Introduction

Organic farming could be an option to ensure food, air, water, and soil quality leaving the environment safe for the present and future generation. Long term field experiments have made clear the negative impact of continuous use of chemical fertilizers on soil health (Yadav,2003). Meeting the domestic food requirement has been the foremost social priority for India since independence. Vegetables play vital role in the health and nutrition of people. The food experts and nutritionists have realized and appreciated the food value of vegetables because of its low calorific value, high content of proteins, vitamins, and minerals. Hence, vegetables are the most essential crops in organic farming systems. India has vast potential of manurial resources. Farm yard manure and poultry manure are the most commonly used organic manures by the farmers in Kerala, the most southern State of India. Poultry manure is a rich source of nutrients especially for vegetable production. Vermi compost, which is produced by disintegration of organic matter by earthworms, contain high amount of nutrients, hormones, and enzymes, and has stimulatory effect on plant growth. Among the various vegetable crops grown in Kerala, cowpea occupies a prime position because it is an important protein source. Hence, studies have been carried out in cowpea (*Vigna unguiculata* subsp. *sesquipedalis* (L.) Verdcort*)* in order to monitor the changes in soil health, yield, and quality of crops under organic farming.

Materials and methods

Field experiments have been conducted at the College of Agriculture, Vellayani to evaluate the impact of organic farming practices over inorganic farming on soil fertility, yield, and quality of crops using cowpea as test crop for two seasons. Vellayani is located at $8^0$30' N latitude and 76^0 54' E longitudes and at 29m above msl. The mean maximum and minimum temperatures that prevailed during the cropping period were 34.63^0 C and 20.21^0 C respectively. The mean relative humidity was 81.74%. The mean rainfall of the location is 1293 mm and the place experiences a humid tropical climate. The soil of the experiment site belongs to the soil taxonomic class loamy skeletal kaolinitic isohyperthermic rhodic haplustult. The experiments were laid out in randomized block design with eight treatments and three replications. The treatments consisted of: **T_1:** Full recommended dose as per package of practices recommendation (20 kg N ha^{-1}, 30 kg $P_2O_5 ha^{-1}$ and 10 kg K_2O ha^{-1} with 20 t FYM ha^{-1}); **T_2**: Full recommended dose as farm yard manure; **T_3**: Full recommended dose as FYM + P solubilizing microorganisms; **T_4:** Full recommended dose as Vermi compost; **T_5:** Full recommended dose as Vermi compost + P solubilising micro organisms; **T_6:** Full recommended dose as poultry manure; **T_7:** Full recommended dose as poultry manure + PSM; **T_8:** Inorganic alone (20 kg N ha^{-1}, 30 kg P_2O_5 ha^{-1} and 10 kg K_2O ha^{-1}). Farmyard manure, vermicompost and poultry manure were applied on the N content basis and additional requirements of P and K were met through application of rock phosphate and ash according to treatments. Phosphorus solubilizing micro organisms consisted of a mixture of *Pseudomonas, Aspergillus and Azospirillum*. Phosphorus solubilizing micro organisms @1 g plant $^{-1}$ was applied in T_3, T_5 and T_7 treatments. Entire P and K were applied basally and half the recommended N as basal and rest after two weeks of planting for all the treatments. Lime has been applied to all treatments at 250kg ha^{-1} in order to correct the acidity problem. Phosphorus fixation by Fe and Al oxides is a problem in this soil. Hence P solubilizing micro organisms were used along with organic manures. For this experiment variety Sarika was used which is a trailing vegetable type with duration of 100 days. Soil analyses and plant analyses were carried out using standard procedures outlined by Jackson (1973), Black et al (1965) and Page et al (1982).

Results and Discussion

Soil fertility

All the soil (0-20 cm depth) physical properties like bulk density, water holding capacity, porosity, and soil temperature were found to be significantly influenced by organic nutrition (Table .1)

Table 1. Effect of organic farming practices on soil physical properties.

Treatments	Bulk density ($Mg\ m^{-3}$)	WHC %	Temperature ^0C	Porosity %
T_1	1.41	35.84	31.26	44.00
T_2	1.35	36.54	30.13	44.70
T_3	1.34	35.83	30.33	44.87
T_4	1.32	41.70	29.40	48.00
T_6	1.34	37.30	30.53	45.30
T_7	1.33	37.43	30.43	44.97
T_8	1.48	30.13	32.73	41.13
SE	0.01	0.59	0.15	0.32
CD (0.05)	0.03	1.79	0.47	0.98

In all the cases, vermicompost application (T_4 & T_5) has been found to be superior. According to Brady (1996), organic matter is the major component that stimulates the formation and stabilization of granular and crumb type of aggregates. As organic residue decompose organic acids, sugars, mucilaginous substances, and other viscous microbial byproducts are evolved. Which, along with associated fungi and bacteria, encourage the crumb formation and net effect of these activities will decrease bulk density and increase porosity as reported by Loganathan (1990). Higher organic matter addition could increase organic carbon content of the soil which resulted in an increased water holding capacity of the soil. The humus can absorb water two to six times its own weight. Soil organic matter is responsible to a great extent, directly or indirectly for making the physical environment of the soil suitable for the growth of crops. It exerted this benefit largely through its effect on improving soil aggregation and porosity, which in turn influenced soil structure, water infiltration, moisture conservation, drainage, aeration, temperature, and microbial activities. The treatments with vermicompost application registered superior values for all the soil chemical properties like pH, cation exchange capacity, organic carbon, and C/N ratio (Table.2). The increased level of organic carbon is a good indication of better carbon sequestration in soil by reducing the amount of CO_2 released to the atmosphere.

Table 2. Effect of organic nutrition on soil chemical and biological properties.

Treat-ments	pH	Organic Carbon (%)	CEC (cmol $P^+ kg^{-1}$)	C:N ratio	Available nutrients kg ha^{-1}			Dehydrogenase (µg TPF g $soil^{-1}$ $24hr^{-1}$)	Phosphatase (µg P nitro phenol g $soil^{-1}hr^{-1}$)
					N (Alkaline permanganate method)	P (Bray No.1 extraction & colorimetry)	K (NN NH_4 OAC extraction and flame photometry)		
T_1	5.53	0.61	2.94	10.17	238	25	141	204.67	76.33
T_2	5.51	0.66	3.51	12.20	241	30	144	236.67	81.93
T_3	5.51	0.67	3.37	12.03	261	33	149	231.00	91.00
T_4	6.31	0.78	4.97	9.97	296	37	175	301.00	115.83
T_5	6.33	0.78	5.02	9.97	308	39	171	310.67	135.70
T_6	5.62	0.56	3.78	10.03	237	32	163	238.67	76.07
T_7	5.62	0.58	3.70	10.00	254	34	160	244.30	81.13
T_8	5.30	0.50	2.54	10.13	188	22	122	150.00	39.07
SE	0.04	0.02	0.06	0.25	7.86	0.59	3.88	10.12	3.19
CD (0.05)	0.13	0.05	0.18	0.76	23.85	1.80	11.76	30.71	9.68

Organic matter addition significantly enhanced the nutrient availability of the soil. Available N, P, K, Ca, Mg, Mn, Zn and Cu were increased by vermicompost application. Sulphur availability was found to be increased in poultry manure treated plots. Organic nutrition also enhanced the soil enzyme activities like dehydrogenase and phoshpatase.

The observed pH increase was due to the suppression of the activity of Fe & Al oxides and hydroxides, which played a vital role in protonation - deprotonation mechanism, controlling H^+ ion concentration in soil solution. The higher value of vermicompost treated plots was due to the fact that because of the excretion of NH_4^+ ions from calciferous glands of earthworms, the worm casts had a pH near to neutral range (Baskar etal 1994). Among the various treatments receiving organic manure, T_5 and T_4 recorded top most values for organic carbon. The general decreasing C: N ratio observed in organic treatment helped for higher release of nutrients. A typical value of CEC of humic colloids is of the order of 200-250 cmol $(p^+)kg^{-1}$ (Sanyal, 2002). Vermicompost with higher amount of active humic fraction having high CEC had thus resulted in maximum enhancement of this parameter. Treatments receiving vermicompost are significantly superior in providing available N, P, K Ca, Mg, Mn, Zn and Cu. Vermi compost had a higher urease activity than soils and other compost materials (Bremner & Mulvaney 1978). The process of aminization, amonification, and oxidative de aminisation brought about by microbially mediated enzyme systems are active in vermi compost and other organic amendments, thus contributing more of soluble N. The high microbial activity and enhanced mineralization of soil P coupled with high phosphatase activity are the reasons for high Bray extractable P. K^+ ions from edge, wedge, or inter layer sites within clay minerals, could possibly be replaced by NH_4^+ ions of similar ionic radius, so the concentration of which was increased in the presence of vermi compost. The enzyme assay also indicated the significance of organic nutrition over inorganic. Dehydrogenase activity had been commonly used as indicator of biological activity in soils because of its occurrence only within living cells, unlike other enzymes which can occur in an extra cellular state. The change in dehydrogenase activity corresponds more closely to microbial biomass generated through an enhanced microbial activity rather than direct nutritional or amendment effect (Burns 1982). The superiority of vermi compost from other organic

amendments in exhibiting a higher phosphatase activity was due to the higher microbial load that vermi compost supports.

Yield and quality of crop

The details on yield and quality of crop is presented in Table 3

Table 3: Effect of organic nutrition on yield and quality of Cowpea

Treatments	Pod yield kg ha^{-1}	Bhusa Yield (Total shoot weight) kg ha^{-1}	Protein content (%)	Fibre content (%)	Shelf life (days)	Palatability (Score - 4 point scale)
T_1	3708	8580	25.9	11.6	4.7	2.3
T_2	3403	9236	23.1	10.2	5.7	2.7
T_3	3476	9376	23.1	10.0	5.3	2.7
T_4	3590	9450	26.7	8.7	6.3	3.3
T_5	3606	9600	26.7	8.5	6.3	3.7
T_6	3450	9400	24.0	9.4	4.3	4.0
T_7	3496	9413	22.5	9.3	5.3	3.7
T_8	2866	8090	17.1	15.67	4.3	1.7
CD	38.78	60.10	0.72	1.04	0.27	0.31
SE (0.05)	118	182	2.2	3.15	0.81	0.93

The results of pod yield showed that the treatments with integrated nutrient application (T_1) and vermi compost treatments (T_4 and T_5) were found superior to all other treatments. The treatments with POP recommendation (T_1) got the highest value and were found to be on par with T_4 and T_5. The data also showed the significance of organic nutrition (pure or integrated approach) and made clear that inorganic fertilizer alone was ineffective in enhancing yield of crop. The higher yield for vermi compost compared to the other organic treatments was due to better soil properties, enhanced nutrient availability and better uptake of nutrients. The bhusa yield showed that the vegetative growth was high in organic treatments when compared to integrated and inorganic. The release of N from organic manures through out the growing period might have contributed to considerable vegetative growth of the crop. It was observed that there was an increase of 56.14% for protein in Vermicompost treated plots when compared to inorganic alone treatment. The highest protein content (26.7%), lowest fibre content (8.5%), highest keeping quality (shelf life – 6.3 days) and best taste (palatability – score 4.0) were recorded by organic nutrition especially vermi compost application.

Organic nutrition is good for sustaining soil fertility and quality of produce but a slight reduction may occur in the total yield of crops. For preventing soil degradation organic farming is the best remedy. Soil organic matter is the major active reservoir of carbon, which prevents build up of CO_2 concentration in the atmosphere. If sufficient organic manures are available, organic farming is advisable for environmental safety and human health.

References

Basker A, Kirkmon JH, Macqrger AN. 1994 Changes in potassium availability and other soil properties due to soil ingestion by earthworms. *Biol Fertil. Soils* 17: 154-158

Black CA, Evans DD, Ensminger LE, White JL, Clark FE. 1965. *Methods of soil Analysis*. Part I. American Society of Agronomy Inc., Madison, USA, 1569 p.

Brady NC. 1996. The nature and properties of soils. Tenth edition. Prentice Hall of India Pvt. Ltd. *Agron.J.* 54:464-465

Bremner JM, Mulvaney RL. 1978. Urease activity in soils. *Soil Enzymes*. Academic Press, London, pp 149-196

Burns RG. 1982. Enzyme activity in soil, location and possible role in microbial ecology. *Soil Biol. Biochem*. 14:423-427

Jackson ML. 1973. *Soil Chemical Analysis*. Second edition. Prentice Hall of India Pvt. Ltd., New Delhi, p 498

Logananthan S. 1990. Effect of certain tillage practice and amendments on physico chemical properties of problem soil. *Madras agric.J* 77:204-208

Page AL, Miller RH, Keeney DR. 1982. *Methods of Soil Analysis Part 2. Chemical and Microbiological Properties.* American Society of Agronomy, Inc., Madison, Wisconsin, USA, 1159p.

Sanyal SK. 2002. Soil Colloids. *Fundamentals of Soil Science* (eds. Sekhon, G.S., Chhonkar, P.K., Das, D.K., Goswami, N.N., Narayanasamy, G., Poonia, S.R., Rattan, R.K. and Sehgal, J.). Indian Society of Soil Science, New Delhi, pp. 229-260.

Yadav JSP. 2003. Managing soil health for sustained high productivity. *J. Indian Soc*. Soil Sci. 51 (4):448-465.