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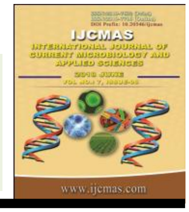

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Effects of Organic and Inorganic Nutrient Application in *Tikhur* (*Curcuma angustifolia* Roxb.) on Soil Physicochemical Properties and Nutrient Availability in *Inceptisol* of *Chhattisgarh* Plateau

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A B S T R A C T

The investigation was undertaken during kharif season 2016 at Shaheed Gundadhoor College of Agriculture and Research Station (IGKV) Kumharawand, Jagdalpur, Bastar (C.G.). The experiment was laid out in Factorial Randomized Complete Block Design (FRCBD) with the treatments comprised of four levels of fertilizers ($N_0P_0K_0$, $N_{30}P_{20}K_{30}$, $N_{60}P_{40}K_{60}$ and $N_{90}P_{60}K_{90}$ kg ha^{-1}) and four levels of vermicompost (0, 10, 20 and 30 t ha^{-1}) and three replications. Application of organic and inorganic nutrients had significant effect on soil electrical conductivity, cation exchange capacity, available nitrogen, available phosphorus and available potassium. However organic nutrients had significant effect on soil organic carbon, bulk density of soil, soil porosity %, available sulphur, available calcium and available magnesium. The highest value of all these parameters found in fertilizers levels @ $N_{90}P_{60}K_{90}$ kg ha^{-1} and vermicompost @ 30 t ha^{-1} except soil electrical conductivity highest found due to application of fertilizer @ $N_0P_0K_0$kg ha^{-1} and vermicompost @ 30 t ha^{-1}. The interaction effect of fertilizer with vermicompost had not found significant on all the observation.

Introduction

Tikhur (*Curcuma angustifolia*; family Zingiberaceae) is a rhizomatous herb also known as white turmeric or East Indian arrowroot. Its cultivation has now been undertaken by the farmers of Bastar on a large area. Tikhur cultivated as medicinal crop in many parts of the state under moist deciduous mixed and sal forest of Madhya Pradesh, Chhattisgarh and Jharkhand. The integrated nutrient management system will have a strong impact on soil fertility and may need to be taken in to consideration in the development of fertilizer commendations. Conjoint use of fertilizers and manures would not only impart substance to the production and improve soil health, but also enhance the efficient use of applied nutrients. The organic manures could ameliorate these adverse effects of inorganic fertilizers (Sikora and Azam, 1993). It is well known that addition of organic manures has shown considerable increase in crop yield, quality and exert significant influence on physical, chemical and biological properties of soil. Ramesan *et* *al.*, (1996) studied the nutritional requirement of arrowroot on biomass production, rhizome yield, nutrient uptake and available N, P and K status of the soil and found that N and K @ 50 and 75 kg ha^{-1} significantly increased rhizome yield. Maheswarappa *et al.*, (2000) and Veena (2000) reported highest uptake of N and K at the highest level of fertilization in arrowroot intercropped in coconut gardens. Suja *et al.*, (2006) studied the influence of nutrient management on arrowroot yield, nutrient uptake and soil nutrient status and found that application of N P and K @ 50:25:75 kg ha^{-1} was ideal to obtain better yield (23.29 t ha^{-1}), higher uptake of nutrients and substantial improvement in the nutrient status. Looking to very limited information on the proper nutrient doses to maximize yield of Indian arrowroot, present investigation was undertaken with the objective Effects of Organic and Inorganic Nutrient application in Tikhur (*Curcuma aungustifolia* Roxb.) on Soil Physicochemical properties and Nutrient availability in *Inceptisol* of Chhattisgarh *Plateau*.

Materials and Methods

The investigation was undertaken during the year of *kharif* season 2016 at Indira Gandhi Krishi Vishwavidyalaya, Shaheed Gundadhoor College of Agriculture and Research Station, Jagdalpur, Bastar (Chhattisgarh). The experiment was laid out in factorial randomized complete block design with the treatments comprised of four levels of fertilizers ($N_0P_0K_0$, $N_{30}P_{20}K_{30}$, $N_{60}P_{40}K_{60}$ and $N_{90}P_{60}K_{90}$ kg ha^{-1}) and four levels of vermicompost (0, 10, 20 and 30 t ha^{-1}) and three replications.

Before conducting the experiment, the initial physicochemical characteristics of the experimental soil (*Inceptisol*) and vermicompost were determined (table 1) using common field and laboratory procedures. The planting of Tikhur was done on May 17, 2016. Full dose of vermicompost, phosphorus and potassium and 1/3 dose of nitrogen, as per treatment, were applied in the form of diammonium phosphate, *muriate* of potash and urea, at the time of planting and the remaining dose of nitrogen was applied at 60 and 75 days after planting. The Intercultural operation like, hand weeding done three times at 60, 90 and 120 days after planting, earthing up done at 110 days after planting, spraying of macoban (carbendazim + mancozeb) fungicide for the control of blight disease at 100 days after sowing and crops are grown in rainfed field conditions. The crop was harvested at 30 December 2016 after complete maturity, as indicated by the leaf drying and falling down of plants. Before conducting the experiment the soil samples were taken from various places randomly of the experimental plot with the help of auger from the surface 0 to 15 cm of depth.

The soil samples settle down for four hours then conductivity of supernatant liquid was determined by solu-bridge as described by Black (1965), cation exchange capacity was determined by leaching the soil with neutral normal ammonium acetate as described by Black (1965), organic carbon was determined by Walkley and Black's rapid titration method (1934), bulk density was measured as per method given by Black (1965), bulk density was determined by removing natural undisturbed core sample from soil by core sampler. The samples were oven dried at 105^0C to a constant weight, bulk density was calculated by dividing weight of oven dry soil by volume of soil, soil porosity was measured by using standard unit of particle density 2.65 of normal soil which is estimated by using bulk density of soil porosity was estimated by one dividing bulk density of soil by particle density of soil multiplied by hundred, available N was determined by alkaline permanganate method as suggested by Subbiah and Asija (1956), available soil P was extracted by 0.03 *N* NH_4F and 0.025 *N* HCl phosphorus in the extract was determined by ascorbic acid method for - acidic soils (Bray, 1948), soil potassium was extracted by neutral normal ammonium acetate (Hanway and Heidal, 1952), available sulphur in soil was determined by the $CaCl_2.2H_2O$ (0.15 % solution) method (Williams and Steinergs, 1959) and soil available (water soluble plus exchangeable) calcium and magnesium ion are extracted by shaking the soil with NH_4OAc solution. The extractant solution is determine by comlexometric titration using ethylene diamine tetra acitic acid (EDTA) first introduced by Schwarzenbach *et al.,* (1946).

Results and Discussion

Soil electrical conductivity

The data presented in (Table 2 and Fig. 1) revealed that organic and inorganic nutrients had significant effect on soil electrical conductivity. However, the interaction effect of fertilizers with vermicompost was not found significant. The electrical conductivity of soil ranges from 0.12to0.13 $dsm^{-1}$and 0.12 to 0.14dsm^{-1} with highest under application of fertilizer @ $N_0P_0K_0$ kg ha^{-1} and vermicompost @ 30t ha^{-1}, respectively. The electrical conductivity of soil decreased significantly as we increase fertilizer levels from $N_{30}P_{20}K_{30}$ kg ha^{-1} to $N_{90}P_{60}K_{90}$ kg $ha^{-1}$and highest value was recorded under fertilizer @ $N_0P_0K_0$ kg ha^{-1}which was at par with $N_{30}P_{20}K_{30}$ kg ha^{-1}. Whereas, soil electrical conductivity was found significantly higher under vermicompost @ 30 t ha^{-1}as compare to vermicompost @0 and 10 t ha^{-1} and at par with 20 t ha^{-1}.

Soil organic carbon

The data presented in (Table 2 and Fig. 2) revealed that organic nutrient had significant effect on soil organic carbon, however interaction effect of fertilizers with vermicompost was not found significant. The organic carbon ranges from 0.73 to 1.05 % with highest under application of vermicompost @ 30 t ha^{-1}, which was significantly higher than vermicompost @ 0, 10 and 20 t ha^{-1}.

Soil porosity

The data presented in (Table 2 and Fig. 3) revealed that organic nutrient had significant effect on soil porosity, however interaction effect of fertilizers with vermicompost was not found significant. The soil porosity ranges from 37.91 to 39.37 % with highest under application of vermicompost @ 30t ha^{-1}, which was significantly higher than vermicompost @ 0 and 10t ha^{-1} but at par with vermicompost @ 20 t ha^{-1}.

Soil bulk density

The data presented in (Table 2 and Fig. 4) revealed that organic nutrient had significant effect on soil bulk density, however interaction effect of fertilizers with vermicompost was 55not found significant. The soil bulk density ranges from 1.65 to 1.61 g $cm^{-3}$with lowest value due to application of vermicompost @ 30t ha^{-1}, which was significantly lower than vermicompost @0 and 10 t ha^{-1}but at par with vermicompost @ 20 t ha^{-1}.

Soil cation exchange capacity

The organic and inorganic nutrients had significant effect on soil cation exchange capacity (Table 2 and Fig. 5), however interaction effect of fertilizers with vermicompost was not found significant. The soil cation exchange capacity ranges from10.76 to 11.78 c mol (p+) $kg^{-1}$and 8.63 to 13.77 c mol (p+) kg^{-1} with the highest under application of fertilizer @ $N_{90}P_{60}K_{90}$ kg ha^{-1}

and vermicompost @ 30t ha^{-1}, respectively. The soil cation exchange capacity due to the application of fertilizer @ $N_{90}P_{60}K_{90}$ kg ha^{-1} and$N_{60}P_{40}K_{60}$ kg ha^{-1} was found at par with each other but both were significantly higher than $N_0P_0K_{0.}$ Whereas, increasing vermicompost levels from 0 to 10, 10 to 20 and 20 to 30t ha^{-1}, significantly increased soil cation exchange capacity at all successive levels.

Lower bulk density and porosity of soil due to organic management was recorded by several workers (Suja, G., 2013, Suja and Sreekumar, 2014, Radhakrishnan *et al.,* 2014). Wapa and Oyetola (2014) reported increased values of soil pH, EC organic carbon and CEC of the soil due to application of municipal wastes either applied singly or in combination with N fertilizer. Hemalatha and Chellamuthu (2013) reported that cation exchange capacity of the soil has increased significantly in the treatment receiving 100 per cent NPK+FYM. Singh *et al.*, (2015) reported that application of 20t FYM ha^{-1} improved the soil pH, EC, organic carbon and available NPK in comparison to control.

Available nitrogen

The organic and inorganic nutrients had significant effect on soil available nitrogen (Table 3 and Fig. 6), however interaction effect of fertilizers with vermicompost was not found significant. The available nitrogen ranges from 208.25 to 215.92 kg ha^{-1} and 200.67 to 221.08 kg ha^{-1} with the highest under application of fertilizer @ $N_{90}P_{60}K_{90}$ kg $ha^{-1}$and vermicompost @ 30t ha^{-1}, respectively. The effect of fertilizer levels @ $N_{90}P_{60}K_{90}$ kg ha^{-1} was significantly higher than $N_0P_0K_0$ and $N_{30}P_{20}K_{30}$ kg ha^{-1}but at par with $N_{60}P_{40}K_{60}$ kg ha^{-1}. Whereas, available nitrogen was increased significantly as we, successively, increased vermicompost levels from 0 to10, 10 to 20 and 20 to 30t ha^{-1}.

Table.1 Initial physico-chemical properties of soil and nutritional composition of vermicompost used in the study

S. No.	Properties	0-15 cm
1	Mechanical composition	
	Sand (%)	46
	Silt (%)	30
	Clay (%)	24
	Texture class	Loam
2	Soil pH (1:2.5)	5.5
3	Electrical conductivity (dSm^{-1})	0.03
4	Organic Carbon (%)	0.71
5	BD (g cm^{-3})	1.43
6	CEC (C mol (p+) kg^{-1})	14.5
7	Available N (kg ha^{-1})	202.2
8	Available P (kg ha^{-1})	13.9
9	Available K (kg ha^{-1})	206
10	Available S (kg ha^{-1})	16.6
11	Available Ca (meq/100 g soil)	2.51
12	Available Mg (meq/100 g soil)	1.82
13	N content in vermicompost (%)	1.4
14	P content in vermicompost (%)	0.6
15	K content in vermicompost (%)	1.1

Table.2 Effect of graded doses of inorganic and organic sources of nutrients on physicochemical properties of soil

Inorganic/ Organic dose	Soil Ec (dsm^{-1})	Organic carbon (%)	Soil bulk density ($g\ cm^{-3}$)	Soil porosity (%)	CEC (c mol (p+) kg^{-1})
$N_0P_0K_0$	0.13^a	0.94	1.63	38.58	10.76^a
$N_{30}P_{20}K_{30}$	0.13^a	0.92	1.62	38.85	11.08^{ab}
$N_{60}P_{40}K_{60}$	0.12^a	0.92	1.63	38.48	11.58^b
$N_{90}P_{60}K_{90}$	0.12^a	0.92	1.62	38.71	11.78^b
CD(P=0.05)	0.01	N.S.	N.S.	N.S.	0.74
Vermicompost @ 0 t ha^{-1}	0.12^a	0.73^a	1.65^a	37.91^a	8.63^a
Vermicompost @ 10 t ha^{-1}	0.12^a	0.90^b	1.63^{ab}	38.43^{ab}	10.59^b
Vermicompost @ 20 t ha^{-1}	0.13^{ab}	1.02^c	1.62^b	38.91^b	12.20^c
Vermicompost @ 30 t ha^{-1}	0.14^b	1.05^d	1.61^b	39.37^b	13.77^d
CD(P=0.05)	0.01	0.023	0.025	0.93	0.74
Interaction CD(P=0.05)	N.S.	N.S.	N.S.	N.S.	N.S.

Table.3 Effect of graded doses of inorganic and organic nutrient application in *Tikhur* on nutrient availability in soil

Inorganic/ Organic dose	Available nitrogen ($kg\ ha^{-1}$)	Available phosphorus ($kg\ ha^{-1}$)	Available potassium ($kg\ ha^{-1}$)	Available sulphur ($kg\ ha^{-1}$)	Available calcium (meq/100g soil)	Available magnesium (meq/100g soil)
$N_0P_0K_0$	208.25^a	15.94^a	204.58^a	21.68	2.45	1.85
$N_{30}P_{20}K_{30}$	209.33^a	16.82^a	209.83^a	22.47	2.51	1.86
$N_{60}P_{40}K_{60}$	211.83^{ab}	18.18^{ab}	216.41^{ab}	23.27	2.56	1.87
$N_{90}P_{60}K_{90}$	215.92^b	19.87^b	229.67^b	23.18	2.58	1.88
CD(P=0.05)	4.73	2.26	16.83	N.S.	N.S.	N.S.
Vermicompost @ 0 t ha^{-1}	200.67^a	9.50^a	197.33^a	17.13^a	2.23^a	1.79^a
Vermicompost @ 10 t ha^{-1}	208.08^b	15.64^b	211.83^{ab}	21.53^b	2.48^{ab}	1.83^{ab}
Vermicompost @ 20 t ha^{-1}	215.50^c	21.48^c	222.25^b	24.42^c	2.66^b	1.89^b
Vermicompost @ 30 t ha^{-1}	221.08^d	24.19^d	229.08^b	27.52^d	2.73^b	1.95^c
CD(P=0.05)	4.73	2.26	16.83	2.38	0.29	0.053
Interaction CD(P=0.05)	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

Fig: 1: Effect of graded doses of inorganic and organic sources of nutrients on soil electrical conductivity of Tikhur

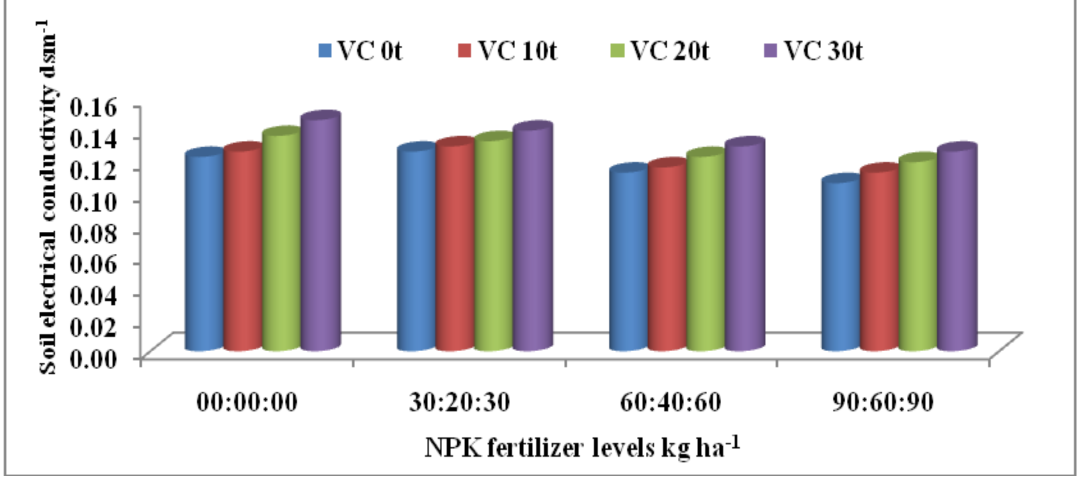


Fig. 2 : Effect of graded doses of inorganic and organic sources of nutrients on soil organic carbon of Tikhur

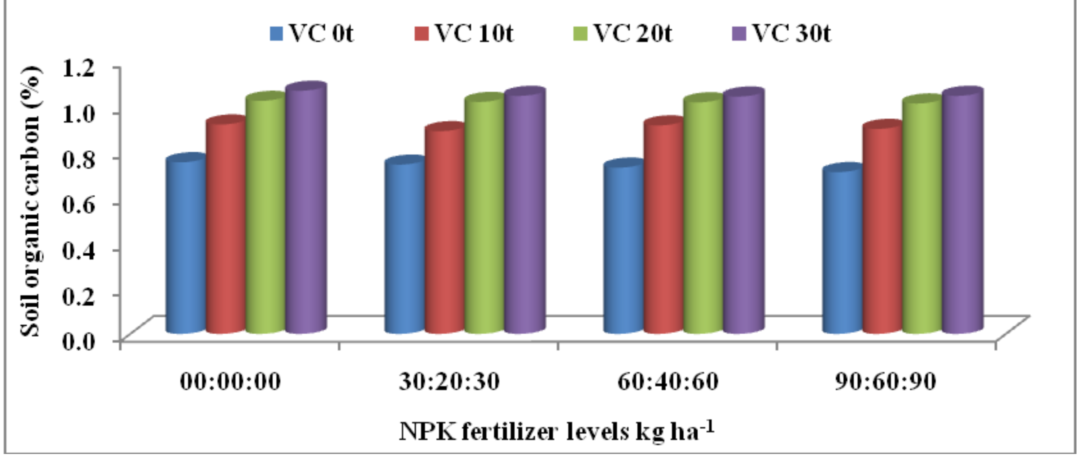


Fig. 3 : Effect of graded doses of inorganic and organic sources of nutrients on porosity of soil (%) of Tikhur.

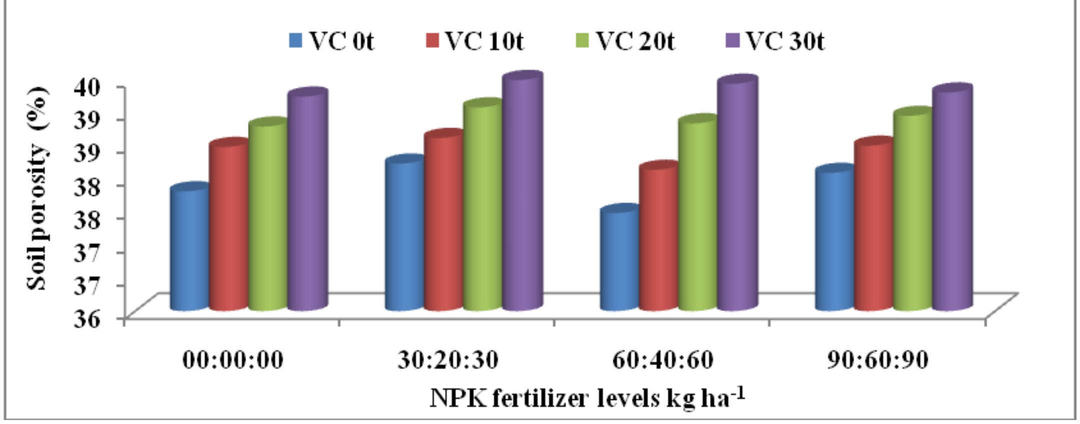


Fig. 4 : Effect of graded doses of inorganic and organic sources of nutrients on soil bulk density of Tikhur

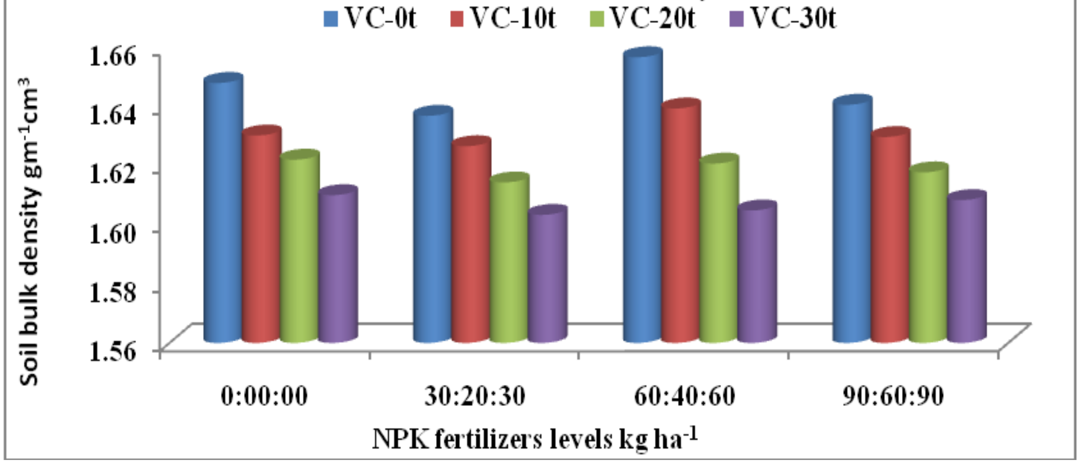


Fig. 5: Effect of graded doses of inorganic and organic sources of nutrients on soil cation exchange capacity of Tikhur

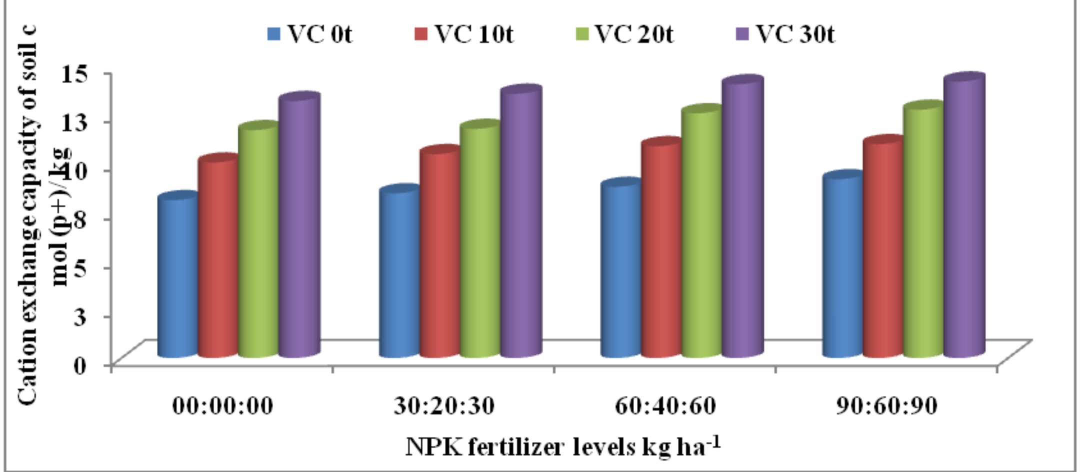


Fig. 6: Effect of graded doses of inorganic and organic sources of nutrients on soil available nitrogen of Tikhur

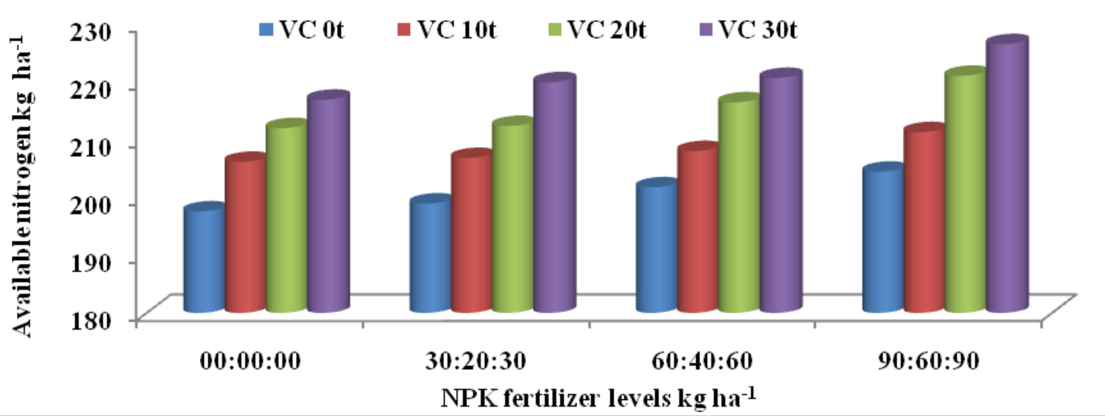


Fig. 7 : Effect of graded doses of inorganic and organic sources of nutrients on soil available phosphorus of Tikhur

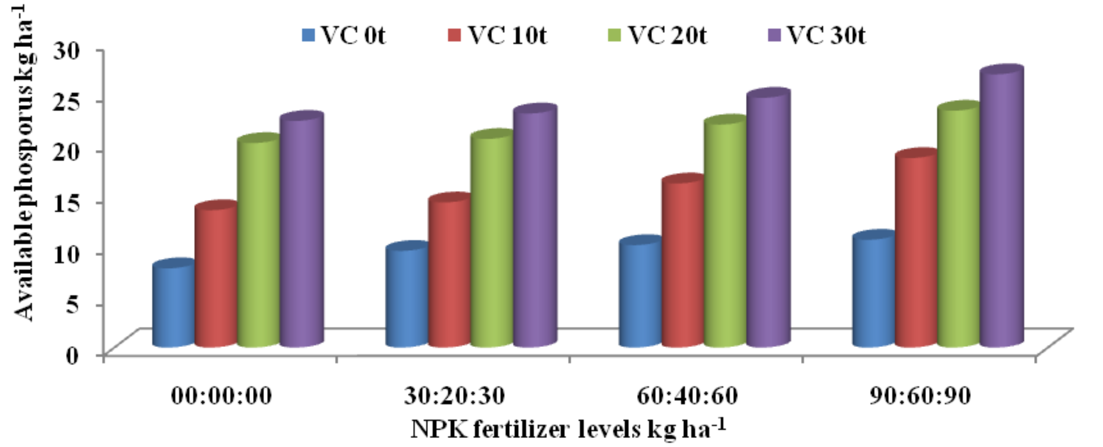


Fig. 8 : Effect of graded doses of inorganic and organic sources of nutrients on soil available potassium of Tikhur

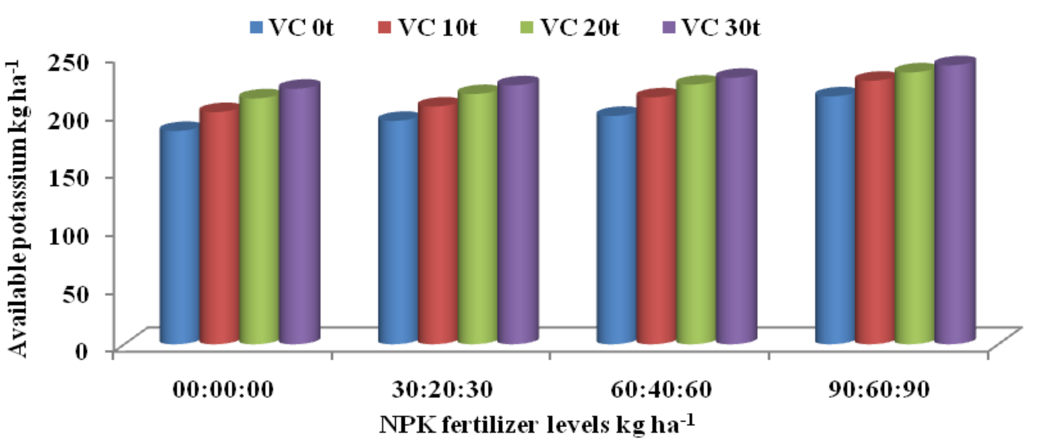


Fig. 9 : Effect of graded doses of inorganic and organic sources of nutrients on soil available sulphur of Tikhur

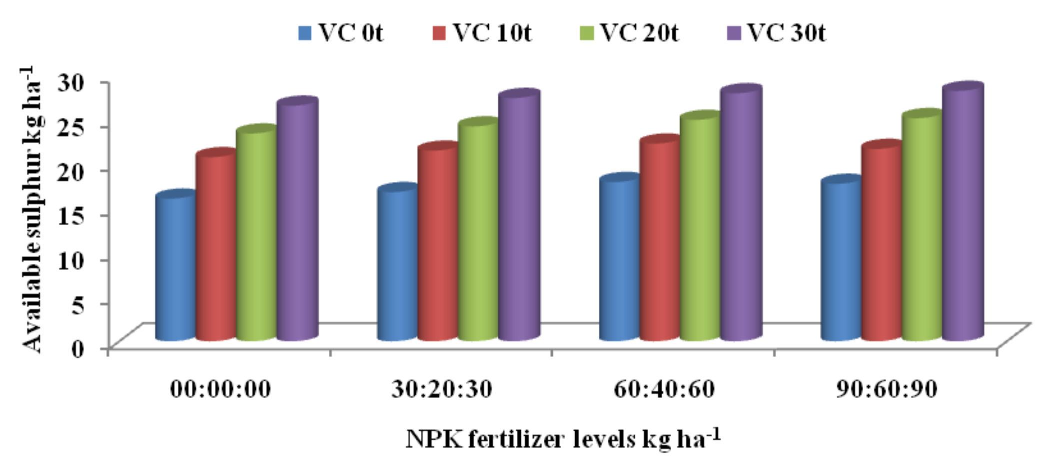


Fig. 10 : Effect of graded doses of inorganic and organic sources of nutrients on soil available calcium of Tikhur

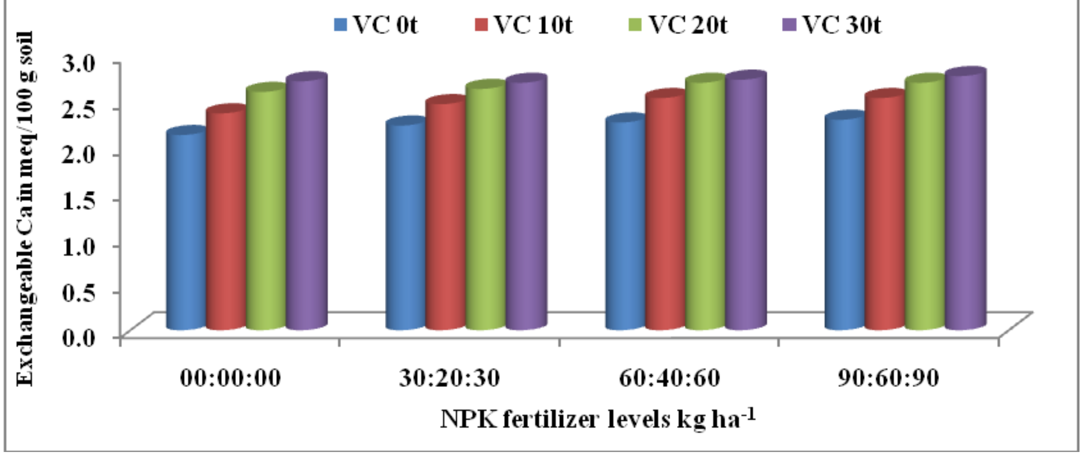
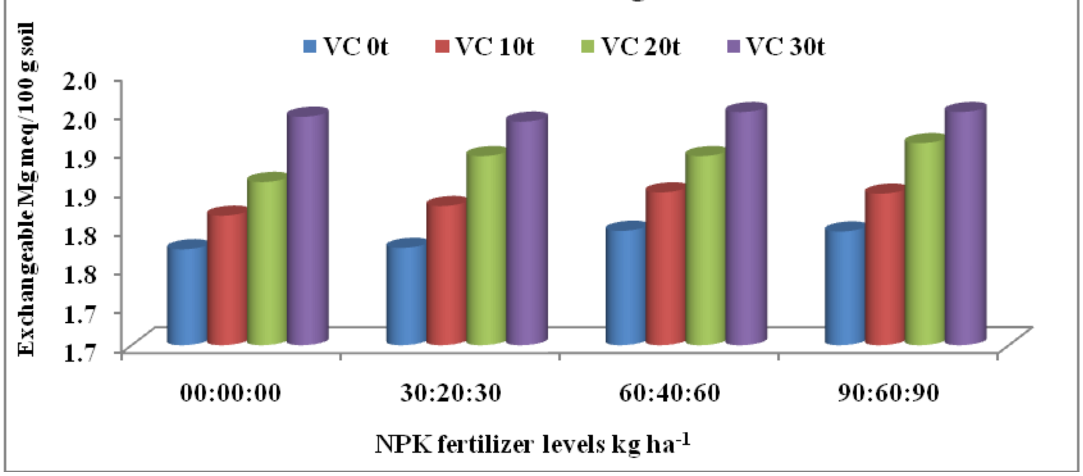


Fig. 11: Effect of graded doses of inorganic and organic sources of nutrients on soil available magnesium of Tikhur



Available phosphorus

The organic and inorganic nutrients had significant effect on soil available phosphorus (Table 3 and Fig. 7), however interaction effect of fertilizers with vermicompost was not found significant. The available phosphorus ranges from 15.94 to 19.87 kg ha^{-1} and 9.05 to 24.19 kg ha^{-1} with the highest under application of fertilizer @ $N_{90}P_{60}K_{90}$ kg ha^{-1} and vermicompost @ 30 t ha^{-1}, respectively. The effect of fertilizer levels @ $N_{90}P_{60}K_{90}$ kg ha^{-1} was significantly higher than $N_0P_0K_0$ and $N_{30}P_{20}K_{30}$ kg ha^{-1} but at par with $N_{60}P_{40}K_{60}$ kg ha^{-1}. Whereas, available phosphorus was increased significantly as we, successively, increased vermicompost levels from 0 to10, 10 to 20 and 20 to 30t ha^{-1}.

Available potassium

The organic and inorganic nutrients had significant effect on soil available potassium (Table 3 and Fig. 8), however interaction effect of fertilizers with vermicompost was not found significant. The available potassium ranges from 204.58 to 229.67 kg ha^{-1} and 197.33 to 229.08 kg ha^{-1} with the highest under application of fertilizer @ $N_{90}P_{60}K_{90}$ kg ha^{-1}and vermicompost @ 30t ha^{-1}, respectively. The effect of fertilizer levels @ $N_{90}P_{60}K_{90}$kg ha^{-1}was significantly higher than $N_0P_0K_0$ and $N_{30}P_{20}K_{30}$ kg ha^{-1} but at par with $N_{60}P_{40}K_{60}$ kg ha^{-1}. Whereas, available potassium was found significantly higher under vermicompost @ 30 t ha^{-1}as compare to vermicompost @ 0 and 10 t ha^{-1}and at par with 20 t ha^{-1}.

The similar findings were also recorded by Kolambe *et al.,* (2013) reported that soil properties influence by organic manures and bio-fertilizers under organic farming on elephant foot yam and the available N and K were not significantly affected due to the different treatments though these were slightly higher than the initial content. Suja and Sreekumar (2014) reported that organic plots showed significantly higher available K, by 34% and pH, by 0.46 unit and higher soil organic matter by 14%. Laxminarayana K. (2013) reported that integrated use of organics (FYM, neem cake, green manure) along with ½ NPK and lime increased the nutrient use efficiency, apparent nutrient recovery and available nutrient status of the soil in comparison to inorganics and organic manures.

Available sulphur

The data presented in (Table 3 and Fig. 9) revealed that organic nutrient had significant effect on soil available sulphur, however interaction effect of fertilizers with vermicompost was not found significant. The available sulphur ranges from 17.13 to 27.52 kg ha^{-1} with highest under application of vermicompost @ 30t ha^{-1}, which was significantly higher than 0, 10 and 20 t ha^{-1}.

Available calcium

The data presented in (Table 3 and Fig. 10) revealed that organic nutrient had significant effect on soil available calcium, however interaction effect of fertilizers with vermicompost was not found significant. The available calcium ranges from 2.23 to 2.73 meq 100 gm^{-1} with the highest under application of vermicompost @ 30 t ha^{-1}, which was significantly higher than 0 and 10t ha^{-1}and at par with 20 t ha^{-1}.

Available magnesium

The data presented in (Table 3 and Fig.11) revealed that organic nutrient had significant effect on soil available magnesium, however interaction effect of fertilizers with vermicompost was not found significant. The available magnesium ranges from 1.79 to 1.95 meq 100 gm^{-1} with the highest under application of vermicompost @ 30 t ha^{-1}, which was significantly higher than 0 and 10t ha^{-1}and at par with 20 t ha^{-1}.

The similar findings were also recorded by several workers. Ullah *et al.,* (2008) reported that organic matter content and availability of N, P, K and S in soil were increased by organic matter application. Srinivasan *et al.,* (2016) reported that exchangeable Ca level was significantly higher in the organic nutrient management treatments followed by the integrated nutrient management treatment, while the conventional nutrient management treatment registered a 53.0-65.0% lower exchangeable Ca level. Suja and Sreekumar (2014) reported that the exchangeable Ca, available Cu and Mn were higher by 12.39, 5.59 and 2.7% under organic management. Radhakrishan *et al.,* (2014) also reported exchangeable Ca and Mg were slightly favoured under organic practice.

The application of fertilizer @ $N_{60}P_{40}K_{60}$ kg ha^{-1} intikhur was found superior as its effect was at par with fertilizer @ $N_{90}P_{60}K_{90}$ kg ha^{-1} and significantly higher than other doses of fertilizer in case of soil cation exchange capacity, available nitrogen, available phosphorus and available potassium. Except soil electrical conductivity found highest under fertilizer @ $N_0P_0K_0$ kg ha^{-1} which was at par with $N_{30}P_{20}K_{30}$ kg ha^{-1}.

Vermicompost level @ 20 t ha^{-1} intikhur found superior as its effect was at par with vermicompost @ 30t ha^{-1} and significantly higher than other doses of vermicompost in case of soil electrical conductivity, soil bulk density, soil porosity, available potassium, available calcium and available magnesium. Except organic carbon, cation exchange capacity, available nitrogen, available phosphorus and available sulphur found highest in vermicompost @ 30t ha^{-1} which was found significant effect in all successive levels.

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