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IMPACT OF ORGANIC MANURES AND BIOFERTILIZERS ON THE PERFORMANCE OF RADISH (*Raphanus sativus* L.)

Sandeep Kumar, Pavitra Dev, Jitendra Kumar* and Himanshu Kumar

Department of Horticulture, Chaudhary Charan Singh University, Meerut- 250004 (U.P.)
**Corresponding Author's E-mail: dhaka1968@gmail.com*

ABSTRACT : A field experiment was conducted to examine the impact of organic manures and biofertilizers on the vegetative and yield behaviour of radish during 2016-17 at the Horticultural Research Farm, Department of Horticulture, Chaudhary Charan Singh University Campus, Meerut (U.P). The experimental field was laid out in randomized block design (RBD) with three replications. The experiment comprised of nine treatments consisting of different organic manures and biofertilizers. All variables parameters regarding vegetative and yield behaviour were significantly influenced by organic manures and biofertilizers. Results indicated that combined application of organic manure and biofertilizer *i.e.* Vermicompost @ 2.5 tonnes/ha + *Azotobacter* @ 2.5 kg/ha (T_8) gave the better effect on vegetative and yield parameters viz., plant height (33.88 cm), number of leaves per plant (26.21), leaf width (10.70 cm), root length (23.33 cm), root diameter (4.88 cm), root weight (179.52 g) and yield (394.94 q/ha) as compared to other treatments.

Keywords : *Radish, farm yard manure, vermicompost, Azotobacter, Azospirillum.*

Radish is an important kitchen garden and cash crop, being grown widely all over the country. It is origin to Central/Western China and belong to the family cruciferae with 2n=18. It is a popular vegetable in India as well as in the world due to its short growing time with higher productivity. In hindi, radish is called as *'Mooli'*. It is mainly cool season crop and popular in both tropical and temperate regions. In India, the area under radish is 199 thousand hectare with an annual production of 2844 thousand metric tonnes during the year 2015-16 (Anon, 1). It is cultivated throughout India, mostly in West Bengal, Haryana, Punjab, Bihar, Assam, Chhattisgarh, Madhya Pradesh, Uttar Pradesh etc. Radish is grown for its young tuberous roots and tender leaves which are eaten raw as salad or cooked as a vegetable. Radish used for making pickles, which is very popular in diet of Indians and Japanese.

Due to increasing demands for food supply by the ever growing population, production systems using chemicals and fertilizers were adopted. Continuous dependence on chemical fertilizer is causing a nutritional imbalance in the soil and it may lead to instability in productivity, besides depleting the nutritional quality of vegetables. To maintain sustainability in production and quality, proper use of techniques, which will help to maintain the fertility of the soil, is required (Palaniappan and Annadurai, 12). One such alternative is organic farming that avoids depletion of soil organic matter and plant nutrients, besides suppression of some insect-pests and diseases. Consequently, people are turning to organically grown foods which promises nutritious and safe food and market for organic foods is expanding at the rate of 12-15% annually. Fertilizers of biological origins *i.e.* biofertilizer can meet this challenge through supplying nitrogen, phosphorus and imparting several other benefits to plants and by enriching the soils at minimum several other benefits to plants and by enriching the soils at minimum cost and keeping the environment safe. The use of biofertilizers seems to be the only ray of hope in this direction. Biofertilizers and organic manures are eco-friendly, low cost agricultural inputs playing a significant role in improving nutrient availability. The application of biofertilizers is thus becoming popular among vegetables grower.

Azotobacter is well known bacteria which are capable of fixing atmospheric nitrogen in the root zone of non leguminous plant through non symbiotic association. This association could meet one third to two third of the total nitrogen requirement of the plants. These bacteria not only fix the atmospheric nitrogen but also produce growth promoting substances which help in increasing the crop yield by regulating various metabolic and physiological activities within the plant system (Sunderavelue and Muthukrishanan, 14). Azospirillum is an associative type of microorganism

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capable of colonizing the root surface of the plants. By establishing a symbiotic association-ship, it helps the plants in getting the nitrogen from the atmosphere. It fixes the atmospheric nitrogen through the process of biological nitrogen fixation and makes it available to the plants in an easily assimilable and utilizable form.

On the other hand organic manures viz. farm yard manure and vermin compost are basic source of essential plant nutrients and applied in large quantities. They also contain other growth promoting agents like enzymes and hormones. Through the process of decomposition and humidification, they give humus, which helps to improve the physical, chemical and biological properties of the soil. The organic acids released during decomposition of organic manure controls certain fungal pathogens and nematode infestation. Use of bio-fertilizers and organic manures are not only helps in increasing the yield of crops but acts as store house of nutrients for successive crop, beside improving the soil physical condition. The organic materials like farm yard manure, crop residues, green manure and vermicompost most commonly used to improve soil condition and soil fertility status reported by several scientists (Das *et al.,* 6).

MATERIALS AND METHODS

The field experiment was conducted at the Horticultural Research Farm, Department of Horticulture, Chaudhary Charan Singh University Campus, Meerut (U.P). Geographically, Meerut is located between 29.01° N latitude and 77.43°E longitude at an elevation of 222 meter above the mean sea level. The soil of experimental field was sandy loam, which was natural in reaction (7.4 pH), low in organic carbon (0.43 %) and medium in available nitrogen, phosphorus and potassium. There was no rainfall occur during the cropping duration. There were applied a total number of nine treatments including control. The experiments were designed in randomized block design (RBD) with three replications. The treatments involved in the study were nine in numbers *i.e.* T_1 (Control), T_2 (Farm yard manure @ 20 t/ha), T_3 (Farm yard manure @ 20 t/ha), T_4 (Vermicompost @ 5 t/ha), T_5 (*Azotobacter* @ 5.0 kg/ha), T_6 (Farm yard manure @ 10 tonnes/ha + *Azotobacter* @ 2.5 kg/ha), T_7 (Farm yard manure @ 10 t/ha + *Azospirillum* @ 3.0 kg/ha), T_8 (Vermicompost @ 2.5 tonnes/ha + *Azotobacter* @ 2.5 kg/ha), T_9 (Vermicompost @ 2.5 t/ha + *Azospirillum* @ 3.0 kg/ha). Farm yard manure was properly mixed in soil fifteen days before sowing while vermicompost before one week of seed sowing in the subjected plots. Both biofertilizers *i.e. azotobacter* and *azospirillum* was well mixed in sand and then applied in soil through broadcasting at the time of seed sowing in the subjected plots. Earthing up was done manually with the help of khurpi on sixteenth days after sowing. All other cultural practices were followed as per recommendations.

RESULTS AND DISCUSSION

Considerable differences for vegetative and yield parameters were observed under different combination of organic manures and biofertilizers (Table 1). Vegetative parameters *viz.,* plant height, number of leaves and leaves width are an important trait for biomass production. A healthy plant with sufficient leaves have the ability of the efficient utilization of sunlight, water and nutrients for photosynthesis for biomass production and better yield. Among the different organic manures and biofertilizers the maximum plant height (33.88 cm), was observed with T_8 (Vermicompost @ 2.5 tonnes/ha + *Azotobacter* @ 2.5 kg/ha) followed by treatment T_9 (Vermicompost @ 2.5 tonnes/ha + *Azospirillum* @ 3.0 kg/ha). Similarly maximum number of leaves per plant (26.21 and 24.99) and leaf width (10.7 and 10.2 cm) were found statistically similar and significant under the treatments T_8 (Vermicompost @ 2.5 t/ha + *Azotobacter* @ 2.5 kg/ha) and T_9 (Vermicompost @ 2.5 t/ha + *Azospirillum* @ 3.0 kg/ha), respectively, The findings of the study confirmed with the findings of Uddain *et al.* (15) and Kumar *et al.* (9). Dev *et al.* (7) also reported maximum vegetative growth under combined application of NPK and FYM in case of tomato. Basavaraju *et al.* (2) reported that inoculation of *Azotobacter chroocoum* significantly increased the germination per cent by 9.33%, radical length by 90.47% and plumule length by 54.37% over uninoculated control.

The pronounced growth in vegetative parameters might be due to the stimulated activities likewise cell elongation, cell division, quick multiplication and synthesized more food materials in the plant by the organic manures and biofertilizers. Among the organic manure, vermicompost is one of the best which contains growth regulators like hormones which increase the growth and yield of crops (Canellas *et al.,* 4). Farm yard manure and vermicompost plays an important role for improving soil physical properties and contains higher level of relatively available nutrients elements, which are essential to plant growth (Mona *et al.,* 11). The organic carbon in vermicompost releases the nutrients slowly and steadily into the system and enables the plant to absorb the nutrients. The soil enriched with vermicompost provides additional substances that are not found in chemical fertilizers are responsible for high vegetative growth. Among the

Table 1 : Impact of organic manures and biofertilizers on the plant growth, development and yield of radish.

Treatments	Plant height (cm)	No. of leaves/ plant	Maximum leaf width (cm)	Root length (cm)	Root diameter (cm)	Root weight (g)	Yield (q/ha)
T_1 : Control (no biofertilizers and manures)	25.44	19.82	8.22	17.38	3.65	133.21	293.06
T_2 : Farm yard manure @ 20 t/ha	28.39	22.55	8.83	20.06	4.35	163.22	359.08
T_3 : Vermicompost @ 5 t/ha	28.61	22.56	8.99	20.25	4.41	167	367.4
T_4 : *Azotobacter* @ 5.0 kg/ha	27.38	22.44	8.79	19.56	4.13	160.32	352.7
T_5 : *Azospirillum* @ 6.0 kg/ha	27.05	21.98	8.77	19.14	4.04	158.66	349.05
T_6 : Farm yard manure @ 10 t/ha + *Azotobacter* @ 2.5 kg/ha	29.55	22.99	9.97	22.01	4.51	172.56	379.63
T_7 : Farm yard manure @ 10 t/ha + *Azospirillum* @ 3.0 kg/ha	29.28	22.67	9.48	21.58	4.46	170.05	374.11
T_8 : Vermicompost @ 2.5 t/ha + *Azotobacter* @ 2.5 kg/ha	33.88	26.21	10.70	23.44	4.88	179.52	394.94
T_9 : Vermicompost @ 2.5 t/ha + *Azospirillum* @ 3.0 kg/ha	31.38	24.99	10.20	22.75	4.74	175.95	387.09
C.D. (P =0.05)	1.769	1.407	1.195	0.634	0.305	2.933	6.469

biofertilizers, Bacteria of the genus *Azotobacter* synthesize auxins, cytokinins, and GA-like substances, and these growth materials are the primary substance controlling the enhanced growth (Eklund, 8). *Azospirillum* increased the vegetative growth of plant may be due to of its direct role in nitrogen fixation and production of phytohormones like substances which stimulated growth and nutrient assimilation (Bhattacharyya, 3).

It is clear from the findings that organic manures and biofertilizers significantly influenced the yield parameters *viz.* root length, root diameter and yield in case of radish. Among the treatments, the maximum root length (23.33 cm), root diameter (4.88 cm) root weight (179.52 g) and yield (394.94 q/ha) was recorded with T_8 (Vermicompost @ 2.5 tonnes/ha + *Azotobacter* @ 2.5 kg/ha) followed by T_9 (Vermicompost @ 2.5 tonnes/ha + *Azospirillum* @ 3.0 kg/ha). The findings of the study confirmed with the findings of Uddain *et al.* (15) and Yanthan *et al.* (17). Our findings are in line with Vijaykumari *et al.* (16) who recorded maximum weight of single radish (211.67 g) and tuber length (24.51 cm) with the soil application of vermicompost. By using Azotobacter, potato yield can be increased by 33.3% and 38.3% (Zena and Peru, 18).

Application of farm yard manure with *Azospirillum* is more beneficial for sustainable higher yield. It is well known that nitrogen play vital role in food manufacturing and phosphorus and potassium essential for better root and leaf stomata activity for producing maximum biomass. Beside the major nutrients, vermicompost is a rich source of trace elements viz., calcium, magnesium, zinc, copper, iron and manganese (Prabha *et al.,* 13). Vermicompost increase the microbial activity in organic matter, which helps in production some plant bioregulators like indole acetic acid and gibberellins by micro-organism. Gibberellins ultimately increase the activity of amylase enzyme, which is responsible for converting starch into sugar. *Azotobacter* inoculants have a significant promoting effect on growth parameters like root, shoot length and dry mass. *Azotobacter* has beneficial effects on crop growth and yield through, biosynthesis of biologically active substances, stimulation of rhizospheric microbes and producing phytopathogenic inhibitors (Chen, 5; and Lenart, 10).

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