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

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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 treatment root yield per ha (3.65), dry weight root of plant (121.67g), fresh weight of plant (318g), harvesting index (7.5), b:c ratio (1.17)was recorded at RDF (90:50:90) kg ha^{1} + farm yard manures (5t/ha) + verimicompost (3t/ha)+ Arka microbial Constrioum (17kg/ha) was 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) [5]. 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) [7].

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) [2]. 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) [4]. 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

Fresh weight of plants (g/plant)

The fresh weight of shoot recorded in gram with the help of a single pan balance and the average fresh weight of shoot was calculated expressed as (g/plant).

Fresh weight of root (g/plant)

Fresh weight of root recorded in gram with the help of a single pan of balance and the average fresh weight of roots was calculated expressed as (g/plant).

Dry weight of plants (g/plant)

The five plants were collected and kept in hot air oven at 700^0C for 24 hours and their dry weight was recorded expressed as (g/plant).

Root yield per plot (kg)

Root yield of radish in kg per net plot was recorded and expressed as (kg/ha).

Harvest index (%)

The harvest index was obtained by the economic yield (root yield) from total biological plant yield and expressed as percentage.

$$\text{Harvest index (\%)} = \frac{\text{Economic yield}}{\text{Biological yields}} \times 100$$

Result and Discussion

Root yield per plot (kg)

The data showed that significantly maximum root yield per plot (kg) was recorded in T_6 (3.65kg) and the treatment T_5, T_7 and T_3 showed intermediate results. While significantly minimum root yield per plot was recorded in treatment T_1 (2.04kg).

This reflected in growth and yield parameters directly for higher yield of radish root yield similar result has been reported by Chang and Chang (2000) [3] Ahmed *et al*. (2004) [1] and Gethe *et al*. (2006) [6] in radish turnip and onion respectively.

Fresh weight of plant (g)

The treatment T_6 recorded significantly maximum fresh weight of plant T_6(318.00g) T_5,T_7,T_3 and T_2 should intermediate effect and were at for with each other while hence fresh weight of plant treatment T_1 (253.33g) were that of recommended dose of fertilizers was applied

It reflected in growth and yield parameters directly led to higher yield of radish root. Similar results have been reported by Chang and Chang (2000) [3]. Ahmed *et al.* (2004) [1] and Gethe *et al.* (2006) [6] in radish turnip and onion respectively.

Dry weight of root and Plant (g)

Data regarding dry weight of root and plant recorded significantly maximum dry weight of root and plant was revealed in treatment T_6 (121.67cm) and T_5, T_7, T_3, T_2 and $T_4$are equal intermediate and lower was regarded in T_1.

It reflected in growth and yield parameters directly led to higher yield of radish root. Similar results have been reported by Chang and Chang (2000) [3]. Ahmed *et al.* (2004) [1] and Gethe *et al.* (2006) [6] in radish turnip and onion respectively.

Harvesting index (%)

Data regarding harvesting index revealed that significantly maximum harvesting index was raved in treatment T_6 (7.5%) followed by the treatments T_5,T_7, T_3, T_2 and T_4 which measure with similarly each other on harvesting index.

It reflected in growth and yield parameters directly led to higher yield of radish root. Similar results have been reported Chang and Chang (2000) [3]. Ahmed *et al.* (2004) [1] and Gethe *et al.* (2006) [6] in radish turnip and onion respectively.

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

Treatment	Fresh weight of plant (g/plant)	Dry weight per plant(g/plant)	Root yield per plot (kg/ha)	Harvesting index (%)
RDF (90:50:90) NPK/ha	253.33^{d}	100.33^{e}	2.04^{e}	2.12^{c}
T_1 + Organic manures in the form of FYM (5 t/ha)	301.67^{b}	105.00^{de}	2.57^{b}	6.35^{b}
T_1 + Organic manures in the form of vermicompost (3 t/ha)	302.00^{b}	107.00^{cd}	2.81^{c}	6.46^{b}
T_1 + Organic manures in the form of neemcake (17 kg/ha)	292.67^{c}	101.67^{e}	2.47^{d}	6.4^{b}
T_1 + FYM (5 t/ha) + IIHR microbial consortium (300 g)	305.00^{b}	116.67^{ab}	3.15^{b}	6.9^{ab}
T_1 + Vermicompost (3 t/ha) + IIHR microbial consortium (300 g)	318.00^{a}	121.67^{a}	3.65^{a}	7.5^{a}
T_1 + Neemcake (17 kg) + IIHR microbial consortium (300g)	303.33^{b}	113.00^{bc}	2.88^{bc}	6.6^{b}
CD@5%	5.12	5.21	0.33	0.6
S.Em ±	1.69	1.71	0.11	1.12

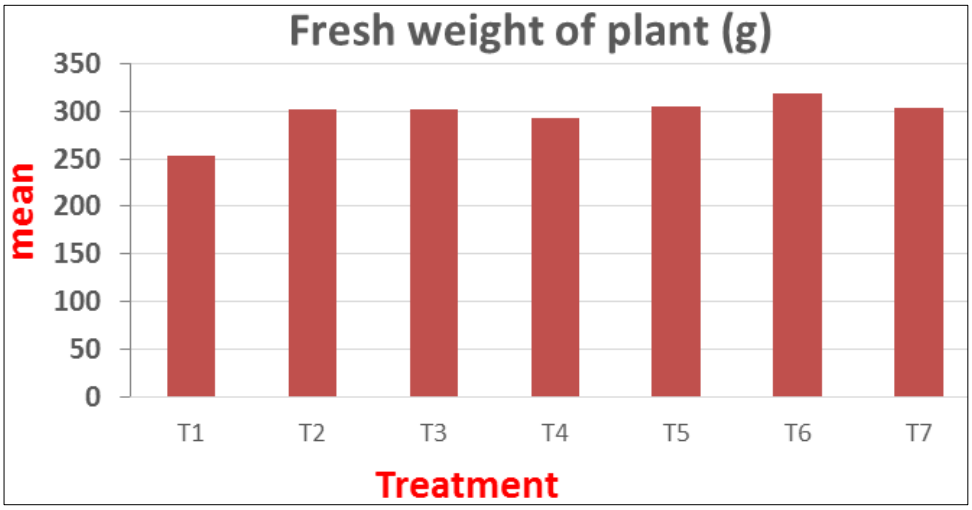

Fig 1: Effect of integrated nutrient management on fresh weight of plant (g/plant) of radish

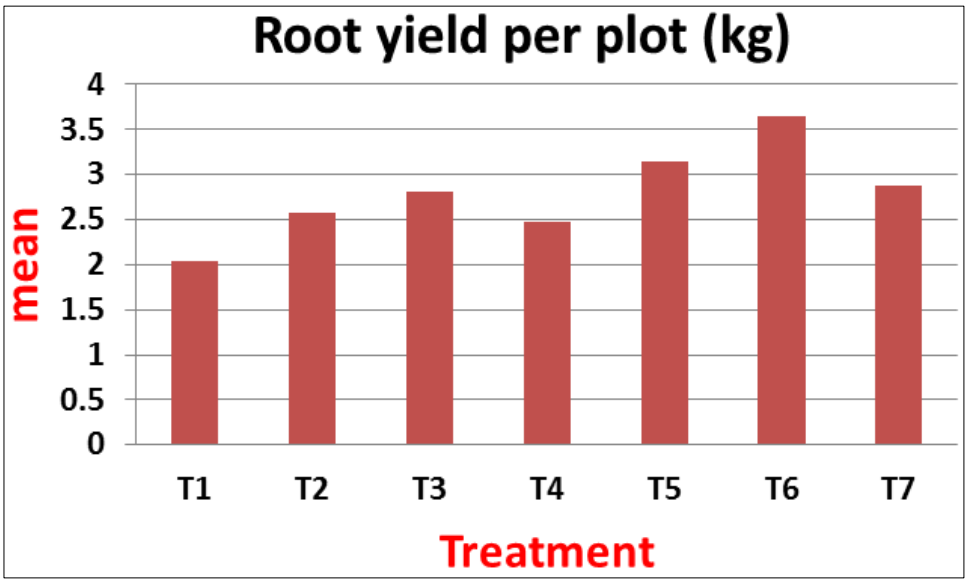

Fig 2: Effect of integrated nutrient management root yield per plot (kg) of radish

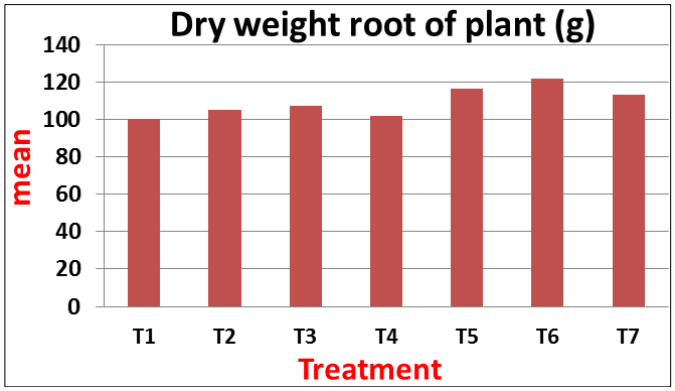

Fig 3: Effect of integrated nutrient management Dry weight root of plant (g/plant) of radish.

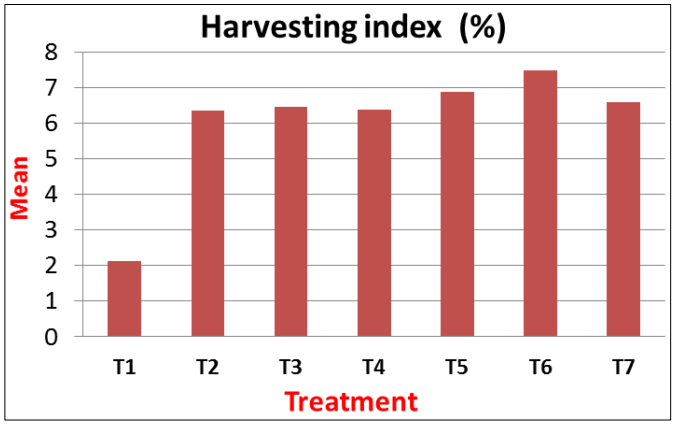

Fig 4: Effect of integrated nutrient management on harvesting index (%) of radish

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