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Akshay Sawant
Department of Vegetable Science, College of Horticulture SKLTSHU, Rajendranagar, Hyderabad, Telangana, India

Dr. CH Raja Goud
Assistant Professor, College of Horticulture, Rajendranagar, Hyderabad, Telangana, India

Prasad Deshmukh
YP, AICRP-WIA, Home Science, VNMKV, Parbhani, Maharashtra, India

Corresponding Author:
Akshay Sawant
Department of Vegetable Science, College of Horticulture SKLTSHU, Rajendranagar, Hyderabad, Telangana, India

Effect of integrated nutrient management on growth, yield and quality of Radish (*Raphanus sativus* L.)

Akshay Sawant, Dr. CH Raja Goud and Prasad Deshmukh

Abstract
The field experiment was conducted during the *rabi* season of the year 2019-20 at Sri Konda Laxman Telangana State Horticultural University, College of Horticulture, Rajendranagar, Hyderabad, Telangana to evaluate "study of integrated nutrient management on growth, yield and quality of radish (*raphanus sativus* L.)''The experiment was laid out in Randomized Block Design with seven different levels of treatment of integrated nutrients and three cultivars replication thrice. Results revealed that yield parameters significantly affected with the application of varying levels of integrated nutrients as well as cultivars. Among the quality parameter TSS (4.4brix), ascorbic acid (1.6%), sulphur content (3.53%) soil nutrient status available nitrogen (195.00kg/ha^{-1}), phosphorous (108kg/ha^{-1}) and potassium content (418kg/ha^{-1}) and plant nutrient status maximum nitrogen, phosphorous and potassium content in dry herb (1.38%, 0.66% and 0.45% respectively) bc ratio (1.17) was recorded at 100% RDF (90:50:90 kg ha^{-1}) + Farm yard manure (5t/ha) + Vermicompost (3t/ha) + arka microbial constrioum (17kg/ha) with cultivar Japanese white.

Keywords: Radish, FYM, NPK, vermicompost, neemcake, microbial consortium

Introduction

Radish (*Raphanus sativus* L.) locally known as Mula, Mullangi, Mullo, Mooli and milli that belongs to the family cruciferae. It is considered to be the native of China and India. It is one of the most ancient vegetables.

Radish is grown for its tuberous root, which are eaten raw as salad or cooked as vegetable. It is relished for its pungent taste and flavour and is considered as an appetizer. The characteristic pungent flavour of radish is due to the volatile isothiocyanates (trans-4 - methyl-thibutenyl-isothiocynate) and the colour of the pink cultivars is due to the presence of anthocyanin pigments. The tender leaves are also cooked and eaten as vegetables. Radish has refreshing and depurative properties and its preparation are useful in liver and gall bladder troubles. In homeopathy, it is used for neuralgic headaches and sleeplessness. The roots are said to be useful in urinary complaints, piles, gastrodynia, enlarged spleen, and jaundice and stomach troubles. The juice of fresh leaves is used as diuretics and laxative.

Radish is nutritious vegetables providing a good source of vitamin-B and Vitamin-C content in roots and shoots are 15-40mg/100gm and103/100gm of edible portion, respectively (Gopalan and Balasubramanium, 1966) [4]. The tracer mineral element found in radish include aluminum, titanium, barium, lithium, silicon, fluorine and iodine.

Radish being a short duration and quick growing crop. The root growth is rapid and uninterrupted. Hence, for the production of good quality roots and higher yield, optimum fertilizers especially nitrogen, phosphorous and potassium assume special significance. The growth of radish plant is checked due to lack of nitrogen and substantially by phosphorous and potassium (Lacas and De Frietas, 1960) [5].

Soil fertility is a dynamic property, which varies with in the rent status of soil, Crops, cropping intensity, and input use. More than 50% of our cultivated soil contains organic matter below the critical level. Annual depletion of plant nutrients in the intensively cropped area ranges from 180 to 250 kg/ha. High and medium highland comprising 60% of total cultivated land, which in most cases deficient in essential nutrients, such as nitrogen, phosphorus, potassium, and sulphur. The low organic matter content, higher cropping intensity, improper cropping sequence, and faulty management Practices are the major causes of depletion of soil fertility.

The productivity, particularly the yield per unit area of a wide range of crops in Telangana state is due to little or no addition of organic matter to the soil, Intensive cropping throughout the year, nutrient depletion, imbalanced fertilization, and poor management practices in crop production.

Crop production system with high yield targets cannot be sustainable unless balanced nutrient inputs are supplied to soil against nutrient removable crops (Bhuiyan *et al.,* 1991) [1]. Sequential cropping ensures maximization of efficient use of moisture and nutrients from soil. Integrated nutrient management for prevailing cropping systems appears to be one of the effective ways to meet the economical nutrition requirement of crop.

Radish is a cultivated variety, suitable on account of its versatile adaptability and also suitable to tropical conditions. Among the various factors influencing yield, adequate nutrition and plant spacing are the most important. Application of nitrogen, phosphorus and potash along with organic manures such as FYM, vermicomposting, and castor cake significantly increased the leaf area, number of leaves, length and diameter of root as well as root yield. (Velmurugan *et al*., 2005) [8].

The growing of radish plants has been affected most severely due to lack of N and subsequently by P as well as K. Growth and yield of radish have been found to increase significantly in response to the application. According to the phosphorus deficient radish plants were shorter in height, leaves were distorted in shape and pink tinge appeared along the margins and veins. In potassium-deficient plants the color of leaves changed from green to pale yellow and brown scorches appeared on the leaves at later stages. Violet streaks appeared on roots which ultimately spread all over. While overall affected yield and quantity of radish the TSS content of radish significantly increased with increasing level of nitrogen (Desuki *et al*., 2005) [3]. Thus, it is essential to find out adequate nutrient requirements of nitrogen, phosphorus and potash along with organic manure in radish crop.

Materials and Methods

The present experiment was conducted to find out the effect of integrated nutrient management on growth, yield and quantity in different cultivars of radish at PG Students Research Farm, College of Horticulture, Rajendranagar, Hyderabad comes under sub-tropical zone and is situated at a latitude of $30^0$17' N, longitude of $91^0$51' E and altitude of 700-800 m above mean sea level. The experiment was laid out in Randomized Block Design replicated thrice.

Treatment details

T_1: RDF (90:50:90) NPK/ha

T_2: T_1+ organic manures in the form of FYM (5t/ha)

T_3: T_1 + organic manures in the form of vermicompost (3t/ha)

T_4: T_1 + organic manures in the form of neemcake (17kg/ha)

T_5: T_1 + FYM (5t/ha) + IIHR microbial consortium (300g)

T_6: T_1 + verimicompost (3t/ha) + IIHR microbial consortium (300g)

T_7: T_1 + neemcake (17kg) + IIHR microbial consortium (300g)

Cultural practices

FYM, Vermicompost, neemcake microbial consortium were incorporated in to the respective experimental plots uniformly, before sowing as basal application. N, P and K @ 90: 50: 90 kg ha^{-1} were applied in the form of urea, single super phosphate and muriate of potash respectively. Urea was applied in two splits, the first dose as basal application and another dose at 15 days after sowing. The entire dose of single super phosphate and muriate of potash were applied at the time of sowing as basal dose. Biofertilizers were inoculated with seeds prior to sowing as a seed treatment method.

The seeds were sown in ridge and furrow system at a depth of 1.5 cm. Thinning and gap filling was done at 20 days after sowing to maintain optimum plant population and retained only one seedling per hill. The uniform stand of plants was maintained at a spacing of 30 cm between the rows and 15 cm between the plants in a row. The data were recorded on five plants per treatment in each replication on yield and economics.

Observation to be recorded

Total soluble solids (TSS Brix)

Total soluble solids (TSS) content of radish root from juice was calculated in percentage (%) using a Japan made Erma Hand Refractrometer.

Vitamin C or Ascorbic Acid content (mg/100 gm)

For the determination of vitamin C grinded paste of radish root and shoot was extracted in 3 percent Meta phosphoric acid and filtered. The filtered was used for the estimation of vitamin C. Reduced ascorbic acid was measured by titration with 2-6 chlorophenol indophenol and expressed in mg/l00 gm. The vitamin C content was calculated by using the following formula.

Sulphur content (%)

A major problem arises when amount of extracted sulphur is too low to be measured precisely. Sulphur in the extract cam also be estimated by a colorimetric method using barium chromate (Palaskar *et al*., 1981) [6] but the tubidimetric method given below is mainly using in the soil testing laboratories.

Result and Discussion

TSS (brix)

Maximum TSS (4.46 brix) content was recorded in T_6 (T_1 + vermicompost (3t/ha) + IIHR microbial consortium (300g) followed by treatment T_7 and T_5 while minimum TSS was recorded in treatment T_1 (2.97 brix) where recommended dose of fertilizers were applied.

Maximum TSS recorded due to higher dose of nutrients resulted in increased plant height, number of leaves, root length and root diameter. Thus, resulting in more scope for photosynthates and translocation to the storage organs, ultimately increasing the storage of more carbohydrates. This ultimately reflected in T.S.S. and hormonal metabolism of plant system which has direct influence for Vitamin -C content in root. These results are in line with various workers like Chang and Chang (2000) [2] in radish and Sunanda and Reddy (2007) [7] in carrot.

Ascorbic acid (mg/100g)

It was evident from the data that all the nutrient application strategies influenced the ascorbic acid content of the roots. Maximum ascorbic acid (16.60mg/100mg) content was recorded in T_6 (T_1 + vermicompost (3t/ha) + IIHR microbial consortium (300g) the treatment T_3, T_4 and T_5 have produced

similar while minimum ascorbic acid was recorded treatment T_1 (16.20 mg/100mg) with recommended dose of fertilizers.
Maximum ascorbic acid recorded might be due to optimum dose of nutrients resulted in increased plant height, number of leaves, root length and root diameter. Thus, resulting in more scope for photosynthates and translocating to the storage organs, ultimately increasing the storage of more carbohydrates. This ultimately is reflected in T.S.S. and hormonal metabolism of plant system which has direct influence for Vitamin-C content in root. These results are in line with various workers like Chang and Chang (2000) [2] in radish and Sunanda and Reddy (2007) [7] in carrot.

Sulphur content (%)

Significantly maximum Sulphur content (3.56%) was recorded in T_6 (T_1vermicompost (3t/ha) + IIHR microbial consortium (300g) the treatment T_5, T_7, $T_3$and T_2 have intermediate effect while, minimum ascorbic acid was recorded treatment T_1 (2.1%)where recommended dose of fertilizers.

Maximum Sulphur content might be due to higher dose of nutrients resulted in increased plant height, number of leaves, root length and root diameter. Thus, resulting in more scope for photosynthates and translocatation to the storage organs, ultimately increasing the storage of more carbohydrates. This ultimately is reflected in T.S.S. and hormonal metabolism of plant system which has direct influence for Vitamin C content and Sulphur content in root. These results are in line with various workers like Chang and Chang (2000) [2] in radish and Sunanda and Reddy (2007) [7] in carrot

Table 1: Effect of integrated nutrient management on quality parameter of radish

Treatment	TSS (brix)	Ascorbic acid (mg/100g)	Sulphur content (%)
RDF (90:50:90) NPK/ha	2.97^{e}	16.20^{e}	2.1^{c}
T_1 + Organic manures in the form of FYM (5 t/ha)	3.53^{cd}	16.30^{c}	3.0^{b}
T_1 + Organic manures in the form of vermicompost(3 t/ha)	3.8^{bc}	16.33^{c}	3.03^{b}
T_1 + Organic manures in the form of neemcake(17 kg/ha)	3.33^{de}	16.23^{d}	2.3^{c}
T_1 + FYM (5 t/ha) + IIHR microbial consortium (300 g)	4.23^{cd}	16.30^{b}	3.17^{c}
T_1 + Vermicompost (3 t/ha) + IIHR microbial consortium (300 g)	4.4^{a}	16.60^{a}	3.53^{a}
T_1 + Neemcake (17 kg) + IIHR microbial consortium (300g)	4.07^{ab}	16.30^{b}	3.1^{b}
CD@5%	0.351	1.12	0.25
S.Em ±	0.113	0.08	0.08

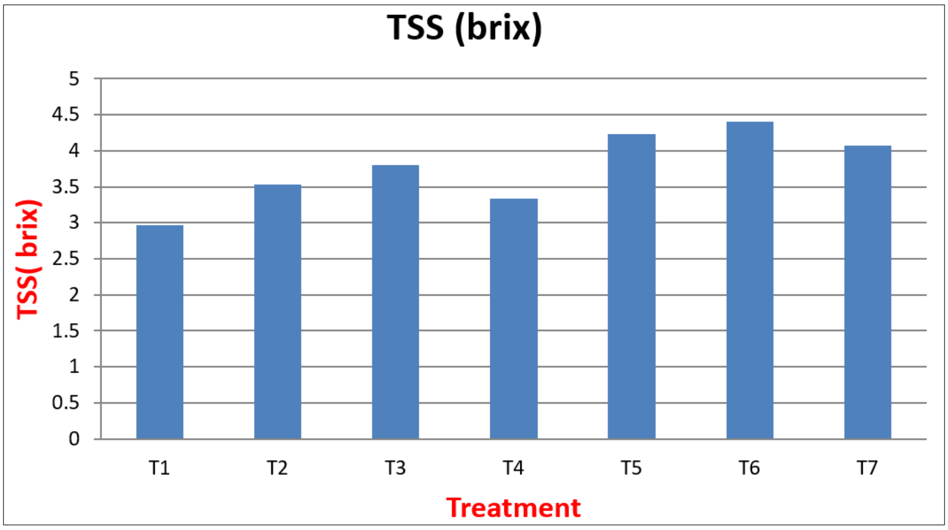

Fig 1: Effect of integrated nutrient management on TSS (brix) of plant on radish.

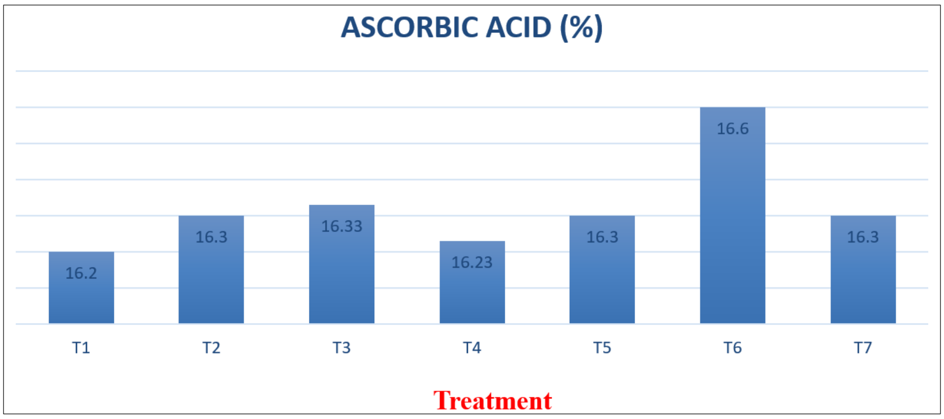

Fig 2: Effect of integrated nutrient management ascorbic acid content (%) on radish.

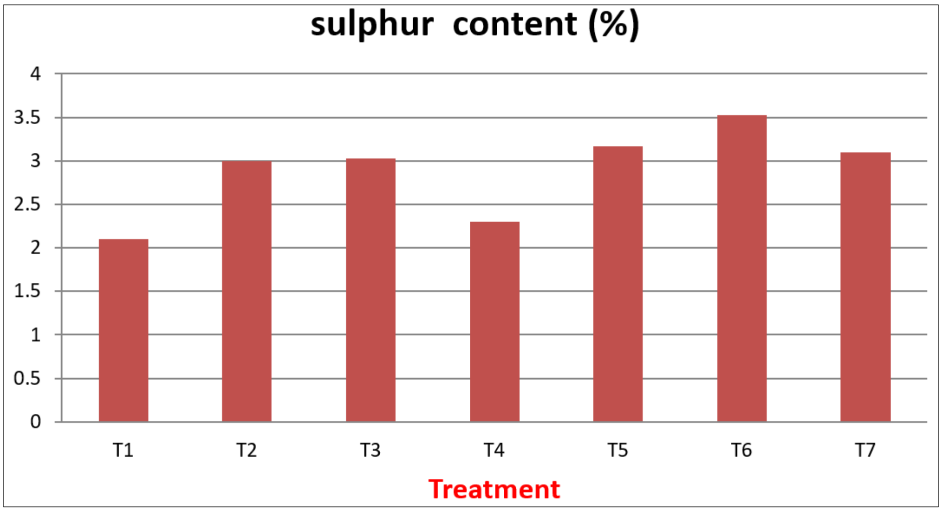

Fig 3: Effect of integrated nutrient management Sulphur content (%) on radish.

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