International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Impact Factor (2012): 3.358

Comparative Studies on the Soil Health Due to Application of Different Manure Combinations

Chandrashekar.B[1], Dr. K. S. Lokesh[2], Dr. D. Istalingamurthy[3]

[1]Former Post Graduate Student, Department of Environmental Engineering, S. J. C. E, Mysore, Karnataka, India

[2]Dr. K. S. Lokesh, Professor & Head and Mellon Scholar (USA),
Department of Environmental Engineering, S. J. C. E, Mysore, Karnataka, India

[3]Dr. D. Istalingamurthy, Professor, Department of Environmental Engineering, S. J. C. E, Mysore, Karnataka, India

Abstract: ***Agriculture is the main occupation in India. Fertilizers are the key inputs in agricultural production and excess uses lead to agricultural pollution. Under these circumstances, India needs a second green revolution based on environmentally safe technology. In the present study, an attempt was made for the comparative study of soil health along with the cultivation of Ring bean in a Randomized block design (RBD) comprising of four treatments with five replications. The combination of W+CF and V+CF has improved the soil health in terms of organic carbon, organic matter, and availability of NPK in soil at different depths. Significant improvement in WHC of soil was observed in the application of H+CF followed by the V+CF options. Combination of organic manure with chemical fertilizer is the better substitute to commercial fertilizers alone. Maximum physical growth of Ring bean plant has been recorded in the chemical fertilizer applied options which are due to the immediate availability of nutrients from the chemical fertilizers. V+CF followed by W+CF shows the improvement in the dry weight of the crop. H+CF followed by V+CF produces more seed yields compared to chemical fertilizer. H+CF and V+CF were found to be good to increase the productivity of yield by 40% and 30% over chemical fertilizer. The residual nutrient content in harvested plant was slightly high in the combination of W+CF. The cost benefit analysis has shown higher benefits V+CF and H+CF followed by other manure combinations. In column studies, the fertilizer applied column has recorded higher rate of percolation of nutrient when compared with other manure combinations***

Keywords: Humanare (H), Wellgrosoil (W), Vermicompost (v), Chemical fertilizers (CF).

1. Introduction

Environmental degradation is a major threat confronting the world, and the rampant use of chemical fertilizers contributes largely to the deterioration of the environment through depletion of fossil fuels, generation of carbon dioxide (CO_2) and contamination of water resources. It leads to loss of soil fertility due to imbalanced use of fertilizers that has adversely affected agricultural productivity and causes soil degradation. Now there is a growing realization that the adoption of ecological and sustainable farming practices can only reverse the declining trend in the global productivity and environment protection

On one hand tropical soils [8] are deficient in all necessary plant nutrients and on the other hand large quantities of such nutrients contained in domestic wastes and agricultural byproducts are wasted. Hence application of bio fertilizers [20]& [31] as a component of organic cultivation is an exciting area for enhanced crop production and suggested as an alternative control measure for mitigation of environmental pollution.

To analyze the changes in soil health when various organic manure and chemical fertilizers combinations applied in twenty plots of equal dimensions were considered. To cross check the results and to find the better alternative, a type of crop namely Ring Bean, a leguminous crop was grown in each of twenty plots with different options for each plot.

2. Material and Methodology

The field studies were conducted on Ring Bean in an area of 2000 sq-ft in a Randomized Block Design (RBD) consisting of four treatment viz. three different Organic manure sources with chemical fertilizer and chemical fertilizer alone (H+CF, W+CF, V+CF and CF) with five replications each, where only tobacco crop was grown for the past two decades. The crops grown and the quantity of seeds sown on the plots with the spacing are as per standard Agricultural practices. Sowing of seed was done during month of February and crops were harvested by mid of March. The physico-chemical properties of soil at three different depths like 0-150mm, 150-300mm and 300-450mm depth were studied prior to studies and for every ten days of interval land also ten days after harvesting. Physical growth and crop yield was also compared. Column studies were also carried out by scaling down the quantities applied to the field.

2.1 Soil Sampling

Soil sample are took randomly from many places in the field in three different depths. Quadrate method is used in preparing sample. For analyzing physico-chemical parameters like Bulk Density, Field density, Specific Gravity, Moisture content, WHC and chemical parameters like pH, Electrical conductivity, Organic carbon, Soil Total Nitrogen, Phosphates, and Potassium was determined as per the procedure mentioned in [12]&[27].

2.2 Plant and Manure Analysis

Above analysis is done by noting average leaf length, width and average height is noted for top third leaf dimensions of the 25 plants in each plot at 45th day. Average dry weight of plant is noted by taking initial and final reading on electronic balance and dried for two days and re-weighted. Average percent of organic matter present is determined and yield of the crop is measured by harvesting the crop and was dried in sunlight for two days in the respective plots and the cereals from the crop were separated after ensuring complete dryness, then cereals were weighed in an electronic balance to note the yield. The obtained yield from 100 sq-ft is then computed for hectare. The nutrient content in the manures was analyzed for its Total nitrogen, Phosphorus, Potassium following [9] &[27].

2.3 Column Studies

Two glass columns of 250 mm long placed one above the other with 125 mm inner diameter, and 3 mm thickness mounted vertically on the brick. A plastic mesh with an effective core diameter of 60 µm was sealed to the inner side of the reducing collar of each column to prevent displacement of the soil from the columns and to minimize the dead end volume. Provision was also made for the collection of leachate at every 150 mm interval by providing nozzles. The overhead tanks were installed to facilitate the constant head flow condition

The agricultural subsoil collected at every 150 mm depth was repacked and compacted accordingly in the two columns up to a depth of 450 mm. All leaching soil column experiments were conducted at room temperature. Prior to the application of the simulated solutions, the column was saturated with distilled water for a period of 15 days to reduce the interference of any background concentration of the nutrients in the soil by maintaining a flooding depth of 30 – 50 mm .The initial background concentration of nitrate and phosphate were noted before applying the manures to the columns and nitrate and phosphate were analyzed regularly

3. Results and Discussions

3.1 Initial Physico-chemical soil properties

The soil properties at various depths before sowing were carried out and tabulated in table 3.1 and Initial percent nutrients in different manures before applying (NPK) is shown in the table 3.2.

Table 3.1: Physico- Chemical Properties of Soil

Parameters	*Depths in mm*		
	Physical Properties		
	0-150	*150-300*	*300-450*
Type of soil	Sandy loam soil		
Bulk Density (g/cc)	1.34	1.25	1.26
Specific Gravity	1.32	1.31	1.32
Moisture content (%)	3.43	3.90	4.32
WHC-Water Holding Capacity	62.9	64.6	61.2
	Chemical Properties		
pH	6.73	6.88	6.68
Electrical conductivity	0.059	0.041	0.039
Organic Carbon (%)	0.06	0.06	0.17
Organic matter (%)	0.10	0.10	0.29
Total Nitrogen (kg/ha)	116.0	86.0	63.0
Phosphorus (P_20_5) (kg/ha)	32.02	19.4	13.72
Potassium as (K_20) (kg/ha)	187.1	174.7	183.67

Table 3.2: Percent Nutrients in Different Manures

Different manures	Nitrogen (%)	Phosphorus (%)	Potassium (%)
Humanure	1.52	0.50	1.00
Wellgro-soil	1.60	0.25	0.89
Vermicompost	1.70	0.70	0.90
Chemical fertilizer			
DAP	18.00	46.00	0.00
SSP	0.00	16.00	0.00
MOP	0.00	0.00	0.00

3.4 Soil Properties of Plot before Sowing and after Harvesting Crop

3.4.1 Total Nitrogen at Various Depths

Figure 3.1 shows that, at 0-150mm depth the Total nitrogen content in soil is very high for the combination of W+CF followed by V+CF, at 150-300mm depth (fig.3.2) Total nitrogen content was slightly higher in Chemical fertilizer treatment when compared to organic manure combinations, this may be due to leaching from top layer to middle layer, at 300-450mm depth (fig.3.3) Total nitrogen content value of V+CF applied treatment plot was at par with other treatments.

3.4.2 Phosphorus as P_2O_5 at Various Depths

Figure 3.4 shows that at depth of 0-150mm, the P_20_5content in soil is high for combination of V+CF when compared with other treatments till the 60th day; since Vermicompost contains maximum phosphorus when compared with other manures. At 150-300mm depth, the combination of V+CF treatment was at par with other treatments and at 300-450mm depth, every treatment follows one another.

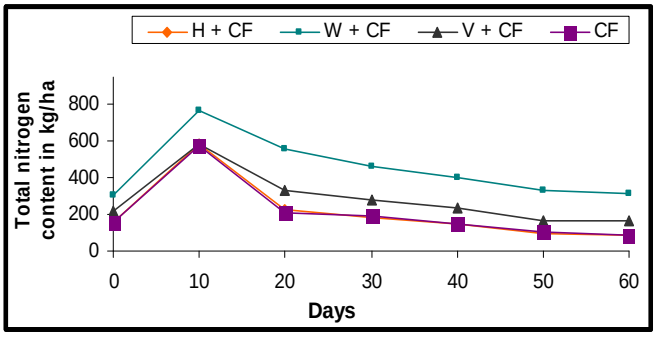

Figure 3.1: Total Nitrogen Content at 0-150 mm depth

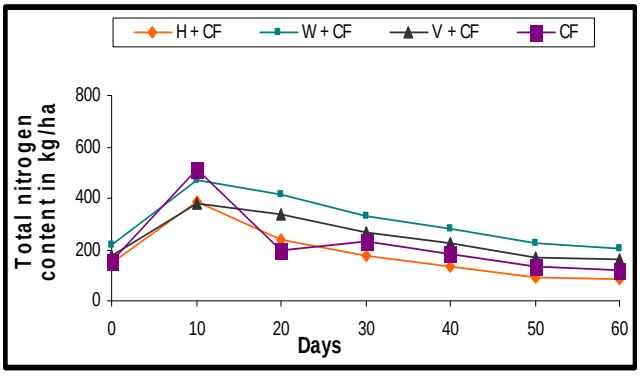

Figure 3.2: Total Nitrogen Content at150-300 mm depth

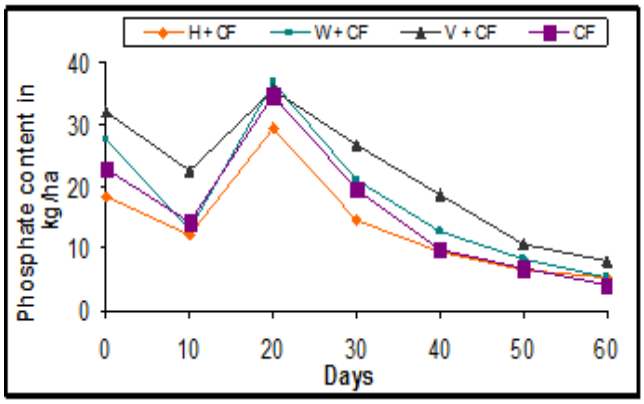

Figure 3.3: Total Nitrogen Content at 300-450 mm depth

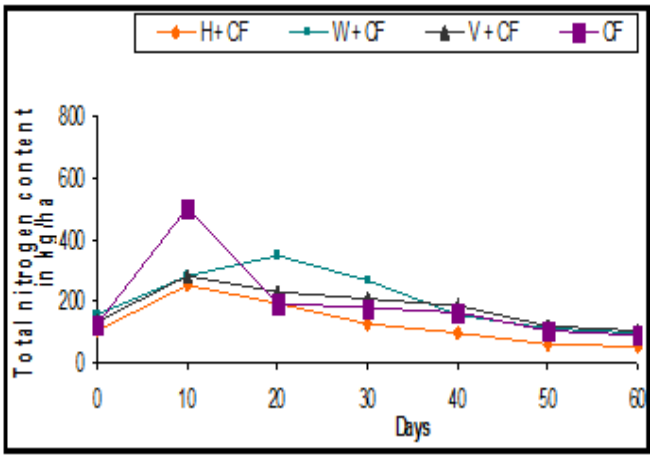

Figure 3.4: Phosphate as P_2O_5Content at 0-150 mm depth

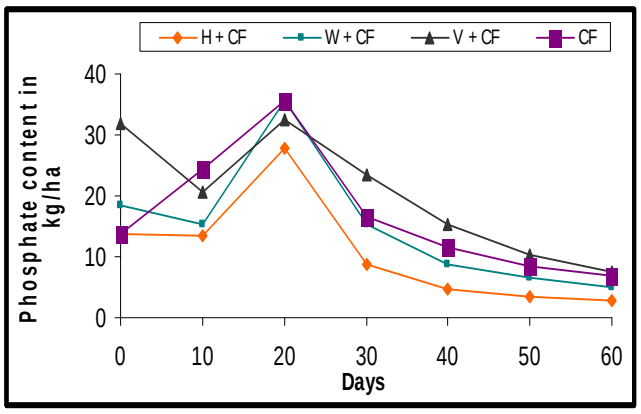

Figure 3.5: Phosphorus as P_2O_5 Content at150-300 mm depth

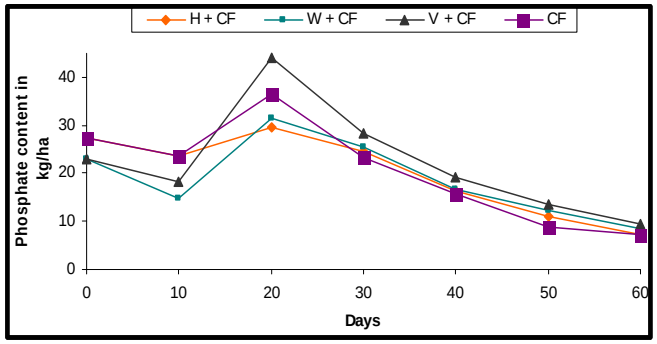

Figure 3.6: Phosphorus as P_2O_5 Content at 300-450 mm depth

3.4.3 Potassium as K2O at Various Depths

It is evident from the Fig. 3.7 that at a depth of 0-150 mm of soil, the "K" content is slightly superior in the combination of W+CF compared to other treatments and lower in CF treatment due to immediate availability of potassium for plants. In Figs. 3.8 and 3.9 at soil depths of 150-300 and 300-450 mm there is not much significant variation, where the entire trend follows similar trend as observed above.

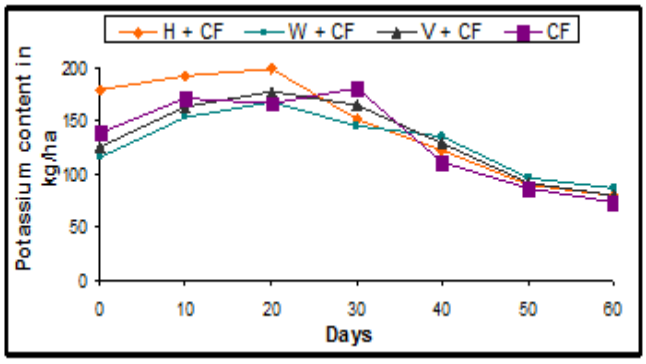

Figure 3.7: Potassium as K_2O Content at 0-150mm depth

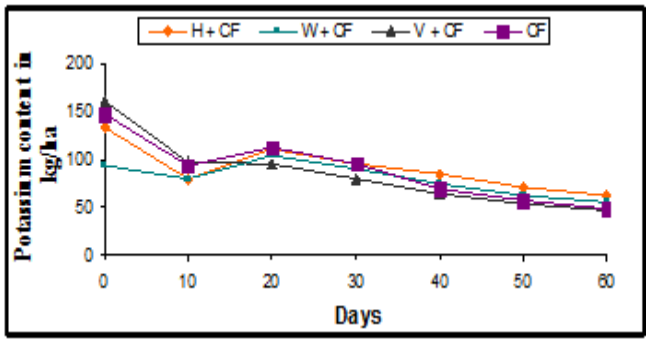

Figure 3.8: Potassium as K_2OContent at 150-300mm depth

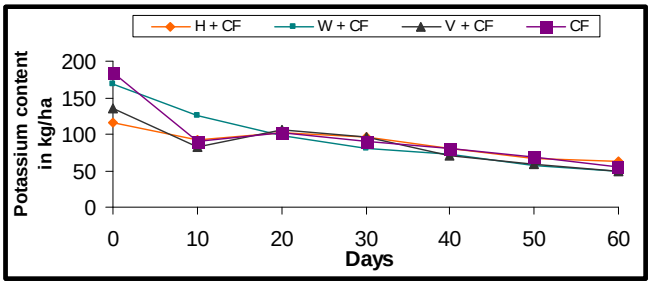

Figure 3.9: Potassium as K_2O Content in 300-450 mm depth

3.4.4 % of Organic carbon content at Various Depths

The percentage of organic carbon content at a soil depth of 0-150 mm was found to be high in plots of W+CF combination which was at par with V+CF combination (Fig. 3.10). At depth of 150-300mm (fig 3.11), improvement of organic carbon was seen in W+CF and V+CF combinations. At the depth of 300-450mm (fig 3.12) combination of W+CF was at par with other treatments thus improved the carbon content hence the fertility.

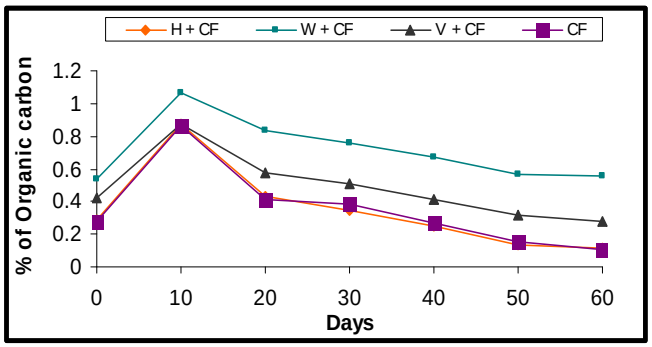

Figure 3.10: % of Organic carbon content at 0-150mm depth

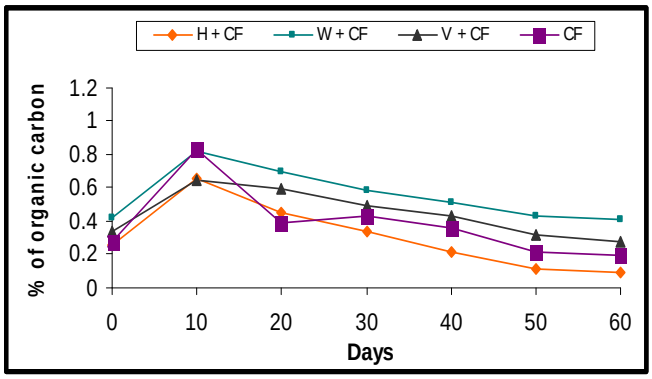

Figure 3.11: % of Organic Carbon content at 150-300 mm depth.

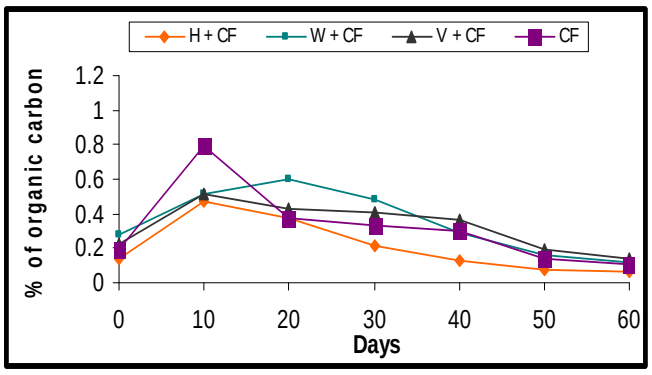

Figure 3.12: % of Organic carbon content at 300-450mm depth.

Figure 3.13 indicates that, at depth of 0- 150mm (fig 3.13) the WHC increases for combination of H+CF which was at par with other treatments. At depth of 150- 300mm (fig 3.14), the WHC increases for H+CF which was at par with V+CF combinations and also it decreases gradually for chemical treatments. At 300-450 mm (fig 3.15) depth of soil, the WHC (%) slightly increases with time for combination of V+CF followed by W+CF options.

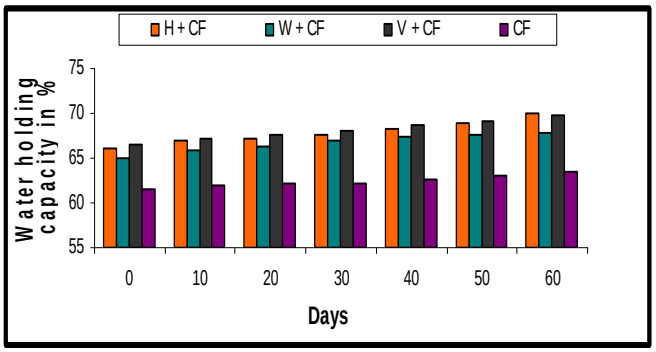

Figure 3.13: % of water holding capacity at 0-150 mm depth

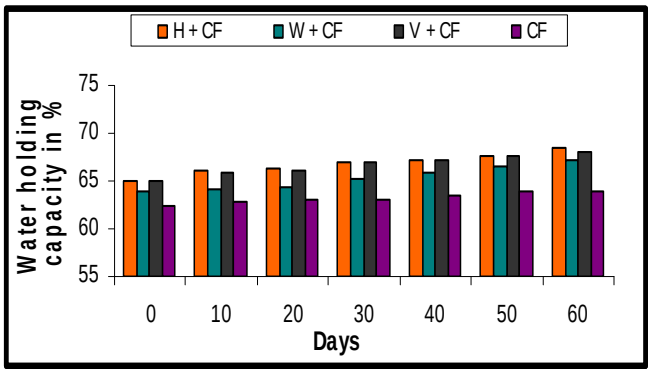

Figure 3.14: % of Water holding capacity at 150-300 mm depth.

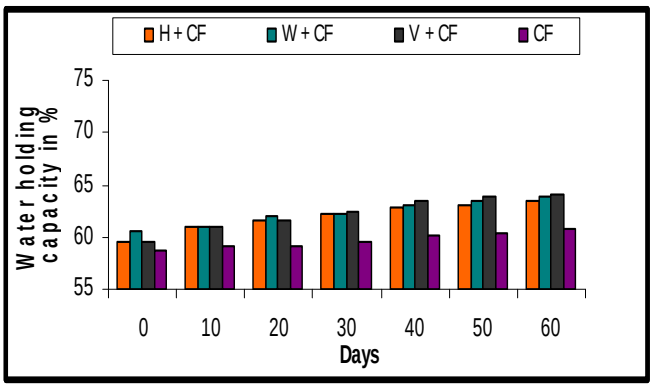

Figure 3.15: % of Water holding capacity at 300-450 mm depth.

At 0-150mm percentage of Organic matter was found to be high in plots where the W+CF combination was applied (Fig.3.16). This is due to the availability of more organic carbon and Total Nitrogen when compared to other treatments. At150-300mm depth (fig 3.17), Organic matter was high in W+CF followed by V+CF. Similar trend was found in 300-450mm depth also (fig 3.18).

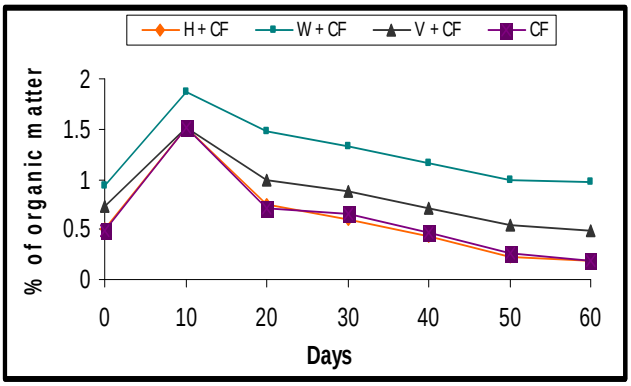

Figure 3.16: % of Organic matter content at 0-150 mm depth

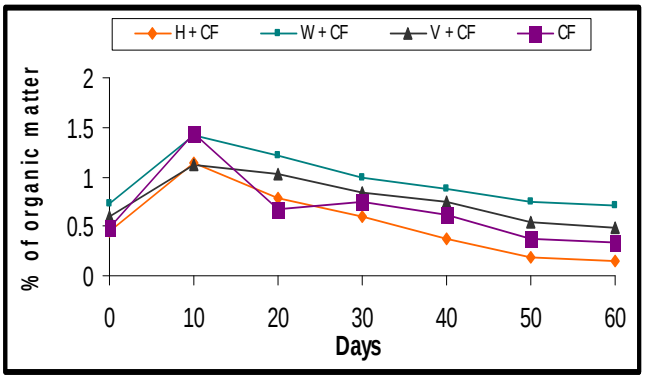

Figure 3.17: % of Organic matter content at 150-300 mm depth.

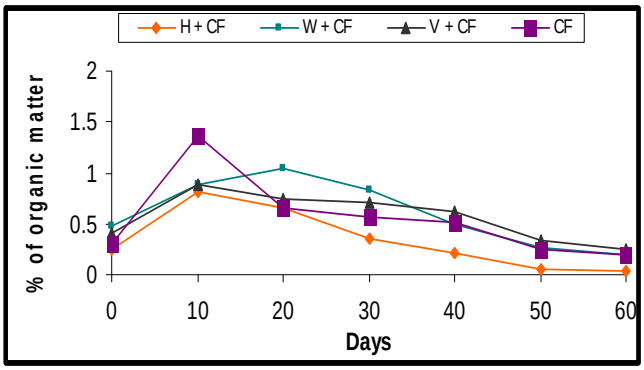

Figure 3.18: % of Organic matter content at 300-450 mm depth.

3.5 Physical Growth, Dry weight, % of Organic matter, Observed &Estimated the crop

The Physical growth of the Ring Bean was monitored and found to be slightly higher in the plot where chemical fertilizer alone was applied (Fig. 3.19). This is due to the immediate availability of nutrients from the fertilizer to the growing plants. The combination of W+CF. W+CF and V+CF improved the dry weight of the crop because of better supply of all the nutrients including NPK in sufficient quantity for the crop to absorb(Fig 3.20). The organic matter monitored has shown higher trends in the plots of H+CF combination, this combination has given maximum yield with enhanced crop quality (Fig. 3.21).

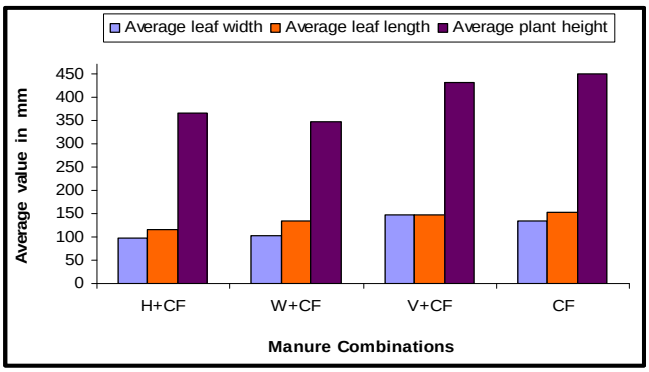

Figure 3.19:Physical growth of the crop

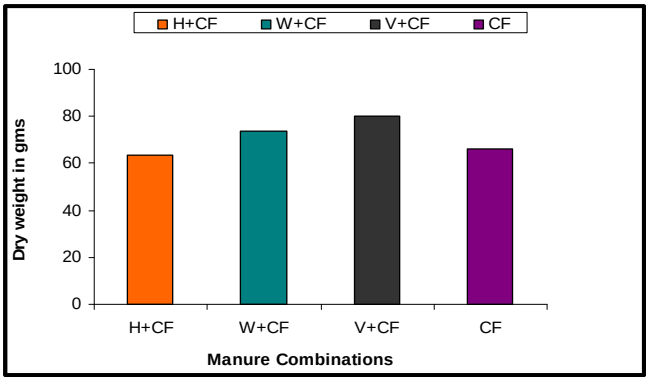

Figure 3.20: Dry weight of the crop.

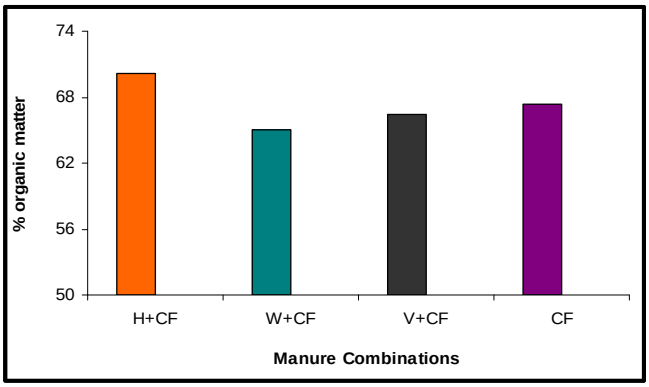

Figure 3.21: % of Organic matter in crop.

The plot applied with H+CF combination has the highest seed yield followed by the combination of V+CF option (Fig 3.22). It may be due to the higher availability of nutrients from the sources for the crop growth. It can be seen that over a period of time, the combination of organic manure and Inorganic manure will be able to give a much higher yield per hectare.

The percentage increase is high in the plots applied with the combination of H+CF and V+CF. A consistent increase in the yield has been recorded. These two sources were found to be good organic sources for increasing the productivity of Ring Bean while H+CF increased the yield by 40 % whereas V+CF increased the yield by 30 % over CF alone (Fig 3.24).

It is observed that in (fig 3.25), Residual nutrient (%) content in plant samples applied with W+CF combination was slightly at par with other treatments. Hence it is concluded that using the combination of Organic manure with inorganic in place of chemical fertilizer is appropriate to maintain soil health and yield of the crop.

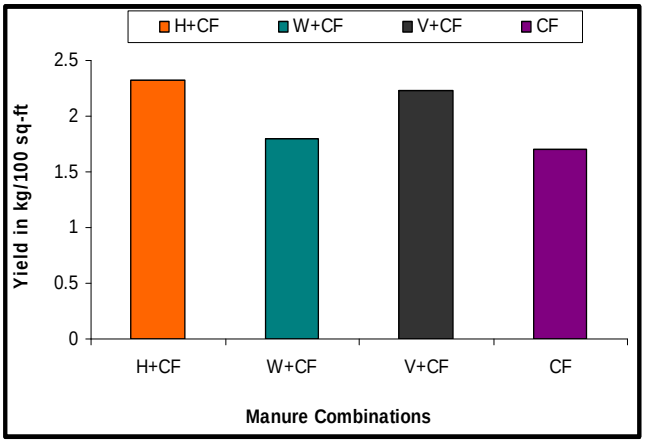

Figure 3.22: Observed Yield of the crop

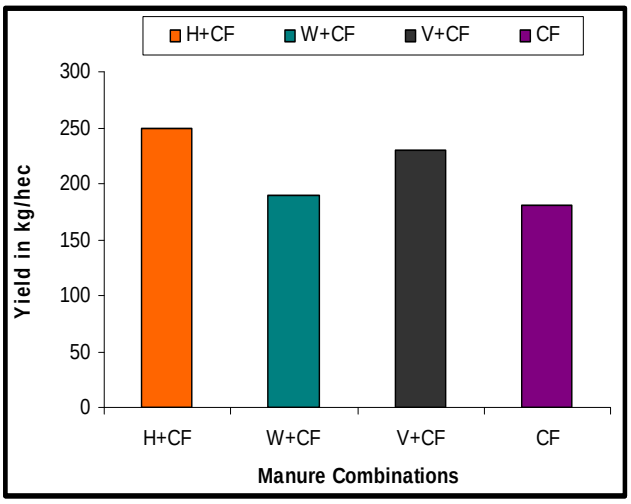

Figure 3.23: Estimated yield of the crop.

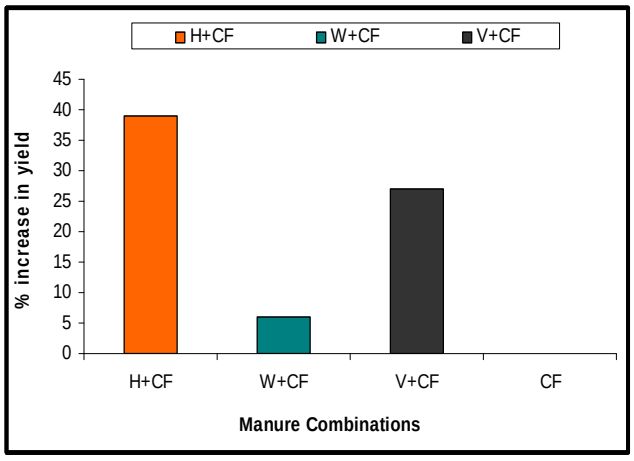

Figure 3.24: Percent Increase in the crop yield

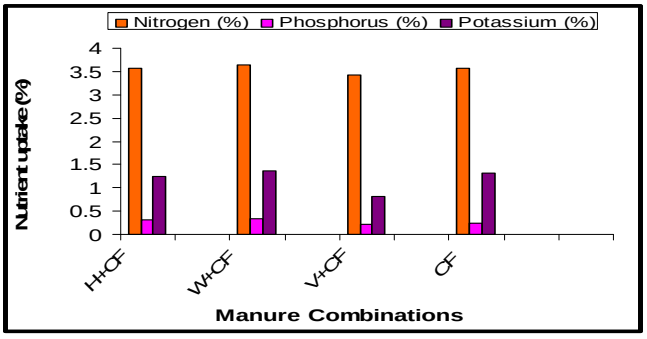

Figure 3.25: Nutrient uptakes in the crop

The initial investment of chemical fertilizer is relatively less compared to organic and chemical fertilizer combinations, but the benefit (profit) seems to be lesser in comparison with H+CF, V+CF and W+CF respectively (3.26).

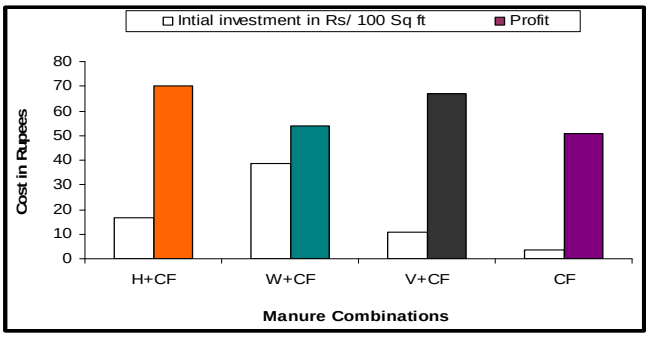

Figure 3.26: Cost Benefit analyses

3.7 Column Studies

3.7.1 Column Studies for Nitrate and Phosphate

It is evident that (fig. 3.27) the nitrate's concentration decreased up to 5th day later increased steadily up to first 10 days and subsequently showed a declining trend with time. The increasing trend has been attributed to the cumulative accumulation of the nitrates in the soil pores and decreasing trend has been ascribed to the transformation processes implicated in the soil system.

At 300mm depth of column H+CF and W+CF combination showed higher values of nitrates. These indicate that the leached concentration must have reached such a depth over a period of time.

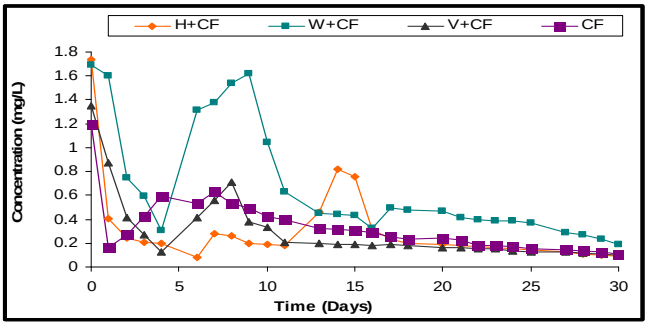

Figure 3.27 Nitrate concentrations at 0-150mm depth

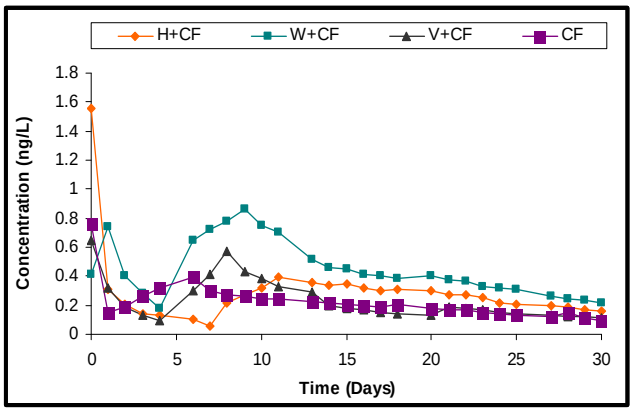

Figure 3.28: Nitrate concentrations at 150-300mm depth

At 450mm depth, at 30th day the nitrate content was found to be low in CF combination. This is due to the use of DAP and Ammonium sulfate containing lower concentrations of nitrates (fig 3.29).

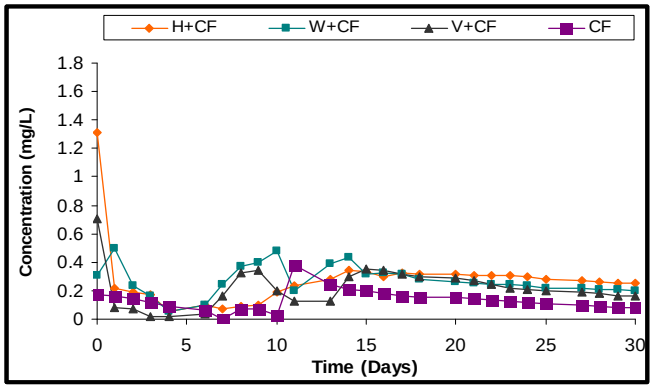

Figure 3.29: Nitrate concentrations at 300-450mm depth

It is observed very much varying during first 10 days in every treatment combination as there was fixation and release during the initial steps. After 14th day all combinations have shown a declining trend (fig 3.30). (Fig 3.31) The Phosphate content was maximum between 10th and 15th day at 150-300 mm depth indicating the release of phosphate during this period. At 300-450 mm depth of soil, the phosphate content was very less in all the treatments. This shows that leaching of phosphate is much slower compared to nitrate leaching (fig3.32).

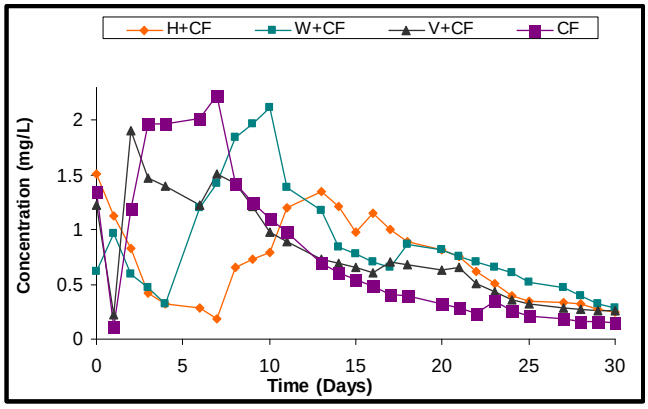

Figure 3.30 Phosphate concentrations at 0-150mm depth

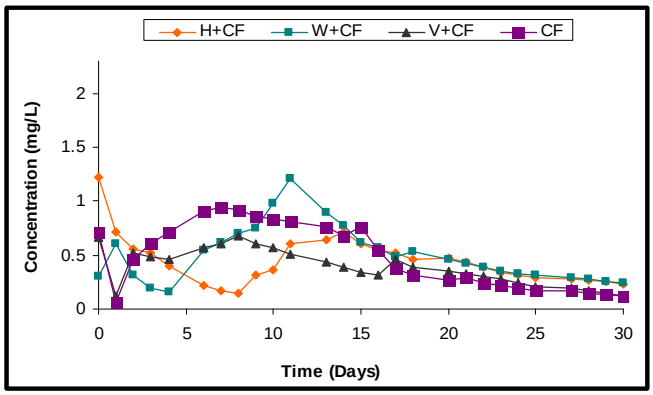

Figure 3.31: Phosphate concentrations at 150-300mm depth

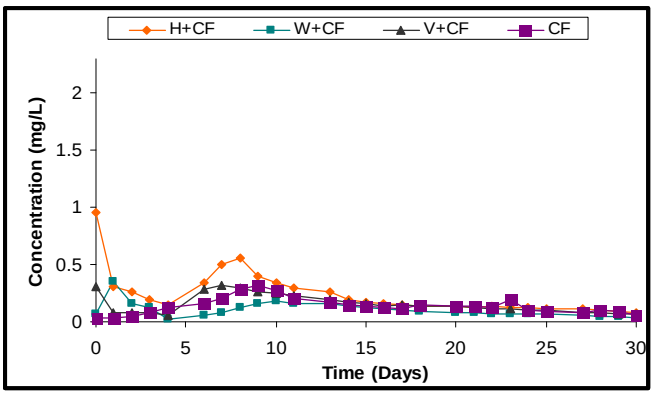

Figure 3.32: Phosphate concentrations at 450mm depth

4. Conclusions

Based on the extensive analytical and laboratory studies, the following conclusions could be drawn.

1. The NPK values, Organic carbon, Organic matter at different depth of soil after harvesting the crop were quite high on plots where W+CF combination was applied, hence increasing the nutrient values and fertility of the soil. The observed trend is W+CF > V+CF > H+CF.
2. H+CF combination has given higher percentage yield when compared to other manure combinations, though the physical growth of the plant is good and equal in case of V+CF and CF alone.
3. Water holding capacity of the soil has shown overall improvement in the plots of V+CF and H+CF combinations ensuring good retention of water for plant growth.
4. Humanure in combination of chemical fertilizer (75:25 ratios) can serves as an alternative to the commercially available inorganic fertilizers, the application of Humanure will reduce the waste disposal consequences on the environment.
5. The Residual nutrient (%) content in plant samples of W+CF applied plot is slightly higher compared to other manure combinations.
6. The results of cost benefit analysis have shown maximum benefits for the combinations of H+CF and V+CF indicating the efficiency and effectiveness of higher percentage of organic manure in combination with chemical fertilizer.
7. The column studies have shown the vertical transport of nutrients from top layer to 450 mm depth.
8. The chemical fertilizer applied column has recorded higher rate of percolation of nutrient when compared to other manure combinations. This concludes that the combination of organic manures with chemical fertilizer retain nutrients in the upper layers of soil thus maintaining soil fertility.

5. Future Scope

1) Various other organic sources like Farm yard manure, Cattle manure, Poultry manures, green manuring etc. may be evaluated to assess the effect of the manure on the physical, chemical and Biological properties of the soil along with different combinations ratios.

2) To estimate the microbial dynamics in terms of population of various micro-organisms and their biomass after application of organic manure in soil system.

6. Acknowledgment

1) With overwhelming sense of gratitude, extreme honor& indebtedness, wish to express my great respect to Late Dr.T. P. Halappa Gowda, Professor, Emeritus, Dept. of EnvEngg, S.J.C.E, Mysore, Karnataka, India
2) Words are insufficient to express my feelings of Indebtedness & sincere thanks to my Guide Dr. K.S. Lokesh, Professor and Head, Dept. of Env. Engg., SJCE an Autonomus Instituion in Mysore, India.
3) I am Greatly Thankful to my Co-Guide Dr. D. Istalingamurthy Professor, Department of Environmental Engineering, S.J.College of Engineering (Autonomous). Mysore-570006, Karnataka, India.
4) Finally, I would like to thank my Dad (My Role Model), Rtd High School teacher & awarded as Best teacher at state level (Karnataka), India& Mother from whom I learned themeaning of the word patience, to complete this research work & to my two sisters, who were working as lecturers.

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Author Profile

Chandrashekar Bcompleted B.E. and M.Tech. degrees in Environmental Engineering from Sri Jaya Chamarajendra College of EngineeringinMysore, Karnataka, India, Under Visvesvaraya Technological University (VTU) during 2007 and 2009, respectively.Completed Post Graduate Diploma in Environmental Law from National Law School of India University, Bangalore during June-2013, Karnataka, India.Presently works as an Assistant Engineering Manager in the Design department of Public Health Engineering division in L&T Construction Company at Chennai with Experience of 5 years 3 months, Tamil Nadu, and India.

Dr. K. S. Lokesh, Graduate of Civil Engineering, turned Environmental Engineer with both M.Tech., and Ph.D. in Env. Engg., Started his career as Lecturer and currently Professor and Head, Dept. of Env. Engg., SJCE an Autonomus Instituion in Mysore, India. He has over 32 years of teaching, research and consultancy experience. He has over 120 research publications and completed 11 sponsored R & D projects.

Dr. D. Istalingamurthy, Graduate of Civil Engineering, turned Environmental Engineer with both M.Tech., and Ph.D. in Env. Engg., Started his career as Lecturer and currently Professor, Dept. of Env. Engg., SJCE an Autonomus Instituion in Mysore, India. He has over 20 years of teaching, research and consultancy experience. He has over 10 research publications and completed 2 sponsored R & D projects.