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GROWTH AND YIELD RESPONSE OF TURNIP TO VARIOUS NITROGEN APPLICATION RATES

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ABSTRACT

Nitrogen is one of the essential macro-elements for plants. However, excessive use of nitrogen in crop cultivation decreases nitrogen-use-efficiency (NUE) of plants and mediate environmental pollution. Hence its optimum use needs to be analyzed critically. We conducted a field experiment during 2014-15 to evaluate the growth and yield response of turnip to various nitrogen (N) application rates. The trial was carried out at the experimental area of the Horticulture garden, Sindh Agriculture University, Tandojam in a three replicated randomized complete block design. The growth and yield related traits of turnip were assessed using five N rates (0, 50, 80, 110 and 140 kg N ha^{-1}). The results exhibited that there was a significant improvement in growth and root development traits with the application of each N level. We observed improvement in plant height (36.46 cm), number of leaves (16.47), fresh weight of leaves (72.64 g), fresh weight of a single root (106.17 g), root yield (15.77 kg plot^{-1}) and root yield (15063 kg ha^{-1}) at higher level of N (140 kg ha^{-1}). However, the results of all these traits remained statistically similar to the results obtained from the plants receiving 110 kg N ha^{-1}. Hence, it can be concluded that the turnip crop may be fertilized with N @ 110 kg ha^{-1} for obtaining better growth and root development.

Keywords: growth, nitrogen, turnip (*Brassica rapa*), yield

INTRODUCTION

The turnip (*Brassica rapa*) is a delicious root vegetable crop and one of the most important members of the family Crucifereae. It is believed that turnip is originated from Europe and West Asian countries, and domestication of this vegetable also took place in those regions (Zohary and Hopf, 2000). It is commonly grown in temperate climates. The small tender varieties of turnip are mostly grown as a feed for human, while larger varieties are cultivated for animal consumption (Shanmugavelu, 1989). Turnip contains various nutrients, including calcium, iron, protein, carbohydrates, and vitamins (A, B and C) (Susan, 2010). The climatic conditions of Sindh, Pakistan provide ample opportunities for the cultivation of turnip. It is mostly grown in plain areas of the country (Baloch, 1994). During 2011-12, turnip was cultivated in Pakistan on an area of 15739 hectares with a production of about 275647 tonnes (GoP, 2013). In Sindh, during

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the same years, turnip occupied an area of 1579 hectares with a production of 18495 tonnes (GoP, 2013). Nitrogen (N) is one of the most important macro nutrients that greatly influence the plant growth and productivity (Fageria and Baligar, 2005). It is a structural component of nucleic acids, enzymes and protein (Xu *et al.,* 2012). It is widely observed that application of N at low quantities significantly reduces the growth and yield of plants (Hoang and Alauddin, 2010). On the other hand, excessive use of N decreases the nitrogen use efficiency of crops and increases total input cost (Mulvany *et al*., 2009). Moreover, overuse of N mediates severe environmental concerns mainly due to nitrous oxide emissions and nitrate leaching in the soil (Raun and Johnson, 1999). In addition, its overuse also causes health risks to human due to excessive nitrate accumulation in the different vegetable parts (Chen *et al*., 2004). Due to these constraints, the optimum use of N in crop production is pre-requisite for the sustainability of agriculture (Good *et al.,* 2004).

Turnip seems to be heavy feeder of nutrients, especially of N, for satisfactory growth and development (Salardini *et al.,* 2009). It has also been observed by several other workers that major input cost of turnip is accounted for the heavy use of N (Sharma, 2007). Several studies have highlighted the importance of N in improving the growth and root yield of turnip (Miller *et al*., 2003; Jacobs *et al.,* 2004). Salardini *et al.* (2009) reported that higher level of N (100 kg ha^{-1}) comparatively displayed higher values for growth and yield traits of turnip. Sharma (2007) reported that N applied at the rate of 125 kg ha^{-1} proved to be better for optimum root growth and seed yield of turnip. Sadia *et al*. (2013) evaluated the different levels of N on the growth and root yield of turnip and obtained better growth and root yield at higher N level (100 kg ha^{-1}).

The yield of turnip obtained in Pakistan is less than the potential exists (20,000-40,000 kg ha^{-1}) (Baloch, 1994). Several factors, including sowing time, variety, proper distance between plants, weeding, timely irrigation and in-appropriate rate of fertilizers are associated to the low yield of turnip (Shanmugavelu, 1989). In Pakistan, the effect of N on the growth and productivity of turnip is not well documented. In this perspective, it is imperative to plan and conduct research on growth and yield response of turnip to various N application rates. In the light of above mentioned facts, the current study was designed to investigate the effect of N on the growth and productivity of turnip.

MATERIALS AND METHODS

A field trial was carried out at the experimental area of the Department of Horticulture, Sindh Agriculture University Tandojam. The experiment was conducted during 2014-15 in a three replicated randomized complete block design with a net plot area of 3 x 3.5 m (10.5 m^2). For current study, land was prepared by three dry ploughings, followed by clod crushing and land levelling for uniform distribution of water. The seed of the variety Red Globe was sown in the month of November 2014. The sowing was done by drilling turnip seeds in rows. After 15 days, thinning was done and a distance of about 6 cm was maintained between two plants. The irrigation was applied at 15 days interval. All the required cultural practices were applied throughout the growing season according to the crop requirement. The nitrogen application rates used in the study were: 0, 50, 80, 110, 140 kg ha^{-1}. The recommended rates (50 kg ha^{-1}) of both P and K were applied (Baloch, 1994). Nitrogen was applied in the form of urea, while the P and K were applied in the form of single super phosphate and sulfate of potash, respectively. One-third of N along with a full dose of P and K was applied at the time of land preparation by broadcasting in the soil. The remaining dose of N was applied at 3rd and 4th irrigations, respectively. For data collection, eight plants were randomly selected from each treatment. The traits for growth and yield attributes were: plant height (cm), number of leaves, fresh weight of leaves (g), single root weight (g) and root yield (kg plot^{-1} and ha^{-1}).

Statistical analysis

The collected data were statistically analyzed for analysis of variance (ANOVA) using a software Statistics 8.1 (Statistics, 2006). The least significant difference (LSD) test was applied to compare the treatment superiority for all the parameters at the 5% level of probability.

RESULTS AND DISCUSSION

Influence of N on turnip growth

The growth of turnip was significantly affected by various nitrogen levels (Table 1). Plants fertilized with higher N level (140 kg ha^{-1}) showed better performance and displayed highest values of all the growth traits, including plant height, number of leaves and weight of leaves. However, the differences between the results of 140 kg ha^{-1} and 110 kg ha^{-1} were statistically non-significant ($P > 0.05$). The results showed that the maximum plant height (36.46 cm) was observed in the plants received N @ 140 kg ha^{-1}, followed by the plants (36.27 cm) where N was applied @ 110 kg ha^{-1} (Table 1). The significant reduction in plant height (31.26 cm and 22.16 cm) was recorded when plants were treated with 80 and 50 kg N ha^{-1}, respectively. The minimum plant height (17.28 cm) was observed in control plots, where N was not applied. The highest plant height might be due to the positive role of nitrogen in cell division, cell enlargement and protein synthesis (Firoz, 2009). The plant height is an important parameter that highly affects the vegetative growth and plant architecture (Reinhardt and Kuhlemeier, 2002). The data related to influence of N on height of turnip is limited. However, the increase in plant height at higher N level was strongly confirmed by Salardini *et al.* (2009) who also found maximum plant height of turnip at higher level of N (100 kg ha^{-1}). These results are also in line with Khan *et al.* (2000) who reported the maximum height of mustard (belongs to Crucifereae family) when N was applied at the rate of 100 kg ha^{-1}.

Regarding the number of leaves, the maximum number of leaves (16.47) was observed from the plants receiving 140 kg N ha^{-1}. These results are statistically similar to the findings (15.33) obtained from plants received N @110 kg ha^{-1}. On the contrary, control plants, where N was not applied, showed fewer leaves (7.40). Leaves are known as food factory of the plants. The whole plant food is manufactured in the leaves and then manufactured food is transported to other parts of the plants. The more leaves in plants grown under high N level might have been associated with the application of N in adequate quantity that positively improved the vegetative growth of turnip plants. The turnip indeed is a fast and heavy feeder of chemical fertilizers (Salardini *et al.,* 2009). Thus, optimum use of N is a prerequisite for healthy and better growth of leaves. The positive and significant response of N on leaves of turnip has also been reported by Sharma (2007). The findings of Inam *et al*. (2011) related to the radish (belongs to Cruciferae family) also support the results of the current study.

The maximum weight of leaves (72.64 g) was obtained from plants received highest quantity of N (140 kg ha^{-1}). These results are at par with the results (72.44 g) obtained from the plants received N @ 110 kg ha^{-1}. The minimum weight of the leaves (36.23 g) was observed from the plants where N was not applied. In the present investigation, the application of N in the soil in large quantities might have enhanced the N levels in soil which improved the growth of turnip plants. The improved plant growth was related to the weight of leaves. Limited work has been reported for the effect of N on growth and development of turnip leaves. However, these results are in agreement with the findings of Salardini *et al.* (2009) who reported positive effect of N on a fresh weight of turnip leaves. Other studies related to radish including Bilekudari *et al*. (2005), and Asghar *et al*. (2006) also confirm the findings of the current study.

Influence of N on turnip root

The root characters revealed significant (P< 0.05) response to various N levels (Table 2). The highest N level of 140 kg ha^{-1} dispaoyed greater values for all the root traits. However, statistically the difference between 140 kg ha^{-1} and 110 kg ha^{-1} was not significant (P> 0.05). The single root weight increased significantly with the application of N. On the contrary, control plots where N was not applied showed minimum single root weight (56.07 g) (Table 2). The significant response of N on root weight of turnip has also been reported by Sadia *et al.* (2013). The greater root weight may be attributed to the application of N to the crop which produced healthy and vigorous plants and resultantly the root weight was increased. The root yield $plot^{-1}$ responded significantly to various N levels. The higher application of N (140 kg ha^{-1}) produced maximum root yield (15.76 kg $plot^{-1}$) closely followed by 110 kg ha^{-1}, where 15.53 kg $plot^{-1}$ root yield was obtained (Table 2). The control plot, where nitrogen was not applied showed the minimum root yield (3.60 kg $plot^{-1}$). The maximum root yield might be due to better root length and root weight that eventually enhanced the root yield $plot^{-1}$ (Sadia *et al*., 2013).

For root yield per hectare, the maximum yield (15063 kg ha^{-1}) was recorded, when plants were treated with higher N level (140 kg ha^{-1}), closely followed by 110 kg ha^{-1}, where root yield of 15016 kg ha^{-1} was recorded (Table 2). The root yield further decreased to 12889 kg and 9905 kg when crop received N at the rate of 80 and 50 kg ha^{-1}, respectively. The minimum root yield (3429 kg ha^{-1}) was recorded from control plots, where fertilizer was not applied. The enhanced root yield per hectare might be related to sufficient application of fertilizer that significantly influenced the plant performance. On the other hand, the low root yield ha^{-1} might be associated with inadequate application of N which adversely affected the shoot growth and root development of turnip plants. These results are in line with Sadia *et al*. (2013), who also reported that root weight and root yield of turnip enhanced when the crop was fertilized with optimum N level (100 kg ha^{-1}). Several other authors have also found the better response of N in improving the root weight and total root yield of radish (Guvenc, 2002; Pervez *et al*., 2004; Liao *et al*., 2009; Jilani *et al*., 2010).

Table 1. Influence of N on growth traits of turnip (*Brassica rapa* cv. Red Globe)

N (Kg ha^{-1})	Plant height (cm)	Number of leaves (plant^{-1})	Fresh weight of leaves (g plant^{-1})
0 (Control)	17.28d	07.40d	36.23d
50	22.16c	09.56c	46.32c
80	31.26b	12.63b	60.55b
110	36.27a	15.33a	72.43a
140	36.46a	16.46a	72.64a
SE±	0.10	0.67	0.11
LSD 0.05	0.24	1.53	0.26
CV%	0.44	6.64	0.24

Each value is a mean of three replicates; SE= Standard error; LSD= Least significant difference; CV= Coefficient of variance; Values followed by same letters do not differ significantly at 0.05 probability level.

Table 2. Influence of N on root traits of turnip (*Brassica rapa* cv. Red Globe)

N (Kg ha^{-1})	Single turnip root weight (g)	Root yield (kg plot^{-1}, 10.5 m^2)	Root yield (kg ha^{-1})
0 (Control)	056.07d	03.60d	3429d
50	070.50c	10.40c	9905c
80	088.93b	13.40b	12889b
110	103.07a	15.53a	15016a
140	106.17a	15.76a	15063a
SE±	1.83	0.17	79.05
LSD 0.05	4.24	0.39	182.28
CV%	2.65	1.81	0.86

Each value is a mean of three replicates; SE= Standard error; LSD= Least significant difference; CV= Coefficient of variance; Values followed by same letters do not differ significantly at 0.05 probability level.

CONCLUSION

Based on the findings of the current study, it is concluded that although higher N level displayed largest values for all the investigated growth and yield traits of turnip, statistically the difference between 140 kg ha^{-1} and 110 kg ha^{-1} was not significant (P>0.05). Hence, for obtaining better yield turnip crop may be fertilized with 110 kg ha^{-1}. However, further study is needed at various locations and in different environmental conditions to validate the optimum level of N for better productivity of turnip

REFERENCES

Asghar, H. N., M. Ishaq, Z. A. Zahir, M. Khalid and M. Arshad. 2006. Response of radish to integrated use of nitrogen fertilizer and recycled organic waste. Pak. J. Bot., 38 (3): 691-700.

Baloch, A. F. 1994. Vegetable Crops. *In:* M. N. Malik (Ed). Horticulture. National Book Foundation, pp. 498.

Bilekudari, M. K., V. K. Deshpande and M. Shekargouda. 2005. Effect of spacing and fertilizer levels on growth, seed yield and quality of radish. Karnataka J. Agric. Sci., 18 (2): 338-342.

Chen, B. M., Z. H. Wang, S. X. Li, G. X. Wang, H. X. Song and X. N. Wang. 2004. Effects of nitrate supply on plant, nitrate accumulation, metabolic nitrate concentration and nitrate reductase activity in three leafy vegetables. Plant Sci., 167: 635-643.

Fageria, N. K. and V. C. Baligar. 2005. Enhancing nitrogen use efficiency in crop plants. Adv. Agron., 88: 97-185.

Firoz, Z. A. 2009. Impact of nitrogen and phosphorus on the growth and yield of okra (*Abelmoschus esculentus* L. Moench) in hill slope condition. Bang. J. Agric. Res., 34 (4): 713-722.

Good, A. G., A. K. Shrawat and D. G. Muench. 2004. Can less yield more? Is reducing nutrient input into the environment compatible with maintaining crop production? Trends Plant Sci., 9: 597-605.

GoP, 2013. Fruits, vegetables and condiments Statistics of Pakistan (2011-12). Ministry of National Food Security and Research, Islamabad.

Guvenc, I., 2002. Effect of nitrogen fertilization on growth, yield and nitrogen contents of radish. Europ. J. Hort. Sci., 67 (1): 23-27.

Hoang, V. N. and M. Alauddin. 2010. Assessing the eco-environmental performance of agricultural production in OECD countries: The use of nitrogen flows and balance. Nutr. Cycl. Agro-Ecosys, 87: 353-36.

Inam, A., S. Sahay and F. Mohannad. 2011. Studies on potassium content in two root crops under nitrogen fertilization. Int. J. Agric. Environ. Sci., 2 (2): 1030-1038.

Jacobs, J. L., G. N. Ward and G. Kearney. 2004. Effect of irrigation strategies and nitrogen fertilizer on turnip dry matter yield, water use efficiency, nutritive characteristics and mineral content in Western Victoria. Austr. J. Exp. Agric., 44 (1): 13-26.

Jilani, M. S., T. Burki and K. Hussain. 2010. Effect of nitrogen on growth and yield of radish. J. Agric. Res., 48 (2): 219-225.

Khan, H., M. A. Khan, and I. Hussain. 2000. Effect of nitrogen and phosphorous on growth and yield of *Brassica juncea* L. Pak. J. Bio. Sci., 3 (8): 1231-1233.

Liao, Y., S. Rong, S. Zheng, Q. Liu, M. Fan, J. Peng and G. Xie. 2009. Influences of nitrogen fertilizer application rates on radish yield, nutrition quality and nitrogen recovery efficiency. Front. Agric. China., 3: 122-129.

Miller, P. R., S. V. Angadi, G. L. Androsoff, B. G. McConkey and C. L. McDonald. 2003. Comparing brassica oil seed crop productivity under contrasting N fertility regimes in the semiarid Northern Great Plains. Can. J. Plant Sci., 83: 489-497.

Mulvaney, R. L., S. A. Khan and T. R. Ellsworth. 2009. Synthetic nitrogen, depleted soil nitrogen: A global dilemma for sustainable cereal production. J. Environ. Qual., 38: 2295-2314.

Pervez, M. A., C. M. Ayub, B. A. Saleem, N. A. Virk and N. Mahmood. 2004. Effect of nitrogen levels and spacing on growth and yield of radish (*Raphanus sativus* L.). Int. J. Agric. Biol., 06 (3): 504-506.

Raun, W. R., and G. V. Johnson. 1999. Improving nitrogen use efficiency for cereal production. Agron. J., 91: 357-363.

Reinhardt, D. and C. Kuhlemeier. 2002. Plant architecture. EMBO, J., 9: 846-851.

Sadia, A. A., M. Mahasen, S. Shahrin, M. Z. K. Roni and A. F. M. Jamaluddin. 2013. Influence of nitrogen on growth and yield of turnip [Bangladesh Bioscience Association:http://www.bangladeshbioscience. com].

Salardini, A. A., R. J. Eckard and D. R. Franks. 2009. Comparison of summer forages and the effect of nitrogen fertilizers on brassica forages in Tasmania. Grass F. Sci., 13 (2): 65-72.

Shanmugavelu, K. G. 1989. Production technology of vegetable crops. Oxford and IBH Pub. Co. Pvt. Ltd., New Delhi, Mumbai, Calcutta. pp. 337.

Sharma, K. C. 2007. Effect of different levels of nitrogen, phosphorus and potash on root and seed yield of turnip (*Brassica rapa* L.). M.Sc. Thesis submitted to University of Horticulture and Forestry, Solan, India.

Statistix, 2006. Statistics User Guide, Version 1.0. Analytical software, P.O. Box 12185, Tallahassee fl 32317 USA. Copyright @ 2006 by Analytical software.

Susan, S. 2010. Are ‘neeps’ swedes or turnips. The Guardian [http//www. guardian.co.uk].

Xu, G., X. Fan and A. J. Miller. 2012. Plant nitrogen assimilation and use efficiency. Annul. Rev. Plant Biol., 63: 153-182.

Zohary, D. and M. Hopf. 2000. Domestication of plants in the old world, (3rd Ed.) Oxford: University Press, pp. 139.

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