

Nitrogen and Phosphorous Fertlizer Management to Enhance Turnip (Brassica Rapa) Procuction in Field

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Abstract
A field experiment was conducted during 2013 to examine the production response of turnip to different levels of nitrogenous and phosphatic fertilizers at the experimental fields of the Horticulture Garden, Department of Horticulture, Sindh Agriculture University Tandojam. Treatments included: T1=0-0 kg ha-1, T2=75-50 kg ha-1, T3=75-75 kg ha-1, T4=100-50 kg ha-1, T5=100-75 kg ha-1, T6=125-50 kg ha-1 and T7=125-75 kg ha-1. Turnip variety "Purple Top White Globe" was used in this study. Our results revealed that the effect of various levels of nitrogenous and phosphatic fertilizers on plant height, leaves plant-1, fresh weight of leaves plant-1, single turnip root weight, root yield plot-1 and root yield ha-1 was statistically significant (P<0.05). The turnip crop fertilized with N-P levels of 125-75 kg ha-1 resulted in 40.67 cm plant height, 15.86 leaves plant-1, 81.74 g fresh weight of leaves plant-1, 113.62 g single turnip root weight, 7.35 kg root yield plot-1 and 14690.88 kg root yield ha-1. The turnips given N-P fertilizers at the rate of 125-50 kg ha-1 produced 40.00 cm plant height, 15.60 leaves plant-1, 80.40 g fresh weight of leaves plant-1, 111.76 g single turnip root weight, 7.23 kg root yield plot-1 and 14450.23 kg root yield ha-1. The crop fertilized with N-P levels of 100-75 kg ha-1 produced 35.00 cm plant height, 13.65 leaves plant-1, 70.35g fresh weight of leaves plant-1, 97.79 g single turnip root weight, 6.32 kg root yield plot-1 and 12643.79 kg root yield ha-1. The turnips given N-P levels at the rate of 100-50, 75-75, 75-50 kg ha-1 and control, resulted in lower values for all the growth and root yield contributing traits. It was concluded that the differences in all the growth and yield parameters of turnip fertilized with N-P levels of 125-75 kg and 125-50 kg ha-1 was non-significant (P<0.05) and hence, 125-50 kg ha-1 N-P level was considered as an optimum level for economical turnip production.
Keywords: Turnip, Productivity, Levels, Nitrogen and Phosphorous

Introduction

The turnip (*Brassica rapa*), a member of the cruciferous family is a root vegetable commonly grown in temperate climates worldwide for its white, bulbous taproot. Small, tender varieties are grown for human consumption, while larger varieties are grown as feed for livestock. The turnip was a well-established crop in Hellenistic and Roman times, which leads to the assumption that it was brought into cultivation earlier. Wild forms of the turnip and its relatives the mustards and radishes are found over west Asia and Europe, suggesting their domestication took place somewhere in that area (Zohary and Hopf, 2000).

Nutritionally the 100 g turnip contains 34 calories, 0.12 % Fat, 7.84 % carbohydrates, 2.2 fibers, 1.10 percent protein, no cholesterol, while the root is high in vitamin C. The green leaves of the turnip top are a good source of vitamin A, folate, vitamin C, vitamin K and calcium. Moreover, the turnip roots contains 4.4 g carbohydrates, 3.5 g dietary fiber, 0.2 g fat, 1.1 g protein, vitamin A 381 µg, vitamin B9 118 µg, vitamin C 27 mg, vitamin B6, vitamin K 368 µg, Calcium 137 mg, sugars 3 g, vitamin B1 0.027 mg, vitamin B2 0.023 mg, vitamin B3 0.299 mg, calcium 33 mg, iron 0.18 mg, magnesium 9 mg, 0.071 manganese, 26 mg phosphorus, 177 mg potassium, 16 mg sodium and 0.12 mg zinc (Susan, 2010).

Fertilizer application to the plants greatly affects their growth, production and plant constituents. Nitrogen strongly stimulates growth, expansion of the crop canopy and interception of solar radiation (Milford et al., 2000). Nitrogen is an essential macronutrient needed by all plants to thrive. It is an important component of many structural, genetic and metabolic compounds in plant cells. Increasing the levels of nitrogen during the vegetative stage can strengthen and support plant roots, enabling plants to take in more water and nutrients; and allows a plant to grow more rapidly and produce large amounts of succulent, green foliage, which in turn can generate bigger yields, tastier vegetables, and a crop that is more resistant to pests, diseases, and other adverse conditions (Eckert, 2010). Similarly, Phosphorus (P) is an essential nutrient both as a part of several key plant structure compounds and as a catalysis in the conversion of numerous key biochemical reactions in plants. P stimulated root development, increased stem strength, improved flower formation and seed production, more uniform and earlier crop maturity, improvements in crop quality, and increased resistance to plant diseases

(Griffith, 2010).

The Brassica species require large amounts of chemical fertilizers and major costs for production of these crops are accounted for by these fertilizers. Plants are surrounded by the nitrogen in our atmosphere. Every acre of the earth's surface is covered by thousands of pounds of this essential nutrient, but because atmospheric gaseous nitrogen is present as almost inert nitrogen molecules, this nitrogen is not directly available to the plants that need it to grow, develop and reproduce (Eckert, 2010). The root yield and dry matter of turnip has been found to improve with higher of N (Miller et al., 2003). The application of P also significantly increases the seed yield, leaf area index and total dry matter as well as increases the P uptake in Brassica species (Lickfett et al., 1999). Salardini et al. (2000) reported that the total bulb yields with 50, 100 and 200 kg N ha-1 were 14, 15.2 and 15 t DM ha-1 for turnips, respectively. Jacobs et al. (2002) supplied turnip crop with nitrogen at the rates from 0 to 50 kg ha-1 and turnip yields were remarkably higher under higher nitrogen levels as compared to lower nitrogen levels or control. Jacobs et al. (2004) found higher turnip yields when N was applied at the rate of 50 kg ha-1 and lower where 0 N was applied. Ohland and Alexandre (2005) reported that nitrogen addition at higher levels increased turnip productivity as compared to control. Sharma (2007) found that application of NPK (75:20:20 kg ha-1) was suitable for the root yield whereas application of 125 kg N coupled with 30 kg each of P and K per hectare for seed yield. Stevens and Carruthers (2008) suggested that knowledge of the available soil nitrogen levels is imperative to assist in decision making concerning rates of fertilizer use. Jacobs and Ward (2008) concluded that turnip bulb yield responses to NP fertilizers were similar across both years despite contrasting climatic conditions, highlighting the ability of turnips to respond to limited moisture inputs. Salardini et al. (2009) reported that Nitrogen fertilizer increased the dry matter yield of tops of all turnips. Albayrak and Yuksel (2010) recommended 150 kg per hectare nitrogen treatments for achieving higher yields in fodder beet. Sadia et al. (2013a) reported that the highest diameter of root (3.7 cm) and highest yield per hectare (25.8 tons) were recorded from N3 (100 kg ha-1) and, the lowest diameter (2.9 cm) and lowest yield (18.8 ton) were recorded from control. The present study was therefore, carried out to investigate the production response of turnip (*Brassica rapa*) to different levels of nitrogenous and phosphatic fertilizers.

Materials and Methods

In order to investigate the production response of turnip to different levels of N-P fertilizers, the experiment was laid out in a 3 replicated Randomized Complete Block Design, having plot size of 2m x 2.5m (5m2) at the experimental area of Orchard, Department of Horticulture, Sindh Agriculture University, Tandojam. The land was prepared by giving 2 dry ploughing. When the land will be ploughed up, the clods were crushed, and leveling was done to eradicate the weeds and to make the soil surface leveled for uniform distribution of irrigation water during soaking dose. The total experimental area was 5m2 (2.5m length x 2m width). The sowing of turnip variety "Purple Top White Globe" was done by drilling the seeds in rows. The treatments included six NP levels and a control. The nitrogen was applied in the form of urea and phosphorus in the form of single super phosphate (SSP). 1/3rd of N alongwith all P was applied at the time of land preparation by mixing in the soil, while the remaining N was divided into two equal doses and was applied with a fortnight interval. The crop was irrigated at fortnight interval and in all, six irrigations were applied.

Methods used for recording observations

Plant height (cm): The plant height (cm) was measured at harvesting of the crop by measuring tape from bottom to tip of plant in labeled plants in each treatment.

Number of leaves plant-1: The leaves on the labeled plants in each replication for all the treatments were counted and average was worked out.

Fresh weight of leaves plant-1 (g): The weight of fresh leaves in labeled plants in each plot was taken by electronic top loading balance in grams and average was calculated on the basis of weight of all the leaves on each plant.

Single turnip root weight (g): The weight of single turnip roots of labeled plants in each plot was taken by means of electronic top loading balance in grams and average was calculated for all the treatments.

Root yield plot-1 (kg): The whole roots in all the experimental treatments in each replication were pulled out and their weight was taken by the field balance in kilograms and averages were worked out.

Root yield ha-1 (kg): The root yield per hectare was calculated on the basis of root yield per plot in kilograms using the following formula:

$$\text{Root yield ha-1 (kg)} = \frac{\text{Root yield plot-1 (kg)}}{\text{Plot size (m2)}} \times 10000 \text{ (m2)}$$

Statistical analysis: The data collected were subjected to analysis of variance and in view of the statistical outcomes the results were interpreted using the statistical software MSTATC, followed statistical method developed by Gomez and Gomez (1984).

Results

Plant height (cm)

The crop growth is generally assessed on the basis of height of the plants; however turnip is a root crop and its productivity is based on the healthy roots. The results in regards to plant height of turnip variety "Purple Top White Globe" as affected by various levels of nitrogenous and phosphatic fertilizers are shown in Table-1 and its analysis of variance as Appendix-I. The analysis of variance demonstrated that the plant height of turnip was significantly (P<0.05) affected by various levels of nitrogenous and phosphatic fertilizers. The turnip plants grew to a maximum height on average (40.67 cm) when the crop was fertilized with highest N-P level of 125-75 kg ha-1; closely followed by N-P level of 125-50 kg ha-1 with average turnip plant height of 40.00 cm. A significant decrease in the plant height such as: 35.00 cm and 31.00 cm, observed in crop fertilized with N-P levels of 100-75 kg ha-1 and 100-50 kg ha-1, respectively. There was a simultaneous decrease in plant height i.e. 30.33 cm and 25.33 cm with decreasing N-P levels upto 75-75 kg ha-1 and 75-50 kg ha-1, respectively. However, in control plots, where nitrogenous and phosphatic fertilizers were not applied to turnip, the minimum plant height of 19.33 cm was recorded. The results clearly indicated that nitrogenous as well as phosphatic fertilizers both are essential for achieving proper plant growth in turnip as the decrease in plant height was entirely associated with the decrease in N-P levels. The LSD test suggested that differences in plant height under N-P levels of 125-75 and 125-50 kg ha-1 were statistically non-significant (P>0.05) and significant when compared with rest of the treatments and control; suggesting that N-P level of 125-50 kg ha-1 was an optimum level so far the plant height of turnip is concerned.

Table 1. Plant height (cm) of turnip as affected by various levels of nitrogenous and phosphatic fertilizers.

N-P levels	R-I	R-II	R-III	Mean
Control	19.00	21.00	18.00	19.33 c
75-50 kg ha^{-1}	23.00	26.00	27.00	25.33 d
75-75 kg ha^{-1}	32.00	30.00	29.00	30.33 c
100-50 kg ha^{-1}	33.00	30.00	30.00	31.00 c
100-75 kg ha^{-1}	35.00	36.00	34.00	35.00 b
125-50 kg ha^{-1}	40.00	39.00	41.00	40.00 a
125-75 kg ha^{-1}	41.00	42.00	39.00	40.67 a

In a column, means followed by same letters are not significantly different at P=0.05 as suggested by LSD test.

Number of leaves plant-1

Number of leaves plant-1 is another trait to reflect the plant growth and vigor and more leaves sprout in healthy plants as compared to weaker plants. The data in relation to number of leaves plant-1 of turnip variety "Purple Top White Globe" as influenced by different levels of nitrogenous and phosphatic fertilizers are presented in Table-2 and its analysis of variance as Appendix-II. The analysis of variance indicated that the leaves plant-1 of turnip was significantly (P<0.05) affected by various levels of nitrogenous and phosphatic fertilizers. The leaves plant-1 developed in highest number (15.86) in crop fertilized with highest N-P level of 125-75 kg ha-1; closely followed by N-P level of 125-50 kg ha-1 with 15.60 average number of leaves plant-1. The number of leaves plant-1 declined sharply to 13.65 and 12.09 in crop fertilized with lower N-P levels of 100-75 kg ha-1 and 100-50 kg ha-1, respectively. There was a consecutive decrease in leaves with decreasing N-P levels and number of leaves plant-1 were 11.83 and 9.88 under decreased N-P levels of 75-75 kg ha-1 and 75-50 kg ha-1, respectively. However, in control plots, where nitrogenous and phosphatic fertilizers were not applied to the experimental turnip, the lowest number of leaves plant-1 (7.54) was observed. This more number of leaves plant-1 under higher N-P levels was mainly associated with the plant height. The LSD test indicated that differences in leaves plant-1 under N-P levels of 125-75 and 125-50 kg ha-1 were statistically non-significant (P>0.05) and significant when compared with lower N-P levels as well as control; indicating that application of N-P fertilizers beyond 125-50 kg ha-1 would not be economical.

Table 2. Number of leaves plant^{-1} of turnip as affected by various levels of nitrogenous and phosphatic fertilizers.

N-P levels	R-I	R-II	R-III	Mean
Control	7.41	8.19	7.02	7.54 e
75-50 kg ha^{-1}	8.97	10.14	10.53	9.88 d
75-75 kg ha^{-1}	12.48	11.70	11.31	11.83 c
100-50 kg ha^{-1}	12.87	11.70	11.70	12.09 b
100-75 kg ha^{-1}	13.65	14.04	13.26	13.65 b
125-50 kg ha^{-1}	17.60	13.21	15.99	15.60 a
125-75 kg ha^{-1}	15.99	16.38	15.21	15.86 a

In a column, means followed by same letters are not significantly different at P=0.05 as suggested by

LSD test.

Fresh weight of leaves plant-1 (g)

The results pertaining to weight of fresh leaves plant-1 of turnip variety “Purple Top White Globe” as affected by different levels of nitrogenous and phosphatic fertilizers are given in Table-3 and its analysis of variance as Appendix-III. The analysis of variance indicated that the weight of fresh leaves plant-1 of turnip was significantly (P<0.05) influenced by different levels of nitrogenous and phosphatic fertilizers. The weight of fresh leaves plant-1 was highest (81.74 g) in crop fertilized with highest N-P level of 125-75 kg ha-1; closely followed by N-P level of 125-50 kg ha-1 with 80.40 g average weight of fresh leaves plant-1. The weight of fresh leaves plant-1 declined sharply to 70.35 g and 62.31 g in crop fertilized with lower N-P levels of 100-75 kg ha-1 and 100-50 kg ha-1, respectively. There was a successive reduction in weight of fresh leaves with decreasing N-P levels and weight of fresh leaves plant-1 was 60.97 g and 50.92 g under decreased N-P levels of 75-75 kg ha-1 and 75-50 kg ha-1, respectively. However, in control plots, where nitrogenous and phosphatic fertilizers were not applied, the minimum weight of fresh leaves plant-1 (38.86 g) was noted. This higher weight of fresh leaves plant-1 under higher N-P levels was mainly associated with the plant height and the number of leaves plant-1. The LSD test demonstrated that the differences in weight of fresh leaves plant-1 under N-P levels of 125-75 and 125-50 kg ha-1 were statistically non-significant (P>0.05) and significant when compared with rest of N-P levels and control. This showed that 125-50 kg ha-1 N-P level would be an optimum level for turnip so far the weight of fresh leaves plant-1 is concerned.

Table 3. Fresh weight of leaves plant^{-1} (g) of turnip as affected by various levels of nitrogenous and phosphatic fertilizers.

N-P levels	R-I	R-II	R-III	Mean
Control	38.19	42.21	36.18	38.86 e
75-50 kg ha^{-1}	48.23	50.26	54.27	50.92 d
75-75 kg ha^{-1}	64.32	60.30	58.29	60.97 c
100-50 kg ha^{-1}	66.33	60.30	60.30	62.31 c
100-75 kg ha^{-1}	70.35	72.36	68.34	70.35 b
125-50 kg ha^{-1}	80.40	78.39	82.41	80.40 a
125-75 kg ha^{-1}	82.41	84.42	78.39	81.74 a

In a column, means followed by same letters are not significantly different at P=0.05 as suggested by LSD test.

Single root weight (g)

The data in relation to single root weight of turnip variety “Purple Top White Globe” as influenced by various levels of nitrogenous and phosphatic fertilizers are presented in Table-4 and its analysis of variance as Appendix-IV. The analysis of variance described that the single root weight of turnip was significantly (P<0.05) affected by different levels of nitrogenous and phosphatic fertilizers.

The single root weight was highest (113.62 g) in plots fertilized with highest N-P level of 125-75 kg ha-1; closely followed by N-P level of 125-50 kg ha-1 with 111.76 g average single root weight. The single root weight diminished to 97.79 g and 86.61 g in crop given lower N-P levels of 100-75 kg ha-1 and 100-50 kg ha-1, respectively. There was a consecutive decrease in root weight with each decrease in N-P level and single root weight was 84.75 g and 70.78 g under decreased N-P levels of 75-75 kg ha-1 and 75-50 kg ha-1, respectively. However, the lowest single root weight of 54.02 g was in control, where nitrogenous and phosphatic fertilizers were not applied. This higher single root weight under higher N-P levels was mainly associated with the plant height, leaves plant-1 and weight of fresh leaves.

The LSD test demonstrated that the differences in single root weight under N-P levels of 125-75 and 125-50 kg ha-1 were statistically non-significant (P>0.05) and significant when compared with rest of N-P levels and control. This showed that 125-50 kg ha-1 N-P level would be an optimum level for turnip so far the single root weight is related.

Table 4. Single root weight (g) of turnip as affected by various levels of nitrogenous and phosphatic fertilizers.

N-P levels	RI	RII	RIII	Mean
Control	53.08	58.67	50.29	54.02 e
75-50 kg ha^{-1}	67.04	69.86	75.44	70.78 d
75-75 kg ha^{-1}	89.40	83.82	81.02	84.75 c
100-50 kg ha^{-1}	92.20	83.82	83.82	86.61 c
100-75 kg ha^{-1}	97.79	100.58	94.99	97.79 b
125-50 kg ha^{-1}	115.76	108.96	110.55	111.76 a
125-75 kg ha^{-1}	114.55	117.34	108.96	113.62 a

In a column, means followed by same letters are not significantly different at P=0.05 as suggested by LSD test.

Root yield plot-1 (kg)

The results in regards to root yield plot-1 of turnip variety “Purple Top White Globe” as affected by different levels of nitrogenous and phosphatic fertilizers are given in Table-5 and its analysis of variance as Appendix-V. The analysis of variance illustrated that the root yield plot-1 of turnip was significantly (P<0.05) influenced by different levels of nitrogenous and phosphatic fertilizers.

It is apparent from the results that the root yield plot-1 was highest (7.35 kg) when the crop was fertilized with highest N-P level of 125-75 kg ha-1; closely followed by N-P level of 125-50 kg ha-1 with 7.23 kg average root yield plot-1. The root yield plot-1 declined to 6.32 kg and 5.60 kg in crop given lower N-P levels of 100-75 kg ha-1 and 100-50 kg ha-1, respectively. The root yield plot-1 decreased simultaneously with decreasing N-P levels and it was 5.48 kg and 4.58 kg plot-1 when N-P fertilizers were applied at lower rates of 75-75 kg ha-1 and 75-50 kg ha-1, respectively. However, the lowest root yield plot-1 of 1.88 kg was obtained in control, where nitrogenous and phosphatic fertilizers were not applied. This higher root yield plot-1 under higher N-P levels was mainly associated with the plant height, leaves plant-1, weight of fresh leaves and single root weight.

The LSD test indicated that the differences in root yield plot-1 under N-P levels of 125-75 and 125-50 kg ha-1 were statistically non-significant (P>0.05) and significant when compared with rest of the treatments. This showed that 125-50 kg ha-1 N-P level was an optimum level for economical turnip production.

Table 5. Root yield plot^{-1} (kg) of turnip as affected by various levels of nitrogenous and phosphatic fertilizers

N-P levels	R-I	R-II	R-III	Mean
Control	1.93	2.03	1.68	1.88 e
75-50 kg ha^{-1}	4.33	4.52	4.88	4.58 d
75-75 kg ha^{-1}	5.78	5.42	5.24	5.48 c
100-50 kg ha^{-1}	5.96	5.42	5.42	5.60 c
100-75 kg ha^{-1}	6.32	6.50	6.14	6.32 b
125-50 kg ha^{-1}	7.48	7.04	7.15	7.23 a
125-75 kg ha^{-1}	7.41	7.59	7.04	7.35 a

In a column, means followed by same letters are not significantly different at P=0.05 as suggested by LSD test.

Root yield ha-1 (kg)

The data pertaining to root yield ha-1 of turnip variety “Purple Top White Globe” as influenced by various levels of nitrogenous and phosphatic fertilizers are presented in Table-6 and its analysis of variance as Appendix-VI. The analysis of variance suggested that the effect of different levels of nitrogenous and phosphatic fertilizers on root yield ha-1 of turnip was significant (P<0.05).

It can be seen from the results in Table-6 that the highest root yield ha-1 (14690.88 kg) was achieved from the plots fertilized with highest N-P level of 125-75 kg ha-1; closely followed by N-P level of 125-50 kg ha-1 with average root yield ha-1 of 14450.23 kg. The root yield ha-1 decreased considerably to 12643.79 kg and 11198.79 kg in plots fertilized with lower N-P levels of 100-75 kg ha-1 and 100-50 kg ha-1, respectively. With decreasing N-P levels further to 75-75 kg ha-1 and 75-50 kg ha-1, the root yield ha-1 of turnip was also decreased to 10957.96 kg and 9151.70 kg ha-1, respectively. However, the lowest root yield ha-1 of 3760.67 kg was obtained in control plots, where nitrogenous and phosphatic fertilizers were not applied. This higher root yield ha-1 under higher N-P levels was mainly associated with the plant height, leaves plant-1, weight of fresh leaves, single root weight and root yield plot-1.

The LSD test suggested that the differences in root yield ha-1 under N-P levels of 125-75 and 125-50 kg ha-1 were statistically non-significant (P>0.05) and significant when compared with rest of the treatments. This showed that 125-50 kg ha-1 N-P level was an optimum level for economically maximum production in turnip..

Table 6. Root yield ha^{-1} (kg) of turnip as affected by various levels of nitrogenous and phosphatic fertilizers

N-P levels	R-I	R-II	R-III	Mean
Control	3863.00	4065.00	3354.00	3760.67 e
75-50 kg ha^{-1}	8668.23	9033.08	9753.78	9151.70 d
75-75 kg ha^{-1}	11560.04	10837.54	10476.29	10957.96 c
100-50 kg ha^{-1}	11921.29	10837.54	10837.54	11198.79 c
100-75 kg ha^{-1}	12643.79	13005.05	12282.54	12643.79 b
125-50 kg ha^{-1}	14967.77	14088.80	14294.12	14450.23 a
125-75 kg ha^{-1}	14811.30	15172.55	14088.80	14690.88 a

In a column, means followed by same letters are not significantly different at P=0.05 as suggested by LSD test.

Discussion

Although the soils of Pakistan and particularly of Sindh province are deficient of most of the macro- and micronutrients, but the soil deficiency of N and P is severe. Hence, with the passage of time with increasing the soil deficiency of these nutrients, the application rates are also needed to be increased simultaneously. The present study was carried out to examine the production response of turnip to different levels of nitrogenous and phosphatic fertilizers.

The present study showed that the effect of various levels of nitrogenous and phosphatic fertilizers on plant height, leaves plant-1, fresh weight of leaves plant-1, single turnip root weight, root yield plot-1 and root yield ha-1 was statistically significant ($P<0.05$). The turnip crop fertilized with N-P levels of 125-75 kg ha-1 resulted in 40.67 cm plant height, 15.86 leaves plant-1, 81.74 g fresh weight of leaves plant-1, 113.62 g single turnip root weight, 7.35 kg root yield plot-1 and 14690.88 kg root yield ha-1. The turnips given N-P fertilizers at the rate of 125-50 kg ha-1 produced 40.00 cm plant height, 15.60 leaves plant-1, 80.40 g fresh weight of leaves plant-1, 111.76 g single turnip root weight, 7.23 kg root yield plot-1 and 14450.23 kg root yield ha-1. The crop fertilized with N-P levels of 100-75 kg ha-1 produced 35.00 cm plant height, 13.65 leaves plant-1, 70.35 g fresh weight of leaves plant-1, 97.79 g single turnip root weight, 6.32 kg root yield plot-1 and 12643.79 kg root yield ha-1. The turnips given N-P levels at the rate of 100-50, 75-75, 75-50 kg ha-1 and control, resulted in lower values for all the growth and root yield contributing traits. These results are further supported by many past research workers. Sharma (1989) investigated the effect of different levels of nitrogen, phosphorus and potash on root and seed yield of turnip and maximum seed yield was obtained with the application of 125 kg N ha-1. Application of NPK (75:20:20 kg ha-1) was suitable for the root yield whereas application of 125 kg N coupled with 30 kg each of P and K per hectare for seed yield. Salardini et al. (2000) reported that the total yields with 50, 100 and 200 kg N ha-1 were 14, 15.2 and 15 t DMha-1 for turnips, 7.5, 8.5 and 10 t for pasja and 10, 12 and 12.2 t DM ha-1 for rape, respectively. Similarly, Lickfett et al. (1999) concluded that the application of P also significantly increases the seed yield, leaf area index and total dry matter as well as increases the P uptake in Brassica species. Salardini et al. (2000) reported that the total bulb yields with 50, 100 and 200 kg N ha-1 were 14, 15.2 and 15 t DM ha-1 for turnips, respectively. Jacobs et al. (2002) supplied turnip crop with nitrogen at the rates from 0 to 50 kg ha-1 and turnip yields were remarkably higher under higher nitrogen levels as compared to lower nitrogen levels or control. Ohland and Alexandre (2005) reported that nitrogen addition at higher levels increased turnip productivity as compared to control. Sharma (2007) found that application of NPK (75:20:20 kg ha-1) was suitable for the root yield whereas application of 125 kg N coupled with 30 kg each of P and K per hectare for seed yield. Stevens and Carruthers (2008) suggested that knowledge of the available soil nitrogen levels is imperative to assist in decision making concerning rates of fertilizer use. Jacobs and Ward (2008) concluded that turnip bulb yield responses to NP fertilizers were similar across both years despite contrasting climatic conditions, highlighting the ability of turnips to respond to limited moisture inputs. Salardini et al. (2009) reported that Nitrogen fertilizer increased the dry matter yield of tops of all turnips. Albayrak and Yuksel (2010) recommended 150 kg ha-1 nitrogen treatments for achieving higher yields in fodder beet. Sadia et al. (2013a) reported that the highest diameter of root (3.7 cm) and highest yield ha-1 (25.8 tons) were recorded from N3 (100 kg ha-1) and, the lowest diameter (2.9 cm) and lowest yield (18.8 ton) were recorded from control.

Conclusion

It was concluded that the differences in all the growth and yield parameters of turnip fertilized with N-P levels of 125-75 kg and 125-50 kg ha-1 was non-significant ($P<0.05$) and hence, 125-50 kg ha-1 N-P level was considered as an optimum level for economical turnip production.

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