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Effect of integrated nitrogen management on the quality attributes of beetroot (*Beta vulgaris* L.) var. crimson globe

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Abstract
In order to investigate the "Effect of Integrated Nitrogen Management on the Quality Attributes of Beetroot (*Beta vulgaris* L.) var. Crimson Globe," an experiment was carried out at the Horticultural Research Farm, Department of Horticulture, B. A. College of Agriculture, Anand Agricultural University, Anand during the *rabi*, 2020–2021.The experiment was set up using a Randomised Block Design (RBD), which consists of three replications and ten treatments. The results as regard to quality parameters *viz*. total soluble solids (8.13°Brix), and total sugar (7.61%) was found to be significantly superior for treatment30 kg N/ha + 12.5 t/ha FYM + 5 t/ha Vermicompost + Seed treatment of Anubhav Bio NPK consortium (5ml/kg seed) and which was at par with treatment (T_6) 60 kg N/ha + 5 t/ha Vermicompost + 5 t/ha Castor cake + Seed treatment of Anubhav Bio NPK consortium (5ml/kg seed) and T_3 60 kg N/ha + 5 t/ha Vermicompost + 5 t/ha Castor cake. Application of various treatments had no appreciable impact on the ascorbic acid concentration of beetroot roots.

Keywords: Nitrogen, management, beetroot, *Beta vulgaris* L.

Introduction
The well-known root vegetable beetroot (*Beta vulgaris* L.), sometimes known as garden beetroot or table beetroot, is a member of the Chenopodiaceae family, which also contains spinach, Palak, Swiss chard, parsley and celery among its botanical cousins. It has a 2n=18 chromosomal number. The productions of beetroot for human and cattle food have a long history, with its origins in Western Europe and North Africa. Even though it is a biennial plant by nature, it is usually produced as an annual crop, particularly in the cooler months. Although on a smaller scale, beetroot agriculture is mostly centred in India's northern and southern areas. Beetroot yields both leafy green tops and swollen roots, both of which are used in culinary preparations and salads. It is highly productive and typically pest- and disease-resistant (Ado, 1999) [1]. Beetroot is grown on around 5000 hectares of land in India and produces 90,000 tonnes of product yearly (Anon, 2001) [2]. This crop grows well in cold climates, with perfect growth taking place on the Indian plains during the winter when the temperature is just a little bit warmer. The best roots are harvested when the weather is cool, usually between 18.3°C and 21.1°C, and they are rich in sugar content and brilliant red in colour. Before the plants achieve marketable root size, they start to wilt if the temperature drops below 10 °C (Sadhu, 1986; Nath *et al.*, 1987) [10, 8]. In warmer conditions, beetroot may exhibit a zoning pattern with alternating white and colored rings when sliced.
A sufficient supply of nitrogen fertilizers benefits beetroot by enhancing growth, increasing both yield and quality, (Goodlass *et al.* 1997) [3]. Nitrogen is a crucial component of proteins, enzymes, and plant vitamins and is essential for plant development and beetroot nutrition. However, the excessive use of fertilizer mixtures can lead to an overabundance of nitrogen in crops. Given that vegetables serve as a primary source of dietary nitrates for humans, the concern over nitrate accumulation in fresh produce is particularly pronounced. Nevertheless, the accumulation of nitrate in beetroot can pose health risks to humans. When ingested, nitrate can be converted to nitrite within the body, potentially entering the bloodstream and causing methemoglobinemia, as highlighted (Hemmat*et al*. in 2010.) [4].

In order to improve soil fertility and increase crop production potential, the integrated nutrient management (INM) system blends inorganic fertilizers with organic waste products. The combined use of organic and inorganic fertilizers increases agricultural yield and is beneficial. Sandy loam soil, when enriched with carbon and available nutrients through inorganic fertilizers, can significantly increase crop yields while sustaining soil fertility. The use of organic fertilizers increases crop output while reducing the negative environmental effects of excessive chemical fertilisers. INM's main goal is to effectively and sustainably enhance agricultural yield while preserving the soil's fertility for future generations. It does this by balancing the use of both naturally occurring and artificial sources of plant nutrients.

Materials and Methods

The present research on "Effect of Integrated Nitrogen Management on the Quality Attributes of Beetroot (*Beta vulgaris* L.) var. Crimson Globe " was conducted during the rabi season of 2020-21 at Horticultural Research Farm, Department of Horticulture, A. A. U., Anand. The experiment used Randomised Block Design (RBD) with three replications and ten treatments *viz*., T1: 60 kg N/ha + 12.5 t/ha FYM + 5 t/ha Vermicompost; T2: 60 kg N/ha + 12.5 t/ha FYM + 5 t/ha Castor cake; T360 kg N/ha + 5 t/ha Vermicompost + 5 t/ha Castor cake; T_1: 60 kg N/ha + 12.5 t/ha FYM + 5 t/ha Vermicompost; T_2: 60 kg N/ha + 12.5 t/ha FYM + 5 t/ha Castor cake; $T_3$60 kg N/ha + 5 t/ha Vermicompost + 5 t/ha Castor cake; T_4: 60 kg N/ha + 12.5 t/ha FYM + 5 t/ha Vermicompost + Seed treatment of Anubhav Bio NPK consortium (5 ml/kg seed);T_5: 60 kg N/ha + 12.5 t/ha FYM + 5 t/ha Castor cake + Seed treatment of Anubhav Bio NPK consortium (5ml/kg seed);T_6: 60 kg N/ha + 5 t/ha Vermicompost + 5 t/ha Castor cake + Seed treatment of Anubhav Bio NPK consortium (5ml/kg seed);T_7: 30 kg N/ha + 12.5 t/ha FYM + 5 t/ha Vermicompost + Seed treatment of Anubhav Bio NPK consortium (5ml/kg seed);T_8: 30 kg N/ha + 12.5 t/ha FYM + 5 t/ha Castor cake + Seed treatment of Anubhav Bio NPK consortium (5ml/kg seed);T_9: 30 kg N/ha + 5 t/ha Vermicompost + 5 t/ha Castor cake + Seed treatment of Anubhav Bio NPK consortium (5ml/kg seed);T_{10}: 60 kg N/ha + 25 t/ha FYM (control).

Results and Discussion

Quality parameters

The total soluble solid content (^{0}Brix) and total sugar content (%) of beet root as influenced by various treatments was significantly maximum TSS (8.13 ^{0}Brix) and total sugar (7.61%) was recorded in treatment T_7 (i.e. 30 kg N/ha + 12.5 t/ha FYM + 5 t/ha Vermicompost + Seed treatment of Anubhav Bio NPK consortium (5 ml/kg seed) which was at par with treatment T_6 i.e. (60 kg N/ha + 5 t/ha Vermicompost + 5 t/ha Castor cake + Seed treatment of Anubhav Bio NPK consortium (5 ml/kg seed) and T_3 i.e. 60 kg N/ha + 5 t/ha Vermicompost + 5 t/ha Castor cake.The lowest was recorded in T_{10} i.e. control (60 kg N/ha + 25 t/ha FYM).

This might be due to better nitrogen accessibility and absorption aided by the application of organic manures, resulting in a balanced C/N ratio and increased plant metabolic activity. These outcomes align with similar research findings, as reported by Szopinska and Gaweda (2013) [13] and Jagadeesh *et al.* (2018) [5] in the case of beetroot, and by Rani *et al.* (2006) [9], Sunandarani and Mallareddy (2007) [12], and Sarma *et al.* (2015) [11] in studies involving carrots.

According to Kale and Masalkar (1993) [6], using vermicompost increased the activity of beneficial microorganisms and encouraged the colonization of mycorrhizal fungi. These microorganisms and fungi are vital in facilitating nutrient mobilization within plants, ultimately leading to enhanced nutrient availability and uptake, consequently contributing to improved crop quality. Similarly, Kolodzieg and Kostecka (1994) [7] observed superior root quality in carrots when grown with vermicompost compared to mineral fertilizers.

The ascorbic acid content (mg/100g) of beet root as influenced by various treatments was found to be statistically non-significant.

Table 1: Effect of Integrated Nitrogen Management on the Quality Attributes of Beetroot (*Beta vulgaris* L.) var. Crimson Globe

Treatment	TSS content (°Brix)	Total sugar content (%)	Ascorbic acid content (mg/100 g)
T_1	7.37	6.49	2.81
T_2	7.45	6.72	2.89
T_3	7.95	6.96	2.92
T_4	7.40	6.60	2.83
T_5	7.07	6.39	2.80
T_6	8.10	7.26	3.17
T_7	8.13	7.61	3.29
T_8	7.57	6.76	2.91
T_9	7.43	6.70	2.88
T_{10}	6.47	6.09	2.56
S.Em. +	0.06	0.22	0.13
C.D. (P=0.05)	0.19	0.63	NS
C.V. (%)	1.52	5.68	7.86

Conclusion

According to the outcomes of this study, treatment T_7, which included 30 kg N/ha, 12.5 t/ha FYM, 5 t/ha Vermicompost, and seed treatment with Anubhav Bio NPK consortium, produced the highest grade beetroot with the greatest total soluble solids (8.13 °Brix) and total sugar content (7.61%). The use of organic manure increased nutritional availability, resulting in enhanced beetroot quality. All treatments had the same amount of ascorbic acid.

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