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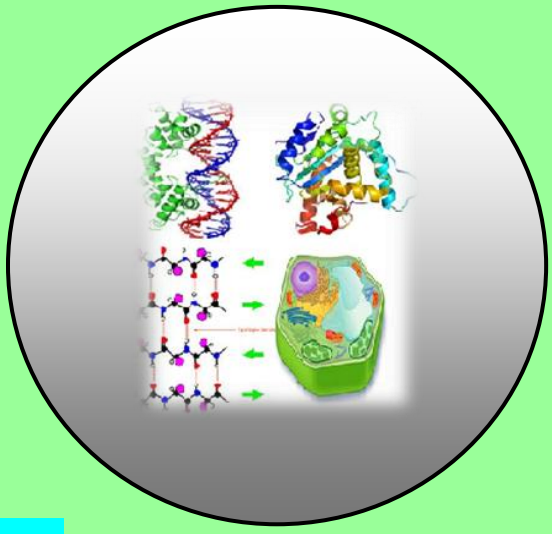

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RESEARCH PAPER

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Effect of Integrated Nutrient Management in Alluvial Soil on Growth and Biochemical Responses of Radish

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ABSTRACT

A field experiment was conducted to study the nutrients management from inorganic and organic sources in alluvial soil of a semi arid region in Lucknow district (Janakipuram area). Their effects on growth (leaf area, root length, girth and biomass) and some biochemical constituents (pigments, total protein and sugar contents) in radish (Raphanus sativus L.) plants were studied. The soil was highly deficient in macro (N, P and K) and micronutrients (Zn and Cu), moderate alkaline in reaction, low in organic matter content (< 0.3%) and moderately calcareous, showed its poor fertility status. Radish plants grown in soil amended with T0 – nil; T1 – $ZnSO_4$ + $CuSO_4$); T2 - $ZnSO_4$ + $CuSO_4$ + N, P and K fertilizers T3- $ZnSO_4$ + $CuSO_4$ + N, P and K fertilizers+ vermicompost (V.C.) @ 5t ha-1 and T_4- $ZnSO_4$ + $CuSO_4$ + N, P and K fertilizers +V.C. @10t ha-1. The amendment of various fertilizers improved growth and biochemical responses of radish. But, a maximum growth response was observed at treatment T_4. The maximum increase in leaf area, root length and root dry weight by 105.6, 66.9 and 158% and biochemical constituents such as total chlorophyll, total protein and sugar contents by 149, 128 and 500% was observed at soil amended with inorganic fertilizers in combination with organic manure vermicompost.
Keywords: Alluvial Soil, Organic and Inorganic Fertilizers, Growth and Radish.

INTRODUCTION

In modern agricultural practices chemical fertilizers are used on a large scale by the formers for increasing the yield of crops. The continuous use of chemical fertilizers, oftenly in excess over a long period of time in arable land has led to contamination of food material, environmental pollution and depletion of soil fertility (Singh, 1999). The concept of integrated forming by the appropriate use of organic and inorganic fertilizers as sources of nutrients may be helpful to increase soil fertility and improvement of crops quality and growth (Semwal *et al*. 2007). A site specific integrated nutrient management after

sustainable productivity, availability and supply of plant nutrients in balance proportion in the soil , a key factor in the practical way for high productivity (Prasad, 1999). In semi-arid areas of northern India, most of the soils are very deficient in some micro nutrients such as Zn and Cu (Agarwala *et al*., 1980). The deficiency of micro nutrients poses a major constrain to crop production (Pandey *et al.,* 2009). Least work is available on site specific integrated management of semi-arid alluvial soil for production of vegetable crops. Therefore, study was undertaken to find out the suitable combination of organic manure (vermicompost) and inorganic fertilizers of macronutrients (N, P and K) and micronutrients (Zn and Cu) to improve growth and some biochemical responses of a vegetable crop radish (*Raphanus sativus* L.) grown in alluvial soil of Lucknow district. The radish (*Raphanus sativus* L.) is a vegetable crop grown throughout the world. The common radish is a quick growing annual herb and primarily a cold season crop.

MATERIAL AND METHODS

A filed experiment was conducted in Jankipuram area of Lucknow district a semi-arid region of north India. Before amendment of the fertilizers, some physico-chemical properties of the soil were analyzed by the method described by Jackson (1956). The soil was also analyzed for the DTPA extractable Zn and Cu (Lindsay and Norvell, 1978). The soil was mild calcareous and very low in oganic matter content (Table 1). Also, soil was very deficient in Zn and Cu. The experiment was conducted in RBD (Randomized block design) with three replicates of each.

In the experimental filed five treatment plots of 5x2 m size were made. Each plot was separated with 1 m distance. Five treatments were made in the soil plots viz **.**T_o (control, without amendment of any fertilizer), T_1 ($ZnSO_4$ @ 10 Kg ha^{-1} + $CuSO_4$ @ 2 kg ha^{-1}). T2 [$ZnSO_4$ @ 10 kg ha^{-1} + $CuSO_4$ @ 2 kg ha^{-1} + NPK (50:50:50)] T_3 [$ZnSO_4$ @ 10 kg ha^{-1} + Cu SO_4 @ 2 kg ha^{-1} vermicompost (vc) @ 5 t ha^{-1} + NPK (50:50:50) and T_4 [$ZnSO_4$@ 10 kg ha^{-1} + $CuSO_4$ @ 2 kg ha^{-1} + vermicompost (vc) @ 10 t ha^{-1} + NPK (50:50:50) were mixed in soil The regular observations for growth (length and biomass) and some biochemical constituents (Pigments, protein and sugar contents) of radish. All the observations regarding growth and biomass yield of test plants were taken regularly.

The biochemical constituents were determined at 60 days of growth. For dry weight plant was harvested and over dried at 60^o C for 48 hours. Chlorophyll contents were determined by the method of Lichtenthaler and Welburn (1983). Sugar content was determined following the method of Dubois *et al.* (1956). Protein content was determined by the method of Lowry *et. al* (1951). Data presented in the table are mean value and statistically tested by student 't' test method.

RESULTS

Soil Status

Experiment was carried out on a semi-arid alluvial sol of Lucknow district and evaluated for some important physico-chemical properties presented in table 1. The native soil was sandy loam in texture, moderately calcareous ($CaCO_3$ < 1.5%) moderate alkaline and very low in organic matter, observed. Also, soil was highly deficient in Zn, Cu and Fe status. The nitrogen, phosphorus and potassium content were very low indicated poor fertility status of the soil studied.

Table 1. Physico- chemical properties of alluvial soil (Lucknow) and vermicompost used in the experiment.

	Texture	pH	E.C. (mmhos /cm)	O.M. (%)	$CaCO_3$ (%)	Zn (ppm)	Cu (ppm)	Fe (ppm)	N (ppm)	P (ppm)	K (ppm)
Alluvial soil	Sandy loam	8.1	0.60	0.25	1.43	0.25	0.15	3.14	40	30	20
Vermicompost	-	6.5	ND	10.5	ND	5.6	0.86	8.5	150	110	90

O.M.- organic matter, E.C.- electrical conductance, ND- not detected

Table 2. Effect of integrated use of organic and inorganic fertilizers in alluvial soil on growth yield of radish.

Treatment	Leaf area (cm^2)	Root length (cm)	Root girth (cm)	Root D.W. (g/plant)	Root biomass ($t\ ha^{-1}$)
T_0 control	90±0.88 (+0.0)	18.10±1.09* (+0.0)	3.70±0.25 (+0.0)	6.15±0.10 (+0.0)	18.16±0.64 (+0.0)
T_1 Zn+Cu	120±0.58 (+33.3)	20.50±0.60 (+13.3)	5.60±0.23 (+51.4)	7.26±0.12 (+18.0)	22.63±0.71 (+24.6)
T_2 Zn+Cu+ NPK	150±2.40** (+66.7)	25.60±0.62 (+41.4)	6.65±0.22 (+79.7)	9.11±0.49 (+48.1)	34.19±0.17 (+88.3)
T_3 Zn+Cu+ NPK+VC_1	170±4.51** (+88.9)	28.90±0.97* (+59.7)	7.90±0.11 (+113.5)	13.74±0.50 (+123.4)	54.95±0.32 (+202.6)
T_4 Zn+Cu+ NPK+VC_2	185±2.89** (+105.6)	30.20±0.48 (+66.9)	9.45±0.25 (+155.4)	16.00±0.18 (+158.0)	71.93±0.57 (+296.0)

VC_1= vermicompost @ 5 tons ha^{-1}; $VC_{2=}$ vermicompost @ 10 tons ha^{-1}; NPK fertilizers @ 50kg ha^{-1}; Zn= $ZnSO_4$ @ 10kg ha^{-1}; Cu= $CuSO_4$ @ 2kg ha^{-1}; ± S.E. value (n=5); *- significant at $P<0.05$ level; **- significant at $P<0.01$ level.

Growth Observations

Plants grown at nutrient deficient alluvial soil showed poor growth. When soil amended with nutrients inorganic sources of Zn, Cu, N, P, K and organic manure vermicompost singly, and in combination, increased growth (biomass and length of root and leaf area) of radish was observed. Maximum growth and yield of radish was observed at soil amended with Zn, Cu, N, P and K fertilizers with vermicompost at the rate 10 tone per hectare (Table 2). Maximum leaf area, root dry weight and per hectare yield was observed to be increased by 105.6, 158 and 296% respectively. The growth of radish plants was increased at amendment of inorganic fertilizers (Treatment T_1 and T_2) only but it was less effective positively than the soil amended in combination with vermicompost (Treatment T_3 and T_4).

Pigments

Pigments (chlorophyll a and b and total chlorophyll contents) in radish leaves enhanced by application of oganic and inorganic sources of nutrients. Maximum increase in chlorophyll a and b and total chlorophyll content by 208, 190 and 149% observed at treatment T4, respectively. The application of vermicompost enhanced the pigments content at both the doses @ 5 and 10 tone per hectare, but higher dose was more effective in promotion of chlorophyll contents in radish leaves. The promontory effects on pigments content by inorganic fertilizers was less effective as compared to used in combination with vermicompost (@ 10t ha^{-1}).

Table 3. Effect of integrated use of organic and inorganic fertilizers use on biochemical parameters radish.

Treatments	Pigments (mg g^{-1}fr. wt.)			Protein (μg^{-1}fr. wt.)	sugar (μg^{-1}fr. wt.)
	Chl a	Chl b	Total chl		
T_0 Control	0.24±0.02 (+0.0)	0.10±0.01 (+0.0)	0.55±0.02 (+0.0)	87.14±2.03* (+0.0)	5.00±0.10 (+0.0)
T_1 Zn+Cu	0.25±0.03 (+4.2)	0.11±0.02 (+10.0)	0.82±0.02 (+49.1)	118.82±2.62** (+36.4)	7.50±0.40 (+50.0)
T_2 Zn+Cu+ NPK	0.390±0.03 (+62.5)	0.25±0.02 (+150.0)	0.88±0.06 (+60.0)	142.59±2.48** (+63.6)	10.00±0.54 (+100.0)
T_3 Zn+Cu+ NPK+VC_1	0.53±0.04 (+120.8)	0.28±0.01 (+180.0)	0.95±0.04 (+72.7)	134.67±1.27* (+54.5)	17.50±0.66 (+250.0)
T_4 Zn+Cu+ NPK+VC_2	0.74±0.02 (+208.0)	0.29±0.02 (+190.0)	1.37±0.13 (+149.0)	198.04±2.24* (+128.0)	30.00±1.15* (+500.0)

VC_1= vermicompost @ 5 tons ha^{-1}; $VC_{2=}$ vermicompost @ 10 tons ha^{-1}; NPK fertilizers @ 50kg ha^{-1}; Zn= $ZnSO_4$ @ 10kg ha^{-1}; Cu= $CuSO_4$ @ 2kg ha^{-1}; ± S.E. value (n=5); *- significant at $P<0.05$ level; **- significant at $P<0.01$ level.

Total Protein

Total protein content estimated in radish leaves was increased by both organic and inorganic sources of nutrients. Maximum increase in total protein content by 128% was determined in radish at the soil amended with Zn, Cu, N, P and K fertilizers in combination with vermicompost @ 10 tone per hectare.

Total Sugar

Plants grown at native soil showed poor sugar content level as compared to the soil amended with inorganic or organic sources of nutrients either singly or in combination. But maximum sugar content in radish leaves increased by 75 and 200% at treatment T_3 and T_4 soil amended with vermicompost @ 5 and 10 tone per hectare, respectively.

DISCUSSION

The experimental soil collected from a semi arid region of northern India (Jankipuram area of Lucknow district) determined for its fertility evaluation indicated poor fertile status. It could be due to the land was barren, did not used previously for agricultural purposes, the sandy loam texture, presence of moderate level of calcareousness, low organic matter content and alkaline reaction indicated the soil not supportive to plant growth (Marschner, 1988). The poor status of macro (N, P and K) and micro (Zn, Cu and Fe) nutrients was also observed earlier as reported in alluvial soil of Lucknow district (Pandey *et al*., 2009 and Agarwala *et al*., 1984). Plants grown at native soil exhibited visible mixed symptoms of nitrogen, Zn and Cu deficiency such as yellowing of older leaves, chlorosis of young leaves and necrosis on margin of leaves. These symptoms resembled with nitrogen deficiency (Brady and Weil, 2002) and deficiency of Zn and Cu as described by Prasad (1999) and Cakmak and Murschner (1987). Growth (leaf area and dry weight of root) was found to be increased could be due to the addition of organic and inorganic sources of nutrients (Sharma *et al*., 1985). The role of Zn and Cu in promotion of plant growth have been also reported by several workers (Singh, 1999; Sharma, 2006) The application of organic manure makes the soil conditions favorable to absorption of nutrients to the plant roots (Verma and Pandey, 2008). The increase in leaf area, root length and dry weight was found to be increased more at vermicompost amended soil as compared to soil amended only with inorganic fertilizers; it might be due to the improved soil conditions and availability of essential nutrients facilitated by vermicompost (Semwal *et al*., 2007; Brady and Weil, 2002). The pigments content in radish leaves increased affected with each fertilizers application in the order T0<T1<T2<T3<T4 (Table 3) indicated the requirements of all nutrients applied in soil as reported earlier by Singh (1999). The increase in chlorophylls content in radish at VC amended soil could be due to the supply of Fe and Zn along with other nutrients to the plant root (Sharma, 2006). The increase in pigments content due to normal available dose of Zn (Marschner, 1988, Pandey *et al.,* 2009).The protein and sugar contents increased could be due to the essential elements released by organic and inorganic manures (Yadav and Pandey, 2015) in soil, and their tissue concentration in plant (Sharma, 2006). The increased protein and pigments content could be attributed improved sugar content in radish (Verma and Pandey, 2008). Therefore, study concluded that alluvial soil used for growing the test plant radish was poor in N, P and K and micronutrients (Zn and Cu) contents. The application of inorganic fertilizers as source of these nutrients in combination with organic source (vermicompost) improved the growth and biochemical constituents (Pigments, protein and sugar contents) in radish.

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