Indian Journal of Agronomy **61** (2): 259–262 (June 2016)

Research Communication

Effect of sowing date and nitrogen fertilizer on growth, yield and nitrogen uptake of forage turnip (*Brassica rapa*)

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Received : December 2015; Revised accepted : March 2016

ABSTRACT

A field experiment was conducted at the ICAR-National Dairy Research Institute, Karnal, Haryana, during the winter season of 2012–13 on clay loam soils, to evaluate the effect of different sowing dates and nitrogen fertilizer on forage yield and nitrogen uptake in turnip [*Brassica rapa* (L.)]. The crop sown on 26 September recorded significantly higher plant height, number of leaves, forage yield, and nitrogen uptake than that sown on 26 October and 11 November. Higher values of plant height and forage yield were the reflection of higher accumulation of growing degree-days, which gradually reduced with delay in sowing from 26 September to 11 November respectively. Forage yield was significantly improved by application of nitrogen at 160 kg N/ha compared to lower nitrogen levels. Response of nitrogen to forage yield of turnip was linear. Net returns (₹62,411/ha) and (₹56,534/ha) and benefit: cost ratio (2.57) and (2.34) were the highest with 26 September sowing and 160 kg N/ha respectively.

Key words: Date of sowing, Growing degree days, Nitrogen uptake, Net returns

In north-western India, berseem and oats are mainly cultivated as fodder crops during the winter (*rabi*) season and their fodder becomes available by the second fortnight of December. The rainy (*kharif*) season fodder crops like sorghum, *bajra*, maize and cowpea are generally over by October–November. Since month of December is the period of fodder scarcity, there is an urgent need to grow a fodder crop which can supply green fodder during this period. Turnip, a short-duration crop, has a potential to be cultivated as a catch crop and can supply green fodder during scarcity period (Chin *et al.,* 1993). Its fodder is rich in readily-available carbohydrates and crude protein as well as it is highly palatable, succulent and easily digestible and is known for its ability to produce near-concentrate diet. The dates of sowing and nitrogen are the most important factors affecting the productivity of fodder turnip. Sowing of fodder turnip at optimum date results in maximum plant height, number of leaves, leaf-area index, green forage and root yield, whereas delayed one results in poor growth and fodder yield (Tiryakioglu and Turk, 2012).

Nitrogen is the most important factor affecting the root dry matter, root crude protein, leaf dry-matter yield and leaf crude protein of fodder turnip (Soheir E. El-Sherbeny *et al.,* 2012). Since information is lacking on the optimum time of sowing and nitrogen requirement for maximizing fodder yield with higher returns and benefit: cost ratio in fodder turnip, a study was carried out to determine the optimum sowing date and nitrogen dose for maximizing the fodder yield of turnip under north Indian conditions.

A field experiment was conducted during the winter (*rabi*) season of 2012–13 at Research farm of ICAR-National Dairy Research Institute, Karnal (29°45 N, 76°58, E at 245 m above mean sea-level). The soil was clay loam with *p*H 7.3, electrical conductivity 0.64 dS/m and organic carbon 0.54%. Available N, P and K were 212, 21.6 and 301 kg/ha respectively. The experiment was laid out in a split-plot design with 4 replications. The treatments comprised 4 dates of sowing, viz. 26 September, 11 October, 26 October and 11 November, were assigned to the main plots and 5 nitrogen levels, *viz.* 0, 40, 80,120 and 160 N kg/ha, were allotted to sub–plots. The turnip cv. 'Purple Top' was sown, 30 cm apart, as per the sowing-date treatments. Thinning was done 15 days after sowing wherever required to maintain optimum plant population. A uniform

Based on a part of M.Sc thesis of the first author, submitted to the National Dairy Research Institute, Karnal, Haryana (unpublished)

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application of 40 kg P_2O_5 and 30 kg K_2O was applied basal at sowing. Nitrogen was applied as per treatment, 50% as basal and remaining 50% after the first irrigation. Data on plant height and number of leaves/plant were recorded from 5 random plants/plot and green-fodder yield was recorded plot-wise at harvesting (65 days after sowing). Nitrogen uptake under different treatments was determined by multiplying the nitrogen contents with dry-matter yield. Growing degree-days were calculated by taking the average of the daily maximum and minimum temperatures compared to a base temperature 5^{O}C following Nuttonson (1955).

Sowing of turnip on 26 September recorded significantly higher plant height at harvesting than 26 October and 11 November sowing. Delayed sowing on 26 October and 11 November showed reduction of 27.7% and 33.6% respectively, in plant height compared to 26 September sowing. Earlier planting provided the longer period for photosynthesis and growth which might be responsible for higher plant height. Raj Singh *et al.,* (2001) also reported similar increases in plant height in early date of sowing. Plant height was significantly higher at 160 kg N/ha than that at lower nitrogen levels up to 80 kg N/ha. There was increase of 18.6, 8.2, 6.7% in plant height at 160 kg N/ha compared to the control, 40 and 80 N/ha respectively. Sowing on 26 September recorded significantly higher number of leaves than 11 and 26 October at harvesting. There was reduction of 25.3% and 37.6% in number of leaves/plant when sowing was delayed to 26 October and 11 November, respectively, compared to 26 September sowing. The number of leaves/plant showed an increase with the increase in nitrogen and highest numbers of leaves were recorded at 160 kg N/ha which were significantly higher compared to 0, 40 and 80 kg and remained at par with 120 kg Nha. Nitrogen fertilization helps in higher uptake of plant nutrients and water from the soil by crop which might have helped in enhancing photosynthesis and increased yield attributes. Keogh *et al.,* (2012) also reported response of turnip to nitrogen fertilization.

The highest fodder yield (root + leaf, t/ha) of turnip was recorded with 26 September sowing, but variation in this regard was at par with 11 October sowing due to statistically at par variation in plant height. Fodder yield decreased significantly with delay in sowing time at 26 October and 11 November and there was reduction of 21.6 and 56.5% in 26 October and 11 November sowing, respectively, compared to 26 September sowing. Reduction in total fodder yield in late October-and November-sown crop could be due to less taller plants and lesser number of leaves (Table 1). The crop sown on 26 September maintained higher growth compared to delayed sowings which can be ascribed to higher plant growth on account of more conversion of radiant energy into biomass due to bigger size of photosynthetic apparatus; data on plant height and number of leaves/plant endorse this statement. These results are consistent with the results of Keogh *et al.,* (2012). Sowing time influences the development of crop plants due to accumulation of heat units, i.e. growing degree-days. Maximum growing degree-days were accumulated in 26 September sowing and there was a gradual reduction in growing degree-days in the subsequent sowings (Table 1). Relationship between growing degree-days with plant

Table 1. Effect of sowing dates and nitrogen on growth, and forage yield of turnip

Treatment	Plant height (cm)	Leaves/ plant	Growing degree-days	Root yield (t/ha)	Leaf yield (t/ha)	Total fodder yield (t/ha)
Sowing dates						
26 September	83 .0	17.0	1137.0	41.2	29.1	70.3
11 October	72.5	14.1	993.3	41.3	26.2	67.5
26 October	60.0	12.7	830.3	35.9	19.1	55.1
11 November	55.1	10.6	622.7	21.2	9.4	30.6
SEm±	3.0	0.90	-	1.48	1.45	1.9
CD (P=0.05)	9.6	2.8	-	4.7	4.6	6.3
Nitrogen (*kg/ha*)						
0	61.2	12.0	-	27.7	13.8	41.5
40	67.1	12.8	-	31.9	16.9	48.9
80	68.0	13.2	-	34.8	22.7	57.6
120	69.3	14.2	-	38.8	24.4	63.3
160	72.6	15.9	-	41.2	26.7	68.0
SEm±	1.6	0.72		1.3	1.5	1.3
CD (P=0.05)	4.6	2.0		3.8	4.2	3.73

height and total fodder yield observed R^2 value of 0.94 and 0.93 (Fig. 1), indicating that 94% and 93% of mean variation in plant height and green forage yield, respectively, can be explained by estimated regression equation. Increase in growing degree-days increased the green-forage yield, as evident from 26 September sowing; adverse effects of low temperature in November sowing can be very well explained by the lowest accumulation of growing degree-days which resulted in lower plant height and green-forage yield of turnip (Table 1). There was significant reduction in fodder yield of turnip which was 39.9, 28.0, 15.3 and 6.9% in the control, 40, 80 and 120 kg N/ha, respectively, compared to 160 kg N/ha**.** Cumulative effect of higher plant height and number of leaves resulted in the highest fodder yield with 160 kg N/ha. Adequate supply of nitrogen resulted in the production of large-succulent leaves that helped in the maximum utilization of radiant energy and production of more photosynthtates. This is confirmatory with results of Soheir El-Sherbeny *et al.* (2012). The estimated regression equation for the response of nitrogen to forage yield of turnip (Y= 42.38 + 0.168) shows linear response of turnip forage yield to change in the rate of nitrogen application from 0 to 160 kg/ha range was found to be significant at 1% level of significance. The increase in forage yield for every 1 kg nitrogen applied within the range of 0–160 kg/ha expected to fall between 0.024 to 0.31 tonne/ha.

Lowest crude protein contents were recorded with 26

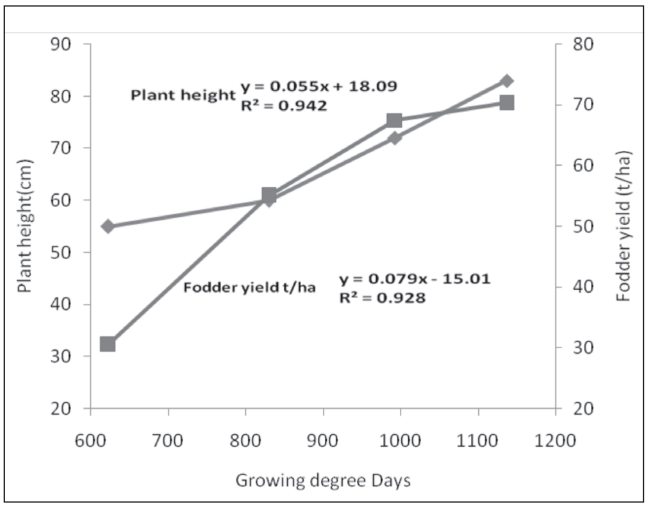

Fig. 1. Relationship between plant height and fodder yield with growing degree days

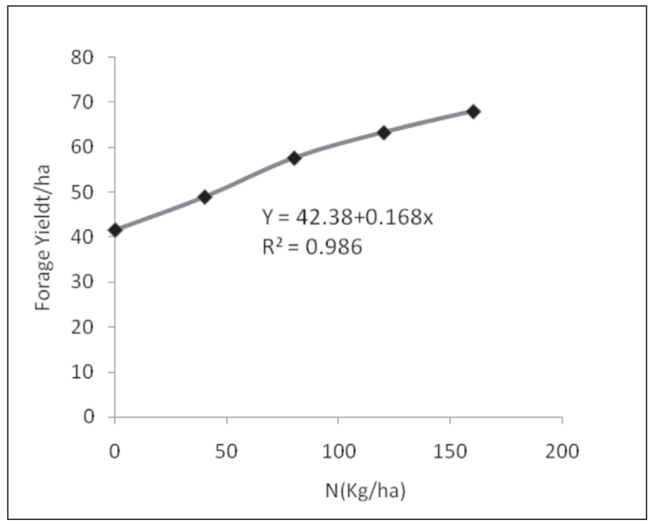

Fig. 2. Linear Regression between turnip forage yield and nitrogen

Table 2. Effect of sowing dates and nitrogen fertilizer on fodder quality, nitrogen uptake and economics of turnip

Treatment	Crude protein (%)	Neutral detergent powder (%)	Acid detergent powder (%)	Nitrogen uptake (kg/ha)	Gross returns (×10³₹/ha)	Net returns (× 10³₹/ha)	Benefit: cost ratio
Sowing dates							
26 September	11.2	24.3	20.3	157.3	101.9	62.4	2.58
11 October	11.6	22.1	19.7	148.2	97.9	58.4	2.47
26 October	13.4	22.1	19.7	138.3	79.8	40.3	2.02
11 November	13.8	21.8	19.7	76.9	44.3	4.8	1.12
SEm±	0.23	-	-	7.03	6.7	-	-
CD (P=0.05)	0.75	-	-	22.5	21.6	-	-
Nitrogen (kg/ha)							
0	11.2	26.1	23.0	73.8	60.2	20.7	1.52
40	12.2	23.6	20.3	110.1	70.9	30.4	1.75
80	12.6	22.1	19.5	136.8	83.5	42.5	2.03
120	10.1	21.7	19.3	161.1	91.7	50.2	2.21
160	13.5	19.5	17.3	176.9	98.6	56.6	2.34
SEm±	0.44	-	-	6.9	2.9	-	-
CD (P=0.05)	1.26	-	-	19.79	8.3	-	-

September sowing, while significantly higher crude protein (CP) contents were recorded with 11 November sowing. The highest crude protein contents were recorded with 160 kg N/ha which was significantly higher than 0, 40 and 80 kg N/ha, respectively, but was at par with 120 kg N/ha. Both (neutral detergent fibre) (NDF) and (acid detergent fibre) ADF were not affected by different sowing dates; however, both the cell wall constituents decreased with the increase in nitrogen level (Table 2). Similar findings were reported by Turk *et al.* (2009). Crop sown on 26 September recorded significantly higher nitrogen uptake in fodder turnip (157.3 kg N/ha) than November 11 (76.9 kg N/ha). Among different levels of nitrogen application, the highest nitrogen uptake was recorded with 160 kg N/ha, while the lowest with the control. Higher uptake of nitrogen with the 160 kg N/ ha may be attributed to better growth-contributing characters which led to increase in productivity owing to higher production of photosynthates. Highest net returns and benefit: cost ratio were recorded in 26 September sowing, whereas the lowest net return with 11 November sowing. Net returns and benefit: cost ratio increased from ₹20,667/ha to ₹56,534/ha and 1.52 to 2.34, respectively, with increase in level of nitrogen application from 0 to 160 kg N/ha.

Thus, fodder turnip may be sown in the last week of September with 160 kg N/ha for obtaining the maximum forage yield, uptake of nitrogen, net returns and benefit : cost ratio during the fodder scarcity period.

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