). The increase in protein content was mainly due to the increase in nitrogen uptake by the crop. It may be stated that due to higher availability of nitrogen in plants, the synthesized carbohydrates may be converted more rapidly in to proteins which in turn enhanced the protein content of seed. Kachroo and Kumar (1999), Kumar *et al.*, (2001) and singh (2002) have also been reported the increase in protein content with increasing doses of nitrogen. Seed oil content was significantly affected by different nitrogen levels and varieties. The maximum oil content (39.45 %) was reported at under control (0 kg ha^{-1} N), then significantly decreased with increase doses of nitrogen rates. The resulting confirmed the finding of earlier researcher's Chuma *et al.*, (2001), Saleem *et al.*, (2001), who pointed out that oil content decrease with the increasing rate of nitrogen. The increase in oil yield was mainly due to increase in seed yield with increasing doses of nitrogen was also reported byDeekshitula *et al.*, (2001), Singh (2002), pandey *et al.*, (2015).

Effect of varieties

Difference among varieties contributed to a great extent in influencing the seed yield of Indian mustard on account of its effect on the attributes, yield and quality and of the plant at various stages. The various growth and yield parameters affected significantly, due to various mustard varieties. Variation among different varieties for different growth and yield attributes culminated in to inconspicuous differences in seed yield in spite of the fact that genotypes differed significantly for stover yield (and also biomass yield).

The seed yield of mustard depends mainly on the number of siliquae $plant^{-1}$ length of siliqua. Number of seed $siliqua^{-1}$, 1000-seed weight as these characters have high degree of positive correlation with seed yiel. Variety NDR-8501 has higher values of all the above mentioned yield contributing characters followed by Vardan and Maya. It may be the main reason for better yield of NDR-8501, which was significantly higher over other varieties. There was significant difference in protein content and oil yield of varieties (Fig. 1 and 2).

Table.1 Physical and chemical properties of soil of the experimental field at the beginning of the study (2015-16)

S.No.	Particulars	Values
(i)	Sand (%)	25.0
(II)	Silt (%)	49.50
(III)	Clay (%)	25.50
(IV)	Textural class	Silt loam
(I)	pH (1:1.25 soil : water)	8.2
(II)	Organic carbon (%)	0.32
(III)	EC dSm^{-1} at 25 ^{0}C	0.24
(IV)	Available N ($kgha^{-1}$)	136.5
(V)	Available P_2O_5 (kg ha^{-1})	14.5
(VI)	Available K_2O ($kgha^{-1}$)	248.5
(VIII)	Available Zn (ppm)	0.54

Table.2 Effect of nitrogen levels on yield attributed and yield of mustard (*Brassica juncea* Curzen and Cross.) varieties under late sown condition

Treatment Siliqua plant^{-1}	No. of siliqua	Length of siliqua^{-1} (cm)	No. of seed weight	Test	Seed yield (q ha^{-1})	Stover yield (q ha^{-1})	Harvest index (%)
Nitrogen levels (kg ha^{-1})							
0	133.6	4.25	8.59	4.36	9.91	43.57	18.53
40	156.8	4.75	10.80	4.51	1.36	48.70	18.91
80	190.7	5.36	12.27	4.52	3.70	54.25	20.16
120	279.4	6.11	13.74	4.26	16.44	59.14	21.75
160	264.0	6.18	14.26	4.56	16.41	60.46	21.34
SEm±	6.8	40.15	0.44	0.08	0.41	1.38	
CD	19.8	20.4	41.27	NS	1.19	3.99	
Varieties							
Vardan	198.6	5.22	11.65	4.50	13.53	51.11	20.93
NDR-8501	219.5	5.60	12.80	4.44	14.25	56.53	20.13
Maya	196.6	5.18	11.30	4.46	12.91	50.84	20.25
SEm±	5.50	0.1	20.3	40.0	10.32	1.07	
CD	15.3	50.3	40.98	0.03	0.92	3.09	

Table.3 Effect of nitrogen levels on protein content, nitrogen content, oil content and oil yield of mustard (*Brassica juncea* Curzen and Cross.) varieties under late sown condition

Treatment	Protein content (%)	Oil content (%)	Oil yield (q ha^{-1})	Nitrogen Content (cm)	
				Seed	**Stover**
Nitrogen Levels (kg ha^{-1})					
0	19.13	39.45	3.91	3.06	0.49
40	21.60	38.86	4.41	3.45	0.62
80	22.95	37.92	5.19	3.67	0.74
120	24.30	37.36	6.14	3.88	0.91
160	24.53	36.54	5.99	3.92	0.98
SEm±	0.54	0.37	0.18	0.04	0.04
CD (P=0.05)	1.57	1.36	0.64	0.11	0.11
Varieties					
Vardan	22.21	38.01	5.14	3.55	0.73
Narendra Rai-8501	22.65	38.03	5.41	3.62	0.82
Maya	21.11	38.05	4.91	3.37	0.70
SEm±	0.42	0.44	0.30	0.03	0.03
CD (P=0.05)	1.22	NS	0.88	0.09	0.08

Fig.1 Seed yield, Stover yield (q ha^{-1}) and harvest index (%) of mustard influenced by nitrogen levels and varieties

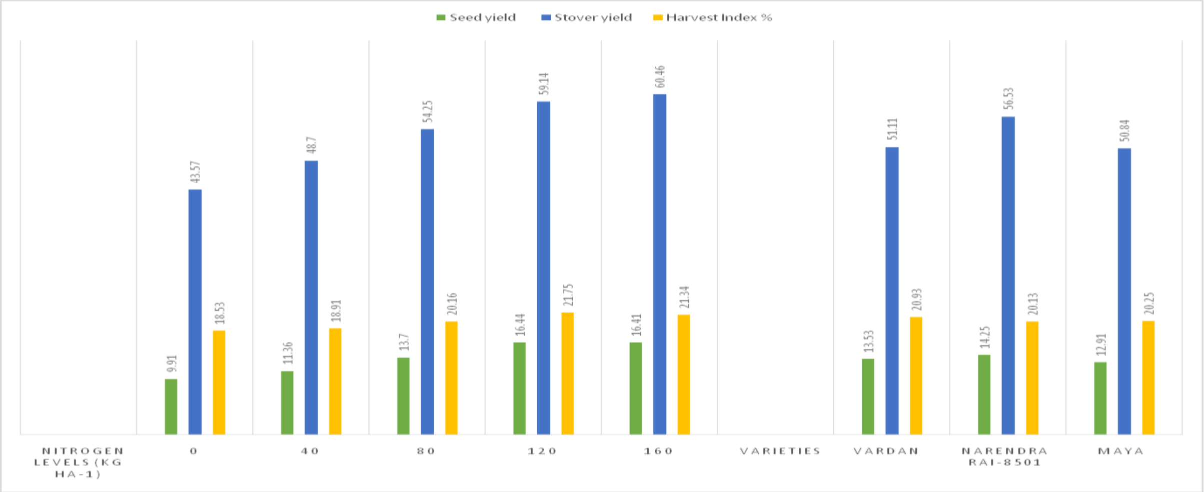
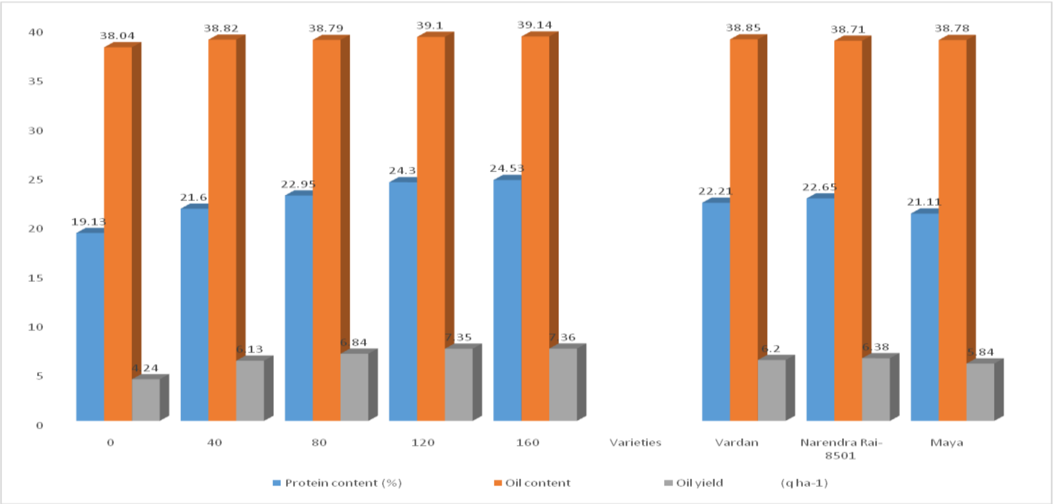


Fig.2 Protein content, oil content and oil yield in seed of mustard influenced by nitrogen levels and varieties



Variety NDR-8501 recorded highest protein content (24.53%) and oil yield (7.35 qha^{-1}) followed by Vardan and Maya, which may be due to little variation in genetic characters of the varieties (Table 3).

Economics

The variations in cost of cultivation were recorded due to different nitrogen levels. Increasing levels of nitrogen increased the cost of cultivation as being major monetary inputs.

On the other hand, major variation in gross return, net return and benefit cost: (Rs. 2.67 Re^1 invested) were observed due to variation of yield and cost cultivation. Maximum cost of cultivation as well gross return were recorded at highest level of nitrogen (160 kg ha^{-1}) with Variety NDR-8501 followed by 120 kg ha^1 with same variety.

In conclusion, a nitrogen level of 120 kg/ha can be considered as suitable dose for higher yield of mustard. Among mustard varieties, NDR-8501 performed most promising followed by vardan and maya in terms of growth and yield and can be recommended for the cultivation in eastern UP.A combination of mustard variety NDR-8501 along with 120 kg N ha-1 recorded significantly higher growing yield over rest of the treatments. Likewise net returns and benefits cost ratio was also found substantly higher with the combination. However further experimentation is required for making the conformation of results.

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