EFFECT OF DIFFERENT ORGANIC SOURCES ON SOIL FERTILITY, NUTRIENT UPTAKE AND YIELD OF SOYBEAN

THESIS

Submitted to
Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola
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(SOIL SCIENCE AND AGRICULTURAL CHEMISTRY)

By

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Enrolment Number - HH/1582

2011

DECLARATION OF STUDENT

I hereby declare that, the experimental work and its interpretation of the Thesis entitled **"EFFECT OF DIFFERENT ORGANIC SOURCES ON SOIL FERTILITY, NUTRIETNT UPTAKE AND YIELD OF SOYBEAN"** or part thereof has neither been submitted for any other degree or diploma of any University, nor the data have been derived from any thesis / publication of any University or scientific organisation. The source of materials used and all assistance received during the course of investigation have been duly acknowledged.

Place : Akola.

Date : 30 /05/2011

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CERTIFICATE

This is to certify that, the thesis entitled **"EFFECT OF DIFFERENT ORGANIC SOURCES ON SOIL FERTILITY, NUTRIETNT UPTAKE AND YIELD OF SOYBEAN"** submitted in partial fulfilment of the requirement for the degree of "**Master of Science in Agriculture (Soil Science and Agricultural Chemistry)**" of Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola is a record of bonafide research work carried out by **Miss. Patil Darshana Ulhas** under my guidance and supervision.

The subject of thesis has been approved by the Student's Advisory Committee.

Place : Akola
Date : 31/03/2011

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Place : Akola.

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(D) Abbreviations

µg	Microgram
%	Percent
@	At the rate
B:C ratio	Benefit cost ratio
BD	Bulk density
CD	Critical difference
cm	Centimeter
$CaCO_3$	Calcium carbonate
DAS	Days after sowing
EC	Electrical conductivity
et al.	*et alia* (and others)
FYM	Farm Yard Manure
GMR	Gross Monetary return
ha	Hectare
K_2O	Potassium
m^2	Square meter
mg	Miligram
mm	Millimiter
N	Nitrogen
NMR	Net Monetary return
NS	Non significant
P_2O_5	Phosphorus
°C	Degree celcius
g	Gram
Sr. No.	Serial Number
R.D	Recommended dose
S.E(m)±	Standard error of mean
t	Tonne(s)
viz.,	*videlicet* (namely)

i.e.	that is
GLM	Green Leaf Manure
PEY	Pigeonpea Equivalent Yield
DTPA	Diethylene Triamine Tetraactetic Acid
AAS	Atomic Absorption Spectrophotometer
Fe	Iron
Mn	Manganese
Cu	Copper
Zn	Zinc
Rs./ ₹	Rupees
$^{-1}$	Per
dS m^{-1}	Desi siemens per meter
g ha^{-1}	Grams per hectare
kg ha^{-1}	Kilograms per hectare
Mg ha^{-1}	Mega grams per hectare
q ha^{-1}	Quintal per hectare

(F) Thesis Abstract

a)	**Title of the thesis**	: **"EFFECT OF DIFFERENT ORGANIC SOURCES ON SOIL FERTILITY, NUTRIETNT UPTAKE AND YIELD OF SOYBEAN"**
b)	**Full name of student**	: **Miss. Patil Darshana Ulhas**
c)	**Name and address of Major Advisor**	: **Dr. G. S. Laharia** Assistant Professor, Department of Soil Science and Agricultural Chemistry, Dr. PDKV, Akola (M.S.) - 444104.
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i)	**Signature of the student**	:
j)	**Signature, name and address of forwarding authority**	:

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ABSTRACT

An investigation entitled "Effect of different organic sources on soil fertility, nutrient uptake and yield of soybean" was conducted under rainfed condition during Kharif season of 2010-11 at the Research Farm, Department of Agronomy, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. The soil of experimental site was fine montmorillonitic hyperthermic family of Typic Haplustepts.

The experiment was laid out in randomized block design with eleven treatments with application of different organic sources. The supply of N, P, K are through organic sources used are FYM, vermicompost, compost, cotton stalk, wheat straw, soybean straw and jeevamrut.

On the basis of results obtained in the present investigation, application of 100% RDN through vermicompost + jeevamrut recorded the significantly higher yield of soybean grain and straw of soybean followed by treatment 100% RDN through vermicompost and 100% RDN through FYM + jeevamrut.

Content and uptake of nutrient (N, P, K) by soybean grain and straw was highest in treatment application of 100% RDN through vermicompost + jeevamrut over other treatments.

Quality parameters like test weight, oil and protein content by soybean has been increased due to use of organic sources over crop residues and jeevamrut application. Highest test weight, oil and protein were recorded by the treatment application of 100% RDN through vermicompost + jeevamrut followed by treatments application of 100% RDN through vermicompost.

Soil properties like physical, chemical, biological after harvest of soybean were improved with the application of organic sources over crop residues and jeevamrut. In case of physical properties bulk density decreased with application of 100% RDN through vermicompost + jeevamrut and remaining parameters like hydraulic conductivity, mean weight diameter and available water capacity were increased with application of 100% RDN through vermicompost + jeevamrut over remaining treatments.

Chemical properties like pH, EC and $CaCO_3$ show slightly changes but found non-significant with application of organic manures, crop residues and jeevamrut. Microbial population like bacteria, fungi and actinomycetes show better response of higher population with application of 100% RDN through vermicompost + jeevamrut over other treatments.

Fertility status like organic carbon, available N, P, K in soil was significantly higher with application of 100% RDN through vermicompost + jeevamrut over remaining treatments and available micronutrients like Zn, Fe, Mn and Cu in soil was found non-significant with application of different organic sources. Highest availability of micronutrient was found in treatment application of 100% RDF through FYM + jeevamrut over other treatments.

On the basis of results GMR, NMR and B:C ratio is calculated. Highest GMR, NMR was recorded in treatment application of 100% RDN through vermicompost + jeevamrut but B:C ratio was found higher in treatments application of 100% RDN through FYM.

CHAPTER I

INTRODUCTION

1.1 Background information

India occupies a premier position in global oilseeds scenario accounting for 15.4 per cent area and 92 per cent of production and has a major share in the global oilseed economy, being one of the important oilseed grower, producer and exporter. India produced 28.16 million tonnes of oilseed during 2008-2009 (Anonymous, 2009) which is nearly and this 2.8 times more than that produced during 1985-86 and this made India a net exporter in oilseed sector so called "Yellow revolution". Among the annual oilseed, bulk of the increase in production during the last two decades is contributed mainly by soybean, sunflower, rapeseed and mustard. Therefore, now a day much attention has been given towards oilseed crop to meet the national demand.

The use of organic manures has been the traditional means of maintaining soil fertility. Most organic manures provide a balanced source of nutrients for crops. Organic manures have a direct effect on plant growth like any other commercial fertilizer. These manures contain nutrients in small amount, therefore the quantity requirement of these organic sources is more to fulfill the crop needs. Besides, the major nutrients, organic manures also contain traces of micro-nutrients and also provide food for soil microorganisms. This increases activity of microbes which in turn helps to convert unavailable plant nutrients into available and fixing the atmospheric nitrogen.

1.2 Importance of study

Soybean (*Glycine max.*) a well known and important oilseed crop of the country. Soybean has come to be recognized as one of the premier agricultural crop today for various reasons. It has originated in China and established itself as a leading crop in USA, Brazil and China. Soybean being rich and cheapest source of protein and fat having vast multiplicity and use as a food is rightly called as "Wonder crop" or the "Miracle bean". It contains 20% oil, 40 to 42% protein, 20 to 30% carbohydrates, vitamin A, B, C, D, E, K and the other essential amino acids. It has vast use as food, like Soya chunks, Soya flour, Soya chips, Soya paneer, Soya milk etc. Soya oil is used in manufacturing of soaps, paints, rubber, lubricants, explosive, glycerin and soybean oil cake is highly useful as poultry feed. Soybean being a legume, helps in improving soil fertility by fixing atmospheric nitrogen in soil through root nodules. Symbiotically soybean fixes 125-150 Kg N ha^{-1} for succeeding crop (Chandel *et al.*, 1989). Soybean due to its various uses is called as "Golden Bean" or Golden gift of nature to the mankind.

In India, soybean is grown in 97.709 lakh ha. area with production of 92.246 lakh MT and productivity 1006 kg ha^{-1}. In Maharashtra, soybean is grown on 30.02 lakh ha. area with production 29.774 lakh MT with average productivity 982 kg ha^{-1}. Similarly, in Vidarbha area under soybean is 18.997 lakh ha. with production of 18.976 lakh MT with productivity of 1993 kg ha^{-1}.

The organic manures supply primary, secondary and micro-nutrients to plant which are liberated in an individual forms during the process of mineralization carried out by different micro-organisms. These manures contain nutrients in small quantities, thereafter large quantities of them need per hectare. The addition of organic matter in the soil is helpful

in improving the physical condition of the soil like soil structure, aeration. Also stimulates the activity of different soil micro-organisms through the supply of energy.

The addition of organic matter in the soil which goes to build up humus required for the improving fertility status. The NPK come from organic sources, such as FYM, vermicompost and green manure can be used as a sole source or as a suitable for part of inorganic fertilizers.

Among the organic manures jeevamrut activates the soil ingredients necessary for a plants healthy growth. Since, it is to be mixed with the water normally given to plants or just sprinkled across the field. It involve a less labour than that required for putting fertilizers and pesticides.

Despite the targeted achievements, agricultural sector is confronted with serious challenges due to rapid growth, depletion of land fertility and shrinking of non-renewable energy sources. The use of chemical fertilizers alone in the intensive cropping system leads in decreasing soil fertility, unfavourable physical condition and biological system. Due to their huge and continuous use of soil health is deteriorating year after year. It can be overcome by use of organic manures along with mineral fertilizers for soil health and sustainable crop production.

The present fertilizer shortage and hike in fertilizer prices have generated serious interest in the use of organic manures for supplementing inorganic nitrogen. The use of organic manure and residues in conjunction with chemical fertilizer is receiving attention in dry lands with a view to cut down the cost on chemical fertilizers and environment for crop growth.

India has about 185 mt of crop residues of which about one third in available for incorporation in arable lands. Recycling of organic

residues is becoming an increasingly important aspect of environmentally sound sustainable agriculture (Bellakki and Badanur, 2000).

The organic matter that is applied through organic manures has a very complex effect as soil and on plant growth as well as improves the physical, chemical and biological properties of soil. This effect is very important in case of most of our arable land. Such manures increases the humus content of soils at least temporarily and consequently, the water holding capacity of sandy soil is improved.

In the present investigation an attempt has been made to study the "Effect of different organic sources on soil fertility, nutrient uptake and yield of soybean" was conducted at the Research Farm, Department of Agronomy, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola with the following objectives.

1.3 Objectives

1) To study the effect of organic sources on soil fertility.
2) To study the effect of organic sources on nutrient uptake, yield and quality of soybean.

1.4 Scope and Limitations

1.4.1 Scope

High cost of chemical fertilizers, average farmers face problems to cultivate their land to desired level. Therefore, efforts should have to be made to follow of integrated nutrient management approach for efficient utilization of chemical fertilizer through supplementation with organic manures.

Component required for organic manures namely FYM, compost, vermicompost, crop residues and jeevamrut are readily available

with many farmers. Procedures of its preparation and application are very easy, if hypothesis is proved then this technique can be profitably used by farmers for increasing crop yield and maintaining soil health.

1.4.2 Limitations

1) There is wide gap between supply and demand which indicates that actual production of oilseeds is lower as compared to required production.
2) More quantity of organic matter is required, higher cost of cultivation and price of soybean seed being costlier, can not be affordable easily.
3) Nutrients present in the organic manure are not available to crops immediately because due to slow releasing activity. Only one-third of nitrogen, two-third of phosphate and most of potash will be available to crops.
4) The present study has data of only one season, therefore the concrete recommendation could not be given to farmers.

1.5 Hypothesis

The application of organic sources namely FYM, compost, vermicompost, crop residues and jeevamrut etc. are very well known to improve the physical, chemical and biological properties of soil. These organic sources contain all the nutrients which are required by the crops. They are not only the source of nutrient but also have effect on physical properties resulting in a better soil structure, maximum water holding capacity, hydraulic conductivity in soil and more favourable environment for root growth and better infiltration of water.

CHAPTER II

REVIEW OF LITERATURE

An attempt has been made to review the literature pertaining to the "Effect of different organic sources on soil fertility, nutrient uptake and yield of soybean." under the following heads -

2.1 Effect of organic sources on yield of soybean.

2.2 Effect of organic sources of nutrient content of soybean.

2.3 Effect of organic sources on nutrient uptake by soybean.

2.4 Effect of organic sources on quality of soybean.

2.5 Effect of organic sources on soil properties.

2.6 Effect of organic sources on fertility status of soil.

2.7 Effect of organic sources of economics of soybean.

2.1 Effect of organic sources on yield of soybean

Mishra *et al.* (1994) conducted a field experiment during kharif 1991-92 at Indore to study the fertility levels, cycocel, *Rhizobium* culture and farmyard manure on growth and yield of soybean grown on black clay soils. Yield attributes and yield of soybean increase significantly, due to application of fertilizer N, P and K at the rates of 20, 60 and 20 kg ha^{-1} respectively and farmyard manure. Maximum seed yield of soybean (2286 kg ha^{-1}) was recorded due to application of fertilizer NPK in conjuction with farmyard manure + *Rhizobium* culture + cycocel.

Sathiyavelu *et al.* (1994) conducted a field experiment at Coimbtore during the rainy seasons of 1987-1988 and 1989 to study the influence of organic manure and fertilizer levels on seed yield of sunflower. It was observed that application of farmyard manure @ 10t ha^{-1} with

recommended dose of 50, 60 and 40 kg N, P and K ha^{-1} is optimum to get economic yield of sunflower.

Application of FYM @ 20t ha^{-1} increased seed yield of sunflower by 0.2 t ha^{-1} over control and by 0.4 t ha^{-1} with use of 50 per cent recommended NPK. Similar responses were also observed on succeeding crop of sunflower as residual effect of FYM application (Anonymous,1992). It has been observed in perarlmilet – wheat cropping sequence that 50 per cent N substitute through farm yard manure or wheat straw to pearlmillet had a significant residual effect on the succeeding rabi crop resulting in maximum total productivity and uptake by succeeding crop (Patel *et al.* 1995).

Jain and Tiwari (1995) conducted a field trial in medium black soil of Madhya Pradesh to study the effect of farm yard manure and sugarcane pressmud on yield and N, P, K content of soybean. The nutrient content and yield of grain and straw of soybean increased with the application of farm yard manure and sugarcane pressmud. More ever they also help in balancing the nutrient availability to growing plants and boost up the production and quality of crop.

Ramamurthy and Shivashankar (1996) found that grain yield of soybean increased significantly from 20.7 to 23.0 and 26.9 q ha^{-1} with increase from 0 to 5 and 10 tonnes ha-1 organic matter and 22.7 to 24.1 gha^{-1} with 37.5 to 56.25 kg P_2O_5 ha^{-1} but stover yield did not differ significant in both year of experimentation.

Kundu *et al.* (1998) reported that a field experiment was conducted during rainy season of 1995 at IASS farm, Bhopal, the organic manure incorporation into the soil increases significantly the N_2 fixation through legume–*Rhizobium* symbiotic process. It was also concluded that

the application of FYM up to beneficial in terms of soybean yield and total N_2 fixation.

Badole *et al.* (2001) conducted the field experiment at Parbhani during 1997-98 and 1998-99 using kharif cotton and succeeding summer groundnut. The treatments 50% NPK through chemical fertilizer + 50% NPK through FYM + Azotobacter + PSB recorded maximum dry pod (2537-62 kg ha^{-1}) and haulm yield (4388.72 kg ha^{-1}) of groundnut among the organic treatments FYM + PMC + Glyricidia + *Azotobacter* + PSB was superior. Similar trend was observed to protein and oil content / yield.

Ghodpage *et al.* (2009) reported that the highest seed cotton yield (1683 kg ha^{-1}) was recorded with the application of 100% RDF which was followed by 75% RDF + Amrutpani + biofertilizer @ 3kgha^{-1} as well as microbial population in soil was found with the use of vermicompost alone or in combination.

Gosavi *et al.* (2009) conducted a field experiment on sweet corn during rabi 2005-06 on a medium black soil of the ASPEE, Agriculture Research and Development Foundation, Tansa Farm, Thane (M.S). They demonstrated that RDF (R_1) recorded significantly superior values of all the yield quality and total N, P and K uptake than control (R_0) and 20 t FYM ha^{-1} (F_3) was significantly superior in respect of sugar content and total N,P and K uptake. Further, 15 t FYM ha^{-1} (F_2) was significantly superior over to 10t FYM ha^{-1} and all the yield characters increased subsequent increase the level FYM.

Shweta *et al.* (2009) reported that the integrated use of organic manures *Viz.*, compost, vermicompost, GLM and fermented organic *Viz.* Beejamruth and panchagavya in soybean–wheat cropping system. Result revealed that grain yield of soybean, wheat and their

soybean equivalent yield were significantly higher in RDF + FYM and combined used of organic manures + fermented organics.

Tomar and Khajanji (2009) found that organic manuring with crop residue + FYM each 5 t ha^{-1} along with 5 kg ha^{-1} Zinc recorded significantly higher plant height, number of branching, number of yield, dry matter accumulation per plant as well as grain and store yield of soybean as compared with control and 50% RDF.

Zalate and Padmani (2009) reported that on experiment was conducted during the kharif 2006-07 at Junagadh (Gujrat) to study the effect of organic manure with and without biofertilizers on growth, nodulation and yield of groundnut. Manuring the crop with FYM 6 t ha^{-1} + *Rhizobium* + PSM gave significantly 40.19 and 35.96 per cent higher pod and haulm yields of groundnut, respectively over no manuring. Fertilizing the crop with vermicompost 2 t ha^{-1} + *Rhizobium* + PSM and FYM 3 t ha^{-1} + Rhizobium + PSM found equally effective and significantly superior to control in respect to growth parameter, yield attributes and yield of groundnut.

Kadam *et al.* (2010) found that the FYM, compost, pressmud cake compost, poultry manure, vermicompost, fresh dung, were used as nitrogen sources along with fulvic acid spray @100 ppm at 30 and 45 days imposed of soybean recorded higher grain (25.7q ha^{-1}) and straw (38.6 q ha^{-1}) yield.

Deshmukh *et al.* (2010) investigation was carried out for four years (2003-07) at Dr. PDKV., Akola. The experiment was planned during kharif season using nine treatments of crop residues alone or in combination with fertilizers including control with three replications. The result indicated that incorporation of crop residues alone as well as in

combination with 50 to 100% RDF to soybean-chickpea sequence significantly increased yield of soybean and chickpea.

Manral and Saxena (2010) conducted a field experiment in the Kharif 1996-97 and 1997-98 at Pantnagar, recorded the significant interaction for grain yield between combined use of inorganic and organic sources of nutrients and the yield of soybean revealed that inorganic and organic sources gave higher productivity when applied in combination that of applied alone. It was concluded that 25 kg N as inorganic source with some organic source (like neem cake and FYM) may be applied for increasing the productivity of soybean.

2.2 Effect of organic sources on nutrient content of soybean

Powlson and Brookes (1987) recorded that the straw and stubbles of spring barley were either burned or incorporated into soil annually for 18 years in two field experiments in Denmark., At both sites 18 years of annual straw incorporation increased total carbon by only 5% and total N by about 10% but produced large increase in microbial biomass measured by $CHCl_3$ – fumigation method, Minaralization of N was 40- 50% greater, where straw had been incorporated, indicating that the long term incorporation of straw and had increased the quantity of mineralizable N in soil.

Jain and Tiwari (1995) conducted the field experiment in medium black soil of Madhya Pradesh to study the effect of FYM and sugarcane pressmud on yield and N, P and K content of soybean. The nutrient content and yield of grain and straw of soybean increased with the application of farm yard manure and sugarcane pressmud. Moreover, they also help in balancing the nutrient availability to growing plants and boost-up the production and quality of crop.

Santhy *et al.* (1998) reported that the continuous cropping and fertilization had significantly increased available N content of soil over the initial status, but in 100 % NPK + FYM, available N content was higher due to higher organic carbon content of the soil.

Ravankar *et al.* (1998) reported that the continuous application of 100% recommended NPK along with FYM (10 t ha^{-1}) has beneficial effect on available nitrogen and phosphorous content of the soil.

Sheeba and Chellamuthu (1999) reported that the available P status of the soil was improved in the plots receiving 100% NPK with FYM.

Sheeba and Chellamuthu (1999) found that in plot receiving 100% NPK + FYM have available nitrogen status was higher. It was also evident that the application of phosphorous in conjunction with nitrogen improved the available nitrogen status of the soil as compared to the application of nitrogen alone.

Dhiman *et al.* (2000) reported that organic carbon and total nitrogen in the soil increased with the incorporation of crop residues like wheat and rice straw.

Babhulkar *et al.* (2000) reported that the available nitrogen, phosphorous and potassium of soil were found to significantly increased by the application of higher dose of FYM and the best treatment was application of 7.5 kg FYM ha^{-1} with half dose of N and P fertilizers.

Singh *et al.* (2001) recorded that significant increase in available K content has been due to either FYM or green manures along with fertilizer N, also suggesting that FYM and green manure helped to maintain the supply of K by releasing the K from reserve source.

Sharma *et al.* (2001) studied that incorporation of wheat residue increased in organic carbon, total N, available P and K content of soil. This practice significantly increased soil fertility over practice of residue renewal.

It is seen that except for nitrogen, the uptake of other nutrients was not very much improved by the application of manure and fertilizer. The use of nitrogenous fertilizers along with FYM has given higher yields, both of the straw and the grain.

Helkiah *et al.* (1981) studies to evaluate the efficacy of organic sources of manures as compared to chemical fertilizers in a black soil revealed that the application of organic sources at different levels in combination with inorganic fertilizers had significantly increased the grain and straw yield of CSH-5 sorghum. The physical properties of the soil *viz.*, Bulk density, hydraulic conductivity and total porosity and also the nutrient content were found to have improved. The uptake of the nutrient by the crop was found increased due to the addition of organic manures with fertilizers as compared to control and inorganic fertilizers alone.

Pannerselvam *et al.* (2000) reported that field experiment were conducted from June 1994 to April 1996, covering two kharif and two summer season to evaluate the combined effect of organic manures and inorganic fertilizers with different weed management practices on the soil available phosphorous status and P uptake of soybean. Application of bio-digested slurry @ 5 t ha^{-1} + 30 : 120 : 140 kg NPK ha^{-1} recorded the highest P uptake by soybean in all the seasons.

Gosavi *et al.* (2009) conducted the field experiment on sweet corn during rabi 2005-06 on a medium black soil of the ASPEE, Agriculture Research and Development Foundation, Tansa Farm, Thane (M.S.). They demonstrated that RDF (R_1) recorded significantly superior values of all the yield quality and total N, P and K uptake than control (R_2) and 20 t FYM ha^{-1} (F_3) and was significantly superior in respect of sugar content and total N, P and K uptake. Further, 15 t FYM ha^{-1} (F_2) was significantly superior

over 10 t FYM ha^{-1} and all the yield character increased with subsequent increase the levels of FYM.

Jeevan Rao and Ramalakshmi (2009) reported that a field experiment was carried out to study the direct and cumulative of enriched urban and agricultural waste compost on yield and nutrient uptake of soybean at Hyderabad during kharif 2003. The results revealed that drastic increase in the yield of soybean was achieved from 40 t ha^{-1} urban waste compost ha^{-1} when compared to lower doses of compost application. The treatment with 40 t ha^{-1} urban waste compost showed maximum N, P, K and S uptake by soybean grain.

2.4 Effect of organic sources on quality parameters of soybean

Aruna and Reddy (1999) found that application of organic manure @ 15 t ha^{-1} produced maximum protein in soybean seed.

Sharma *et al.* (2002) conducted the field experiment were during rainy season of 1997 and 1998 to evaluate the effect of phosphorus levels and sources with and without FYM in soybean. Application of FYM significantly improved various growth parameters except branches / plants and seed yield.

Marimuthu *et al.* (2002) conducted the field experiment during 1998 and 1999 at Pudukkottai, (Tamil Nadu). Treatment found that vermicompost contain high amount of NPK with moderate pH and EC. The results reveled that the treatment (application of ornamental garden waste vermicompost @ 12.5 t ha^{-1}) recorded highest plant height, leaf area index, dry matter production and number of nodules per plant at the time of plant harvest in groundnut also influence on the yield attributes *Viz.* number of pods per plant, 100 seed weight, pod yield and kernel yield.

Anonymous (2003) reported soybean recorded (39.28%) protein with the application of 50% RDF + vermicompost + biofertilizers.

More *et al.* (2008) reported that, maximum pods per plant, number of grains per pod, height of grains per plant, grain yield (q ha^{-1}), straw yield (q ha^{-1}) and test weight (g) with treatment application of FYM @ 5 t ha^{-1} + *rhizobioum* + PSB + Amrutpani over FYM @ 5 t ha^{-1} alone in soybean crop.

Channabasanagowda *et al.* (2008) reported that a field experiment was conducted during rabi 2006-07 on red loamy soil of Dharwad. Application of vermicompost @ 3.8 t ha^{-1} + poultry manure @ 2.45 t ha^{-1} recorded significantly higher plant height (86.30 cm), number of leaves (40.50) and higher number tillers (94.60) at 90 DAS and it also recorded higher number of earheads per meter square (160.10), 1000 seed weight (42.73 g) and seed yield (3043 kg ha^{-1}), vigour index (3223), seeding dry weight (311.27 mg) and protein content (13.41%) compared to other treatments.

Sonkamble *et al.* (2010) conducted experiment on the groundnut during kharif 2008-09 and 2009-10. The result revealed that the soil status can be improved considerably by organic treatments. The crop productivity and seed quality were also found superior over the control. Especially the treatment vermicompost (3 t ha^{-1}) + *Rhizobium* inoculation (5 kg ha^{-1}) is found significantly superior over all other treatments. Similarly, the treatment of green manuring 10 t ha^{-1} + *Rhizobium* inoculation (5 kg ha^{-1}) shown better performance in seed oil content and seed protein content.

Deshmukh *et al.* (2010) conducted field experiment at Rahuri during summer 2007. The result revealed that, growth attributes like plant height and number of branches $plant^{-1}$ and yield components like number of capsules $plant^{-1}$ and thousand seed weight in summer seasamum were

favourably influenced due to application of RDF + 5 t each of FYM and vermicompost ha $^{-1}$ + seed treatment with *Azospirillum* and PSB which was significantly superior to all other treatments followed by 75 % RDF + 5 t each of FYM and vermicompost ha^{-1} + seed treatment of *Azospirillum* and PSB.

2.5 Effect of organic sources on soil properties

A) Physical properties

Badanur *et al.* (1990) reported organic manures and crop residues were incorporated in the soil to study their effect on soybean crop growth and physical properties at a vertisol of Bijapur (Karnataka) incorporation of sorghum stubbles and safflower stalks @ 5 t ha^{-1} significantly increased the infiltration rate and water content at field capacity as compared with fertilizer treatment. Also observed the significant reduction in bulk density of vertisol with crop residues incorporation over fertilizer application.

Boparai *et al.* (1992) found that increased water stable aggregation in loamy sand was due to green manuring of *Sesbania acculeata*. Significant decrease in bulk density of vertisol with incorporation of stubbles either alone or in combination with Subabul over fertilizer application were also noted by Bellakki and Badanur (1994).

Angers and Recous (1997) recorded that in the first 2 days of incubation, decomposition rate of rye increased with decreasing particle size but there after the trend was reversed. For wheat straw, early decomposition was faster for the small sized particles. Thereafter, the largest size classes decomposed faster. It was hypothesized that greater availability and accessibility of N was responsible for the higher rates of decomposition observed for finely ground wheat straw.

A decreased in bulk density with the application of organics such as FYM, green gram mulching, glyricidia and sunhemp in situ green manuring form 1.56 to 4.83% and their combination with inorganic fertilizers from 0.77 to 3.96% was reported by Katkar *et al.* (2002).

Babhulkar *et al.* (2000) concluded the long terms field experiment that application of 7.5 Mg FYM ha^{-1} with 50 % dose of N and P found decreased the bulk density of soil and enhanced soil porosity.

Prakash *et al.* (2002) noticed significant decrease in bulk density in Alfisol with straw application (1.21-1.29 Mg m^{-3}) than recommended dose of fertilizer (1.40 Mg m^{-3}) and absolute control (1.41 Mg m^{-3}).

Guled *et al.* (2002) reported that hydraulic conductivity of soil increased considerably with sunhemp or FYM application as compare to farmers practice.

Bhattacharyya *et al.* (2004) studied the effect of long term manuring on soil organic carbon, bulk density and water retention characteristics under soybean – wheat cropping sequence in North – Western Himalayas and observed that the bulk density was minimum in NPK + FYM treatments in all depths and it has a negative correlation with OC content. It was also found that decrease in BD per unit increase in non – oxidiazable OC content over initial soil was more then decrease in BD per unit increase in oxidiazable OC content.

Ravankar *et al.* (2004) reported that integrated use of FYM + NPK or FYM along on long term basis significantly increased the hydraulic conductivity in treated soil as compared to other treatments and control.

Marathe and Bharambe (2005) observed highest aggregation of soil particles with the application of FYM followed by wheat straw over inorganic fertilizers and control .They also reported highest decreases in

bulk density in FYM treated plots followed by application of vermicompost. Similarly highest porosity was recorded with the application of FYM among all the treatments.

Marathe and Bharambe (2005) observed the significant improvement in hydraulic conductivity (0.725cm hr^{-1}) due to application of FYM (to supply 100% N) in a vertisols.

Selvi *et al.* (2005) reported from a long term experiment on manuring and fertilization that increasing level of fertilizers significantly increased the hydraulic conductivity, combined application of FYM and NPK also resulted in significant higher hydraulic conductivity (2.61 cm hr^{-1}) than NPK application alone (1.81 cm hr^{-1}).

Chalwade *et al.* (2008) found that application of organic manures alone and in combination with inorganic fertilizers resulted into increase in hydraulic conductivity and water stable aggregates.

A field experiment on soybean-chickpea cropping sequence on inceptisol indicated that incorporation of sugarcane trash and wheat straw @ 4t ha^{-1} alone as well as in combination with 50 to 100 % RDF to both the crops significantly improved the bulk density, infiltration rate and hydraulic conductivity. Jadhao and Bharambe (2007).

Surekha and Rao (2009) conduct a field experiment on a vertisol at Hyderabad for three years (2001-02 to 2003-04) to study the influence of organic sources (paddy straw, dhaincha) in combination with chemical fertilizes on productivity and soil quality in irrigated rice-rice system. Organic sources improved the soil physical (bulk density and penetration resistance), fertility (soil organic carbon and available N and K) and biological (soil respiration) parameters over inorganic fertilizers alone.

Ramesh *et al.* (2010) in Maharashtra, Karnataka and Tamil Nadu recorded the survey on certified organic farms in the country to

ascertain the real benefits and feasibility of organic farming in terms of the production potential, economics and soil health in comparison to the conventional farms. They recorded that overall improvement in soil quality in terms of various parameters *Viz.*, physical, chemical, biological properties, availability of macro and micronutrients, indicating an on enhanced soil health and sustainability of crop production in organic farming systems.

B) Chemical properties

Lohakare (1980) studied the effect of various levels of FYM and NPK fertilizers alone and in combination for 15 years on black soils. It found that the long term use of FYM and Fertilizers did not affect the pH, EC and the $CaCO_3$ content to noticeable level. Slight decrease in pH and EC of soil was noticed due to FYM and fertilizers while no specific trend was observed due to various treatments.

The studies on the effect of application of 0,30 and 60 kg P_2O_5 , 30 kg K_2O and 15t FYM ha^{-1} in different combination in three phases of manuring to bajara-wheat rotation revealed that pH and EC of soil remained more or less unaffected under various treatments. The pH of soil was slightly affected due to application of FYM and phosphorus (Chaudhary *et al.*, 1981).

Bhriguvanshi (1988) studied the effect on long term application of high dose of FYM and N fertilizer on properties of clay loam soils and observed that the pH of the soil was unaffected by the action of chemical fertilizers and manures.

Badanur *et al.* (1990) reported that in vertisol, soil reaction decreased (8.5 to 8.2) significantly with Subabul and Sunhemp incorporation while electrical conductivity did not vary much (0.18 to 0.10 dsm^{-1}) with the incorporation to crop residue and green manures over

fertilizer application. While in sodic vertisol, there was reduction in pH and ESP of the soil due to application of pressmud, biogas slurry, FYM and wheat straw. The FYM in combination with pressmud showed maximum reduction in pH from 9.0 to 8.4 and ESP from 22.0 to 14.0 during these successive years (More,1994).

The result of an experiment in mollisol conducted at Pantnagar revealed that continuous use of manures and fertilizers had not affected EC of soil (Tyagi and Bhardwaj, 1994).

Ghuman *et al.* (1997) reported a significant decreases in pH by 0.3 units in surface layers with sunhemp green manuring for four years under rainfed condition on sandy loam soil, however in subsoil layer, the effect was non-significant. Further the combined application of organics (cow dung slurry and paddy straw) and inorganic sources of nutrients resulted in reduction of soil pH (8.45 to 8.24) and EC (0.21 to 0.18 dsm^{-1}) but could not reach the level of significance when compared with control (Bellakki and Badanur, 1994).

Ismail *et al.* (1998) observed a significant reduction (8.07 to 7.99) in pH value of vertisol with application of FYM @ 30 Mg ha^{-1} over control within one year.

Bellakki and Badanur (2000) noticed that the soil pH and EC were not influenced significantly with the incorporation of sorghum stubbles alone or in combination with cellulolytic organisms A and B and other treatments. Prakash *et al.* (2002) reported on increase in pH from 5.5 to 6.2 in acid laterite soil with application of farm yard manure.

Paneerselvam *et al.* (2000) reported that field experiment were conducted from June 1994 to April 1996, covering two Kharif and two summer seasons to evaluate the combined effect of organic manures and inorganic fertilizers with different weed management practices on the soil

available phosphorous status and P uptake of soybean. Application of bio-digested slurry@ 5t ha^{-1} + 30 : 120 : 140 Kg NPK ha^{-1} recorded the highest P uptake by soybean in all the seasons. Hand weeding twice favourably increased the availability of P in soil, followed alachlor + hand weeding.

Slight reduction in soil pH and $CaCO_3$ content of vertisol with organic manure in combination with inorganic fertilizer over control was reported by Lakade *et al.* (2002).

Bharambe and Tomar (2004) reported that application of NPK fertilizers with FYM significantly increased the available phosphorous content in soil over that of without FYM and the treatment combination 100% NPK + FYM was found as the optimum for increasing available P and K contents founded by other treatments.

Halemani *et al.* (2004) observed more reduction in pH with the application of FYM alone @10 t ha^{-1} followed by FYM + IGM and FYM + CR when compared with fertilizer application and control. However, organics alone and their combination had no significant influence on EC.

Surekha and Rao (2009) reported that organic sources improved the soil physical (bulk density and penetration resistance; fertility, (soil organic carbon and available N and K) and biological (soil respiration) parameters over inorganic fertilizer alone.

C) Biological properties

The total bacterial and non–symbiotic N fixing bacterial population increased with increased level of wheat straw application, but were reduced by neem cake addition (Das and Mukherjee, 1990).

Sharma *et al.* (1983) reported that, the microbial population also enhanced significantly due to crop residue and FYM as compared to the chemical fertilization.

Reddy (1997) reported that the crop residues play significant role in altering the dynamics of soil microflora. The bacterial, fungal and actinomycetes population were greater during second year of study due to the effect of crop residue.

Thakare and Gupta (2003) studied the effect of cropping system and nutrient management on microbial population. Maximum fungal, actinomycetes and bacteria population were recorded under condition during summer season. Application of FYM, wheat straw and green manuring greatly boosted the fungal population while FYM in combination with NPK fertilizer was found to be most promising in enhancing actinomycetes and bacterial population. Highest fungal count was noted under sorghum-chickpea-groundnut followed by sorghum-wheat-green gram.

Selvi *et al.* (2004) studied the microbial population and biomass in rhizosphere as influenced by continuous intensive fertilization and concluded that bacteria, fungi and actinomycetes proliferated well under continuous application FYM and NPK.

Thakur and Sharma (2005) studied the long term effect of fertilizers and farm yard manure on chemical, microbiological properties and total productivity in mid hill acid soils. As records the microbial population and microbial biomass, higher values were recorded in FYM + 100% NPK treatment i.e. 71 cfu (10^6 g^{-1} soil) of bacteria and fungi 62 x 10^{-6} g^{-1} of soil compare to 100% NPK i.e. contain only 5 x 10^{-6} g^{-1} and 3.4 x 10^{-6} g^{-1} of soil bacteria and fungi respectively.

Singh *et al.* (2007) reported that soil microbial population (actinomycetes, fungi, bacteria) enhanced due to application of organic amendments in comparison to absolute control as well as recommended fertilizer application that in turn resulted in notable enhancement in soil

dehydrogenase and phosphatase enzyme activity. Addition of four organic amendment Viz. BGA, *azolla*, FYM and vermicompost could give the optimum yield (4.50t ha^{-1}) of organic Basmati rice and improve grain and soil quality.

Battikopad *et al.* (2009) conducted the field experiment at Pune during 2006-07 with enrichment process in earthen composting pits having volume of 0.125 m3 (50 x 50 x 50cm). It indicated that the use of rock phosphate, micronutrients, Bacillus Spp., *Azotobactor*, composting culture, effective microorganisms and earthworm was more effective and beneficial for activities of microorganisms and composting of cattle dung.

Surya *et al.* (2000) observed that bacterial population predominated over fungi and actinomycetes and maximum microbial population was observed in treatment $N_{20}P_{40}$ + 6 mt wheat straw ha^{-1}.

Reddy *et al.* (2002) observed that microbial population was significantly influenced by crop residues like wheat straw, black gram straw. Among the microbiota, the population of bacteria was more followed by actinomycetes and fungi.

Hangare *et al.* (2004) reported that microbial population was significantly enhanced due to application of vermicompost and coir pith compost each alone and in combination with either other organic and inorganic fertilizers over control.

Venkateswarlu and Srinivasrao (2004) noticed that microbial population majority occur in 40 cm of top soil and bacteria are predominant followed by actinomycetes and fungi. Management practices such as irrigation, fertilizer application and residue incorporation have major impact on diversity of biological population.

2.6 Effect of organic sources on fertility status of soil

Singh *et al.* (1980) observed the continuous application of FYM, resulted the lowering pH and increasing in organic carbon content, cation exchange capacity and exchangeable cotions and also build up of available nitrogen, phosphorus and postassium with the used of phosphatic fertilizers.

Sharma (1992) observed the conjuctive use of 6 tha-1 of FYM along with half of the recommended levels of fertilizer N enhanced the crop yield of soybean and Safflower as compared with the equivalent level of nutrient applied through fertilizer source alone. The combined use of FYM along with fertilizer were significant build up of soil fertility and improvement in physico-chemical properties of soil as well as fixation of atmospheric N in soil.

The addition of pressmud, biogas slurry, FYM and wheat straw had beneficial effect in organic carbon content of sodic vertisol. FYM @ 50 t ha^{-1} showed highest increase in organic carbon (0.68%). More (1994).

Rajkhowa *et al.* (2003), reported that, the significant increase in yield of green gram, nutrient (N & P) uptake and nodulation was observed combine use of fertilizer and vermicompost. Soil orgnic carbon, available N, P and K status in soil improved significant with vermicompost alone or in combination with fertilizer. Result clarly indicated the possibility of saving 25 to 50 percent fertilizer through the addition of 2.5 tha^{-1} vermicompost and overall improvement in soil health.

Ismail *et al.* (1998) reported significant increase in organic carbon (5.4 to 6.7 g kg^{-1}) content of vertisol with the application of FYM @ 30 Mg ha^{-1} over control.

Reddy *et al.* 1998 reported that the experiment was conducted for two consecutive years during kharif and rabi season of 1994-95 and 1995-96 at Hyderabad in maize-soybean cropping system. Combination of four levels (25, 50, 75 and 100% substitution of recommended dose of N) each of vermicompost, poultry manure, biogas slurry and farmyard manure along with recommended dose of fertilizer (RDF) and control indicate that the available N, P, K, Fe, Cu, Mn in soil were influenced by the level of manure application .

Sharma (1999) recorded the treatment involving FYM and crop residues applied either alone or in combination with reduced levels of fertilizer N and were most effective in building up of soil fertility in the long run as well as highest productivity of soybean and safflower, water used efficiency and uptake of N, P, K and S were realised due to the treatment FYM 6 t + N_{20} P_{15} i.e. the integrated use of 6 tha^{-1} of FYM along with half of the recommended level of fertilizer N & P.

The organic carbon content was considerably increased with the application of vermicompost in combination with N, P and K over the application of N, P and K alone (Vasanthi and Kumarswamy, 1999). Another field experiment on the residual effect of long term use of fertilizers alone and in combination with FYM in vertisol showed that the application of 7.5 Mg FYM ha^{-1} with 50% dose of N and P increased the organic carbon content (Babulkar *et al.*, 2000).

Vasanthi and Kumarswamy (1999) conducted the field experiment during 1994-95 and 1995-96 on a red sandy clay loam soil at Madurai. A vermicompost prepared were tried at 5 and 10t ha^{-1} with N, P and K at recommended levels. The results showed that the grain yields were significantly higher in treatments that received vermicompost. Organic carbon content and fertility status as reflected by the available status of N,

P and K, micronutrients and CEC were higher and bulk density lower in the treatments that received vermicompost plus N, P and K than in the treatment with N, P and K alone.

Sharma *et al.* (2000) found that incorporation of crop residue significantly increased the DTPA extractable micronutrient i.e. Zn, Fe, Mn and Cu over their status in non residue incorporated plots. Effect of FYM on availability of micronutrients was more pronounced when compared with crop residue treated plots .The application of 5t FYM ha^{-1} + RDF in vertisol increased Zn, Cu, Fe, Mn status of soil (Guled *et al.*, 2002).

After twenty eight years of continuous intensive cropping under various fertilizer and manurial treatments, the organic carbon content of soil increased in all treatments and the highest value (9.6 g Kg^{-1}) was recorded with 100% NPK + FYM treatment (Tiwari *et al.*, 2002).

An experiment on vertisol conducted to study the effect of integrated nutrient management on soil properties revealed that organic carbon content increased from 5.53 to 7.73 per cent with addition of organic manures alone and from 6.92 to 9.52 per cent in combination of organic manures with fertilizers as compared to RDF (Katkar *et al.*, 2002).

A significant build up of Fe, Zn, Mn and Cu in vertisol in the treatment receiving 50 percent RDF + 5 Mg FYM ha^{-1} as compared to application of RDF or FYM alone, whereas depletion of the micronutrient content was noticed in control (Ismail *et al.*, 2002).

Prakash *et al.* (2002) reported that soil available Fe, Cu and Zn content was significantly higher in FYM treated plots as compared to all commercial manures, chemical fertilizer and control. The trend was similar in the second year, except that the availability at Fe, which was similar in FYM and processed city waste.

Sharma *et al.* (2002) reported a significant reduction in bulk density with significant improvement in water holding capacity, CEC available N,P and S status of soil with addition of crop residues and FYM on long term basis.

The studies an effect of continuous application of organic and inorganic fertilizer on micronutrients status of an inceptisol conducted for 25 years showed that application of 100% NPK + FYM increased DTPA-Fe, Cu and Mn content in the soil. There was no significant difference in micronutrient availability within the graded level of NPK and 100% NPK but control plot had lowered the availability of micronutrients (Selvi *et al.* 2002).

Poongothai and Childeshwari (2003) conducted field experiment with black gram in red sandy loam soil for assessing the efficacy of soil application and seed treatment of Zn, B, S and Mg during 2000 and 2001. The results indicated that the available nutrient status of the post harvest soil ranged from 0.72 to 1.29 Mg Kg^{-1} for Zn, 0.37 to 0.53 Mg kg^{-1} for B and 11.2 to 15.6 Mg kg^{-1} for 0.15% $CaCl_2$-S. Application of 5 Kg Zn+ 1.5 Kg B + 0.5 Kg Mo + 40 Kg S ha^{-1} significantly enhanced the availability of Zn (1.29 Mg Kg^{-1}), B(0.53kg^{-1}) and sulphur status (15.6 Mg kg^{-1}).

Sharma and Raghu (2003) observed that application of 6t FYM + 20 Kg N + 13 Kg P ha^{-1} significantly build up to orgnic carbon , available N and P status in the soil.

Vyas *et al.* (2003) conducted a long term field experiment during 1992-98 at Sehore (M.P.) on soybean. The combined application of 5kg Zn and 10t FYM ha^{-1} increased grain yield, NPK contents in and uptake by soybean seed. The highest grain yield (1790 kg ha^{-1}) was recorded in Zn and FYM treatment with a record of B + FYM (13.6%) was

on par with seed treatment with Na molybadate + FYM showed highest build up of N (6kg ha^{-1}) or the harvest of soybean.

Halemani *et al.* (2004) recorded significantly higher soil organic carbon content with the application of FYM alone @ 10 t ha^{-1} followed by FYM + CR and FYM + IGM as compared to fertilizer application and control. Similarly, the organic carbon content of surface soil increased significantly with application of FYM alone or its combination with N and P_2O_5 (Chalwade *et al.*, 2008).

Chaturvedi and Chandel (2005) reported that there was highest yield attributes grain yield as well as NPK uptake with the application of 100 % NPK + FYM @ 10t ha^{-1}. Use of organic sources helped in maintaining soil fertility in terms of available nutrients.

An experiment was conducted at Coimbtore to study direct and residual effects of organic sources on crop performance and soil fertility in groundnut-corn cropping sequence. In both the crops organic manure had significant effect on micronutrient uptake and soil fertility as compared to inorganics and control (Mohanty *et al.*, 2007).

Chaturvedi *et al.* (2010) conducted a field experiment at Pantnagar to assess the effect of various fertilizer and manurial treatments on soybean productivity, quality and residual soil fertility during kharif season of 2003 and 2004. Fourteen treatment that include use of FYM, B and Fe over 50 and 100 per cent recommended dose of fertilizer (RDF) Viz. 20.0 : 26.4 : 33.3 kg NPK ha^{-1}. Integrated use of RDF with FYM or soil application of Fe/B being at par increased the seed yield of soybean over RDF alone (3.13 t ha^{-1}). Use of FYM and micronutrients helped in maintaining soil fertility and rhizospheric microbial population.

2.7 Effect of organic sources on economics of soybean

Badiyala and Verma (1991) studied the effect of FYM and biofertlizers in maize + soybean-wheat cropping sequence and reported that application of FYM @12 t ha^{-1} alone or in combination of biofertlizer increased the gross and net monetary returns ha^{-1} $year^{-1}$ and was more than that those obtained from other supplementary sources of nutrients.

Balsubramanian and Palaniappan (1994) reported that maximum B:C ratio with FYM + *Rhizobium* + PSB over FYM alone treatment in groundnut crop.

Rajput *et al.* (1995) reported that the profitability of conventional and mixed organic farming (organic manure with fertilizer) in Indore (Madhya Pradesh) during the years of 1992-93 and 1993-94 revealed that soybean and potato sequential crop yield was increased 53 and 58 per cent, respectively under mixed organic farming and cost benefit ratio of soybean and potato crop was just doubled in the mixed organic farming area than conventional farming.

Deshmukh *et al.* (2005) conducted the field experiment at Jabalpur during three years (2000-01 to 2002-03) amongst the INM treatments, 100 % RDF (N_{20} P_{40} for both crops) + 2.5 t FYM ha^{-1} + drainage / soil mulching proved most beneficial in raising growth and yield attributes of soybean and chickpea. The grain yield and net return from soybean was 18.16 q ha^{-1} and Rs. 12,248 ha^{-1} and in case of chickpea it was 13.93 q ha^{-1} and ₹ 14,025 ha^{-1} respectively. Thus, the total productivity and net return from soybean-chickpea sequence was 32.09 q ha^{-1} and ₹ 26,273 ha^{-1} respectively. Among the INM treatments 100% RDF + 25 t FYM ha^{-1} + drainage / soil mulching resulted in maintaining avialblel N, P and K in soil over other treatments.

Paslawar *et al.* (2007) reported that a field experiment was conducted from 2000-01 to 2002-03 for suitable integrated nutrient combination for pigeon pea + Soybean intercropping (1:2) system on vertisol, Amravati. The highest yield of pigeonpea (1065 kg ha^{-1}) and soybean (848 kg ha^{-1}) PEY (1844 kg ha^{-1}) and GMR (Rs. 3406 ha^{-1}) was recorded in the INM treatment *Viz.* 50 % RDF + Vermicompost 3 t ha^{-1} + Bio-fertilizers.

Manjunatha *et al.* (2009) field experiment was conducted at Bheemarayanugudi, during kharif 2006. Application of FYM on the rate 7.5 t ha^{-1} + Jeevamrutha recorded highest (₹ 27,384 ha^{-1}) net returns, which was on par with the treatment 100 per cent RDF (₹ 25,475 ha^{-1}) and significantly superior over treatment FYM of the rate 3.75t ha^{-1} + Jeevamrutha (₹ 24,405 ha^{-1}).

Lingaraju *et al.* (2010) conducted a field experiment at Dharwad (Karnataka) during 2005-06 and 2006-07. The treatment which received 7.5 t ha^{-1} FYM and 100% RDF recorded significantly higher maize (6348 kg ha^{-1}), bengalgram (1656 kg ha^{-1}) and maize equivalent yield (12330 kg ha^{-1}). Significantly higher gross returns (₹ 69059 ha^{-1}) and net returns (₹ 51659 ha^{-1}) were realized with application of FYM @ 7.5 t ha^{-1} + 100% RDF which were on par with vermicompost @ 2.5 t ha^{-1} + 100 per cent RDF with respect to gross returns.

CHAPTER III

MATERIAL AND METHODS

The field investigation in relation to "Effect of different organic sources on soil fertility, nutrient uptake and yield of soybean" was conducted during Kharif season of 2010-11 at Research Farm, Department of Agronomy, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola .The details of material used and methods adopted during the period of investigation are given in this chapter under appropriate heads.

3.1 Basic resources information

3.1.1 Experimental Site

The field experimental entitled "Effect of different organic sources on soil fertility, nutrient uptake and yield of soybean" was carried out at Research Farm, Department of Agronomy, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. The field selected for conducting the experiment was fairly levelled, uniform in depth and topography.

3.1.2 Soil of experimental area

The soil under the experimental area was medium in depth and well drained. In order to study the chemical properties of soil samples were taken from 0-30 cm depth from randomly selected spots over the experimental field before sowing .The physical ,chemical and biological properties are determined in laboratory and the results are presented along with method adopted for each.

3.1.3 Description of soil

The soil of the experimental field was clay loam in texture and moderately alkaline in reaction. The result of the physico-chemical and biological analysis indicated that, soil was 204.2 Kg ha^{-1} in available

nitrogen, 16.82 kg ha^{-1} in available phosphorus and 328.3 kg ha^{-1} in available potassium, 4.2 g kg^{-1} in organic carbon, soil pH was 8.1 and EC is 0.26 dSm^{-1}, respectively.

3.1.4 Climate and weather conditions

Akola is situated in sub tropical region between 22°42' N latitude and 77°02' E longitudes. The altitude of the place is 304.42 m above mean sea level. The climate of Akola is semi arid and characterized by three distinct season *Viz.*, hot and dry summer from March to May. Warm humid and rainy season from June to October and mild cold winter from November to February. Average annual precipitation on the basis of last fifteen years is 847.30 mm, which received almost from southwest monsoon during June to October and actual precipitation was 1157.4 mm with 47 rainy days during the year 2010. During the period of investigation the mean maximum temperature in hottest month (May) was 43.67°C, whereas, annual mean minimum temperature in the coldest month (January) was 11.32°C. The bright sunshine hours ranges between 2.6 to 10 per cent to 77 per cent respectively. The metrological data during the course of investigation for the period from January 2010 to December 2010 recorded at Agro-Meteorological observatory along with normal values are presented in Appendix-II.

3.2 Experimental details

3.2.1 Design of experiment and treatments

The experiment was laid out in randomized block design with eleven treatments each replicated thrice. The details of treatment are presented below. The plan of layout giving the relevant details is also presented in Fig. 1

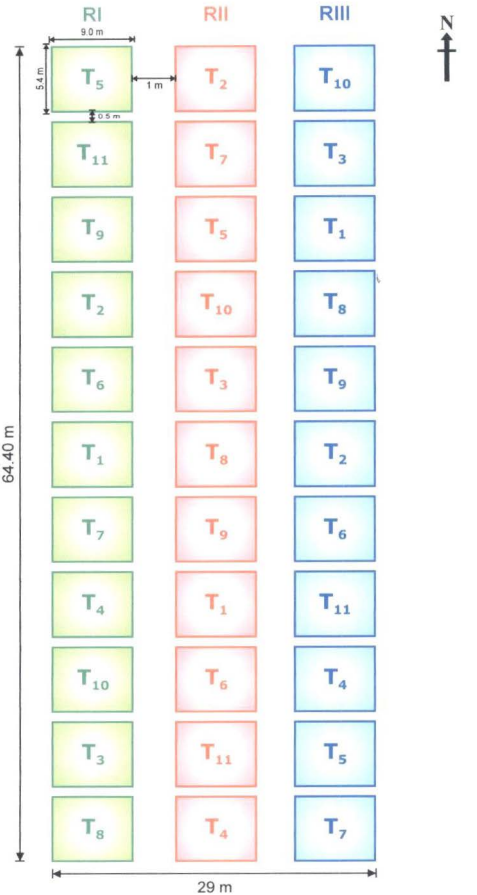
Location	:	Research Farm, Department of Agronomy, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola.
Crop	:	Soybean
Variety	:	JS-335
Season	:	2010-2011
Experimental Design	:	Randomized Block Design (RBD)
Number of Replication	:	Three
Number of Treatment	:	Eleven
Total No. of Plots	:	33
Plot Size	:	Gross 5.40 x 9.00 m Net 4.50 x 8.90 m
Seed rate	:	80 kg ha^{-1}
Method of sowing	:	Drilling method
Date of sowing	:	23/06/2010
Date of harvesting	:	4/11/2010

3.2.2 Treatments details

Treatments

T_1	Control
T_2	100% RDN through FYM
T_3	100% RDN through vermicompost
T_4	100% RDN through compost
T_5	100 % RDN through FYM + jeevamrut (30 and 45 DAS)*
T_6	100 % RDN through vermicompost + jeevamrut (30 and 45 DAS)*
T_7	100% RDN through compost + jeevamrut (30 and 45 DAS)*
T_8	100%RDN through cotton stalk + jeevamrut (30 and 45 DAS)*
T_9	100% RDN through wheat straw + jeevamrut (30 and 45 DAS)*
T_{10}	100% RDN through Soybean straw + jeevamrut (30 and 45 DAS)*
T_{11}	jeevamrut (30 and 45 DAS)*

Note : RDN : 30 kg ha^{-1}
* Spreading of jeevamrut @ 500 lit ha^{-1}



Design : Randomized Block Design (RBD)
Treatments : 11
Replications : 3

Fig. 1. Plan of layout

3.3 Details of cultivation

3.3.1 Field operation

Various cultural operations i.e. weeding, hoeing and harrowing were carried out in experimental field during the crop growing season.

3.3.2 Seed and sowings

Sowing of soybean (JS-335) was carried out in an experimental site on dated 23/06/2010 by drilling method. The plant population was maintained by gap filling. Sowing was carried at 45 x 5cm spacing.

3.3.3 Preparatory tillage

The experiment plot was ploughed and harrowed once to ensure proper tilth. The experimental plot was levelled and laid out as per plan of layout.

3.3.4 Application of organic manures

Organic manures like FYM, Compost, Vermicompost, Cotton Stalk, Wheat straw and Soybean straw were applied before sowing by broadcasting method.

3.3.5 Application of jeevamrut as a liquid manurial

As per the treatments jeevamrut was applied to the soybean after 30 and 45 DAS. Rate of application of jeevamrut was 500 lit. ha^{-1} by spreading.

Methodology for preparation of Jeevamrut

Ingredients :

Fresh cow dung	-	10-15 Kg
Water	-	200-250 lit.
Cow urine	-	3-4 lit.
Jaggery	-	1-2 Kg
Pulse flour	-	2 Kg
Garden Soil	-	1 Kg

The above mixture was prepared in earthen pot. It was stirred daily with wooden stick for 10 minutes up to 7 days. Then the mixture was diluted 10 minutes with water and applied to the crop @500 liters ha^{-1} at 30 and 45 DAS.

Chemical composition (%) of organic sources added in soil

Organic sources	N	P	K
FYM	0.62	0.24	0.64
Vermicompost	1.07	0.28	0.77
Compost	0.58	0.36	0.80
Cotton stalk	0.44	0.31	0.63
Wheat straw	0.41	0.22	0.53
Soybean straw	0.61	0.18	0.45
Jeevamrut	1.13	0.30	0.81

3.3.6 Plant protection

No serious pests and diseases were noticed on the crop during growing period.

3.3.7 Intercultural operation

Gap filling was carried out one week after sowing and 2-3 hoeing and hand weeding were also done during crop growing period.

3.3.8 Harvesting

Cut the soybean crop from ground level with the help of sickle and tied in bunches for threshing.

3.4 Soil and plant sampling

3.4.1 Soil sampling

Composite soil sample (0-30cm depth) before sowing of crop was taken from the experimental area. The soil samples were dried in shade and gently grind with pestle and morter and sieved through 2mm

sieve. These samples were stored in polythene bags. Similarly, the soil clods were also collected for determination of physical properties like BD, HD, MWD etc.

3.4.2 Soil analysis

3.4.2.1 Determination of soil physical properties

3.4.2.1.1 Particle size distribution

Mechanical analysis was carried out by the International pipette method (Black,1965).

3.4.2.1.2 Bulk density

Bulk density was determined by clod coating method (Blake and Hartze, 1986).

3.4.2.1.3 Water tension

Water retention was determined by pressure plate and membrane method (Klute, 1986).

3.4.2.1.4 Hydraulic conductivity

Hydraulic conductivity was determined by constant head method (Klute and Dirksen, 1986).

3.4.2.1.5 Mean weight diameter

Mean weight diameter was determined by Yoder's apparatus method (Kemper and Rosenau, 1986).

3.4.2.2 Determination of soil chemical properties

3.4.2.2.1 Soil reaction

The pH was determined in soil suspension (1:2.5 soil : water) by glass electrode pH meter after equilibrating the soil with water for 30 minutes with occasional stirring (Jackson, 1973).

3.4.2.2.2 Electrical conductivity

Electrical conductivity was determined in soil suspension (1:2.5 soil : water) after equilibrating the soil with water and keeping the sample undisturbed till the supernant solution is obtained and measured using conductivity meter (Jackson,1973).

3.4.2.2.3 Organic carbon

For the determination of organic carbon by the Walkley and Black's method was followed (Jackson, 1973).

3.4.2.2.4 Calcium carbonate

Calcium carbonate was determined by rapid titration method (Jackson,1973).

3.4.2.2.5 Available nutrients

3.4.2.2.5.1 Nitrogen

Available Nitrogen was determined by alkaline potassium permanganate method (Subbiah and Asija, 1956).

3.4.2.2.5.2 Phosphorus

Available phosphorus was determined by Olsen's (1965) method using 0.5 M sodium bicarbonate pH (8.5) as extractant. Darco G-60 free soluble phosphorus was used to absorb the dispersed organic matter and make the filtrate colourless for further colorimetric analysis (Watanabe and Olsen, 1965).

3.4.2.2.5.3 Potassium

Available potassium was determined by neutral normal ammonium acetate method using flame photometer (Hanway and Heidel, 1952).

3.4.2.2.5.4 Micronutrients

Available micronutrients *Viz.*, Zn, Fe, Cu, and Mn, were determined by using DTPA as extractant (Lindsay and Norvell, 1978) using atomic absorption spectrophotometer.

3.5.1 Plant analysis

The treatments wise plant samples were selected randomly from each plot and carefully cut on ground level at harvesting stage. The plant samples were dried in shade and then placed in oven at 64°C. These plant samples were grind in electric grinding machine and this powdered material was used to chemical analysis for determination of total N, P and K.

3.5.2 Chemical studies of plant sample

3.5.2.1 Total nitrogen

It was determined by Microkjeldahl's method (Piper, 1966).

3.5.2.2 Total phosphorus

It was determined by vanadomolybdate phosphoric yellow colour method (Jackson, 1973). The intensity of colour measured on colorimeter.

3.5.2.3 Total potassium

It was determined by diacid extract by using flame photometer (Piper, 1966).

3.6.1 Grain analysis

3.6.1.1 Protein

Protein is calculated by using factor 6.25 multiplied with nitrogen % of grain (Piper, 1966).

3.6.1.2 Oil

Oil was extracted using petroleum ether by souxhlet apparatus (Chapman and Pratt,1961).

3.6.1.3 Test weight

Hundred grains were counted from representative samples from each net plot and weighted separately .This hundred grain weight was worked out as test weight (gm).

3.7 Soil microbial counts

3.7.1 Collection of soil sample for microbial count

The soil samples of 0-10cm depth were collected at grand growth stage for microbial count.

3.7.2 Determination of microbial count from the soil samples

Soil microbial count was determined by serial dilution plate technique (Dhingra and Sinclair, 1993). In this technique one gram of soil sample was taken under aseptic condition in 10 ml sterile test tube and added 9 ml distilled water, shaked thoroughly. Then 1ml suspension transferred in a 10 test tube and added 9 ml distilled water in it. Shake the test tube well and diluted 10 times by distilled water to get desired level of 10^{-3},10^{-4},10^{-5}, 10^{-6},10^{-7},10^{-8},10^{-9} dilution. After dilution transferred 1ml of suspension in Petridish in particular media for specific growth of microorganism.

A) For bacteria

Nutrient Agar (NA) Media

Peptone	:	5 g
Beef extract	:	3 g
Agar	:	20 g
Distilled water	:	1000 ml

Where,

GMR = Gross Monetary Return
COC = Cost Of Cultivation

3.9 Statistical analysis

The data obtained various parameters were analysed in RBD statistical procedure (Panse and Sukhatme, 1985). The appropriate standard error of mean (S.E.M) and the critical difference (C.D.) were calculated at 5% level of probability.

3.10 Place / Duration / Season of experiments

The experiment was conducted during Kharif season of the year 2010-11 on the Research Farm, Department of Agronomy, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola.

Plate 1. View of experimental plot

CHAPTER IV

RESULTS AND DISCUSSION

The result obtained from the field experiment "Effect of different organic sources on soil fertility, nutrient uptake and yield of soybean" conducted at Research Farm, Department of Agronomy, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, during Kharif 2010-11. The results obtained from field study are tabulated and discussed in this chapter under the following heads.

4.1 Physico-chemical properties of soil at the start of experiment

4.2 Effect of organic sources on yield of soybean

4.3 Effect of organic sources on nutrient content of soybean

4.4 Effect of organic sources on uptake of nutrients by soybean

4.5 Effect of organic sources on quality parameters of soybean

4.6 Effect of organic sources on soil properties

4.7 Effect of organic sources on fertility status of soil

4.8 Effect of organic sources on economics of soybean

4.1 Physico-chemical properties of soil at the start of experiment

Soil is important factors which serve as a medium for plant growth. Hence, it is essential to understand the physico-chemical properties as well as monitor the changes in nutrient availability for better crop yields. The initial properties of soil at the start of experiment are given in Table 1.

Table 1. Physico-chemical properties of experimental soil at the start of experiment (Kharif 2010-11)

Sr. No.	Soil characteristics	Values
1	Slope (%)	1 – 2
2	Mechanical analysis	
	Sand (%)	10.8
	Silt (%)	29.8
	Clay (%)	59.4
4	Order	Inceptisol
5	Sub group	Typic haplustepts
6	Textural class	Clay
7	Bulk density (Mg m^{-3})	1.26
8	Water holding capacity (%)	42
9	Hydraulic conductivity (cm hr^{-1})	0.60
10	pH (1 : 2.5)	8.1
11	$CaCO_3$ (%)	6.5
12	EC (dS m^{-1})	0.26
13	Organic carbon (g kg^{-1})	4.2
14	Available Nitrogen (kg ha^{-1})	204.2
15	Available Phosphorus (kg ha^{-1})	16.82
16	Available Potassium (kg ha^{-1})	328.3

The soil of the experimental site was classified as Typic haplustepts (Inceptisol). The soil is developed from basalt on plain land with 1 to 2% slope. The particle size analysis data indicated that the sand content was 10.8%, silt 29.8% and clay content 59.4% indicating that the soil was clay in texture. The calcium carbonate content of soil was 6.5%. The soil was moderately alkaline in reaction, medium in organic carbon,

medium in available nitrogen, low in available phosphorus and high in available potassium.

4.2 Effect of organic sources on yield of soybean

The yield data pertaining to grain and straw of soybean is given in Table 2 and depicted in Fig. 2. Yield of grain and straw of soybean were found statistically significant under different organic treatments over control.

Table 2. Effect of organic sources on yield of soybean

Treatments	Yield of soybean (q ha^{-1})	
	Grain	Straw
T_1 Control	8.08	16.70
T_2 100% RDN through FYM	14.45	27.17
T_3 100% RDN through Vermicompost	15.30	28.48
T_4 100% RDN through Compost	12.20	23.80
T_5 100% RDN through FYM + Jeevamrut (30 and 45 DAS)	14.90	27.42
T_6 100% RDN through Vermicompost + Jeevamrut (30 and 45DAS)	16.70	30.27
T_7 100% RDN through Compost + Jeevamrut (30 and 45 DAS)	13.43	24.88
T_8 100% RDN through Cotton stalk + Jeevamrut (30 and 45 DAS)	9.40	20.09
T_9 100% RDN through Wheat straw + Jeevamrut (30 and 45 DAS)	10.50	21.52
T_{10} 100% RDN through Soybean straw + Jeevamrut (30 and 45 DAS)	11.52	22.10
T_{11} Jeevamrut (30 and 45 DAS)	8.90	17.27
SE (m) ±	0.77	1.08
CD at 5%	2.29	3.18

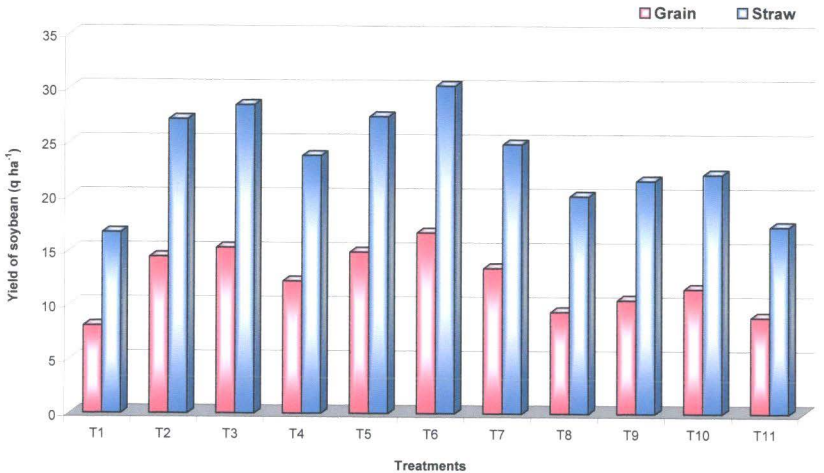


Fig. 2. Effect of organic sources on yield of soybean

The significantly highest yield of grain (16.70 q ha^{-1}) and straw (30.27 q ha^{-1}) were recorded by the treatment application of 100% RDN through vermicompost + jeevamrut (T_6) and which was statistically at par with the treatment application of 100% RDN through vermicompost (T_3), 100% RDN through FYM + jeevamrut (T_5) and 100% RDN through FYM (T_2) which were significantly superior over other treatments, whereas, lowest yield was obtained in control (T_1) and only jeevamrut (T_{11}).

The increase in yield might be due to application of organic sources *viz.* FYM, vermicompost, compost and crop residues. It create maximum nutrient availability to the soybean crop which is substantiated by the results of Tomar and Khajanji (2009) and Ghodpage *et al.* (2009), who reported the advantage of conjunctive use of organic manuring with crop residues + FYM and vermicompost for achieving higher productivity.

4.3 Effect of organic sources on nutrient content of soybean

The data pertaining to the content of nutrients as affected by various organic treatments are discussed as under.

4.3.1 Nitrogen content of soybean

Nitrogen content of soybean grain and straw is presented in Table 3.

Nitrogen content of soybean in grain and straw was highest in treatment application of 100% RDN through vermicompost + jeevaamrut (T_6) which was followed by treatment (T_3) receiving 100% RDN through vermicompost, whereas, lowest N content was observed under control plot (T_1). Comparison between organic manure, crop residues and jeevaamrut, higher N content was observed in application of organic manure over crop residues and jeevaamrut.

Table 3. Effect of organic sources on nitrogen content of soybean

Treatments	Nitrogen content (%)	
	Grain	Straw
T_1 Control	6.02	0.31
T_2 100% RDN through FYM	6.28	0.40
T_3 100% RDN through Vermicompost	6.34	0.42
T_4 100% RDN through Compost	6.23	0.39
T_5 100% RDN through FYM + Jeevamrut (30 and 45 DAS)	6.30	0.40
T_6 100% RDN through Vermicompost + Jeevamrut (30 and 45DAS)	6.35	0.42
T_7 100% RDN through Compost + Jeevamrut (30 and 45 DAS)	6.27	0.40
T_8 100% RDN through Cotton stalk + Jeevamrut (30 and 45 DAS)	6.17	0.36
T_9 100% RDN through Wheat straw + Jeevamrut (30 and 45 DAS)	6.18	0.37
T_{10} 100% RDN through Soybean straw + Jeevamrut (30 and 45 DAS)	6.20	0.39
T_{11} Jeevamrut (30 and 45 DAS)	6.12	0.35
SE (m) ±		
CD at 5%		

Increases in N content might be due to increase availability from vermicompost, FYM and compost which resulted increase N content. Similar results quoted by Bangar and Jatkar (1995) who stated that beneficial effect of vermicompost and FYM was almost identical in respect of N content of maize. Jain and Tiwari (1995) reported that the nutrient content of grain and straw of soybean increased with the application of farm yard manure and sugarcane pressmud. Sharma *et al.* (2001) also reported that incorporation of wheat residue increase in total N.

4.3.2 Phosphorus content of soybean

Phosphorus content of soybean grain and straw is presented in Table 4.

Table 4. Effect of organic sources on phosphorus content of soybean

Treatments	Phosphorous content (%)	
	Grain	Straw
T_1 Control	0.50	0.15
T_2 100% RDN through FYM	0.62	0.26
T_3 100% RDN through Vermicompost	0.66	0.28
T_4 100% RDN through Compost	0.60	0.21
T_5 100% RDN through FYM + Jeevamrut (30 and 45 DAS)	0.64	0.27
T_6 100% RDN through Vermicompost + Jeevamrut (30 and 45DAS)	0.67	0.29
T_7 100% RDN through Compost + Jeevamrut (30 and 45 DAS)	0.61	0.23
T_8 100% RDN through Cotton stalk + Jeevamrut (30 and 45 DAS)	0.55	0.18
T_9 100% RDN through Wheat straw + Jeevamrut (30 and 45 DAS)	0.58	0.19
T_{10} 100% RDN through Soybean straw + Jeevamrut (30 and 45 DAS)	0.59	0.20
T_{11} Jeevamrut (30 and 45 DAS)	0.56	0.16

Phosphorus content of soybean in grain and straw was highest in treatment application of 100% RDN through vermicompost + jeevamrut (T_6) which was followed by treatment (T_3) receiving 100% RDN through vermicompost, whereas, lowest P content was observed under control (T_1). Comparison between organic manure, crop residues and jeevamrut, higher P content was observed in application of organic manure over crop residues and jeevamrut.

Increase in P content might be due to increase availability from vermicompost, FYM and compost which resulted increase P content. Similar results were observed by Bangar and Jatkar (1995) who stated that beneficial effect of vermicompost and FYM was almost identical in respect of P content of maize. Jain and Tiwari (1995), reported that the phosphorus content of soybean grain and straw increased with the application of farm yard manure and sugarcane press mud.

4.3.3 Potassium content of soybean

Potassium content of soybean grain and straw is presented in Table 5.

Table 5. Effect of organic sources on potassium content of soybean

Treatments	Potassium content (%)	
	Grain	Straw
T_1 Control	0.37	1.55
T_2 100% RDN through FYM	0.53	1.79
T_3 100% RDN through Vermicompost	0.55	1.86
T_4 100% RDN through Compost	0.49	1.74
T_5 100% RDN through FYM + Jeevamrut (30 and 45 DAS)	0.54	1.81
T_6 100% RDN through Vermicompost + Jeevamrut (30 and 45DAS)	0.56	1.91
T_7 100% RDN through Compost + Jeevamrut (30 and 45 DAS)	0.51	1.76
T_8 100% RDN through Cotton stalk + Jeevamrut (30 and 45 DAS)	0.42	1.66
T_9 100% RDN through Wheat straw + Jeevamrut (30 and 45 DAS)	0.46	1.69
T_{10} 100% RDN through Soybean straw + Jeevamrut (30 and 45 DAS)	0.47	1.72
T_{11} Jeevamrut (30 and 45 DAS)	0.40	1.61

Potassium content of soybean in grain and straw was highest in treatment application of 100% RDN through vermicompost + jeevamrut (T_6) which was followed by treatment (T_3) receiving 100% RDN through vermicompost whereas, lowest K content was observed under control (T_1). Comparison between organic manure, crop residues and jeevamrut, higher K content was observed in application of organic manure over crop residues and jeevamrut.

Increase in K content might be due to increase availability from vermicompost, FYM and compost which resulted increase in K content. Results are in agreement with the findings by Bangar and Jatkar (1995), who stated that beneficial effect of vermicompost and FYM was almost identical in respect of K content of maize. Jain and Tiwari (1995) reported that the potassium content of grain and straw of soybean increased with the application of farm yard manure and sugarcane pressmud.

4.4 Effect of organic sources on uptake of nutrients by soybean

The data pertaining to the uptake of nutrients as affected by various organic treatments are discussed as under.

4.4.1 Uptake of nitrogen by soybean

The data pertaining to the uptake of nitrogen by soybean grain, straw and total uptake (Kg ha^{-1}) as influenced by various treatments are presented in Table 6 and depicted in Fig. 3.

Total uptake of nitrogen was calculated considering the nitrogen uptake by soybean grain as well as straw. The uptake of nitrogen was found statistically significant under different organic treatment over control.

Table 6. Effect of organic sources on uptake of nitrogen by soybean

Treatment	Nitrogen uptake (kg ha^{-1})		
	Grain	Straw	Total
T_1 Control	48.64	5.17	53.81
T_2 100% RDN through FYM	90.74	10.86	101.6
T_3 100% RDN through Vermicompost	97.00	11.96	108.96
T_4 100% RDN through Compost	76.00	9.99	85.99
T_5 100% RDN through FYM + Jeevamrut (30 and 45 DAS)	93.87	10.69	104.56
T_6 100% RDN through Vermicompost + Jeevamrut (30 and 45DAS)	106.04	12.71	119.11
T_7 100% RDN through Compost + Jeevamrut (30 and 45 DAS)	84.20	9.95	94.15
T_8 100% RDN through Cotton stalk + Jeevamrut (30 and 45 DAS)	57.99	7.23	65.22
T_9 100% RDN through Wheat straw + Jeevamrut (30 and 45 DAS)	64.99	7.96	72.85
T_{10} 100% RDN through Soybean straw + Jeevamrut (30 and 45 DAS)	71.52	8.61	80.03
T_{11} Jeevamrut (30 and 45 DAS)	54.64	6.04	60.68
SE (m) ±	0.32	0.57	0.48
CD at 5%	0.94	1.70	1.44

The highest uptake of nitrogen in soybean grain was observed in treatment, application of 100% RDN through vermicompost + jeevamrut (T_6) and which was statistically at par with treatment T_3, T_5, T_2 and T_7 over other treatments and lowest uptake of nitrogen was found in control (T_1).

The highest uptake of nitrogen in soybean straw was observed in treatment application of 100% RDN through vermicompost + jeevamrut and which was statistically at par with treatment T_3, T_5 and T_2 over other treatments.

The total uptake of nitrogen was observed in treatment application of 100% RDN through vermicompost + jeevamrut (T_6) and which was statistically on par with treatment T_3, T_5 and T_2.

Similar results are in confirmation with the results obtained by Kadam *et al.* (2010) reported that application of 100% N through vermicompost along with fulvic acid sprays recorded significantly higher N uptake of soybean. Rajkhowa *et al.* (2003), also reported that the significant increase in nitrogen uptake by combine use of fertilizer with vermicompost.

4.4.2 Uptake of phosphorus by soybean

The data pertaining to the uptake of phosphorus as affected by various organic treatments are presented in Table 7 and depicted in Fig. 3 are discussed as under.

Table 7. Effect of organic sources on uptake of phosphorus by soybean

Treatment	Phosphorus uptake (kg ha^{-1})		
	Grain	Straw	Total
T_1 Control	4.04	2.50	6.54
T_2 100% RDN through FYM	8.95	7.06	16.01
T_3 100% RDN through Vermicompost	10.09	7.97	18.06
T_4 100% RDN through Compost	7.32	4.99	12.31
T_5 100% RDN through FYM + Jeevamrut (30 and 45 DAS)	9.53	7.40	16.93
T_6 100% RDN through Vermicompost + Jeevamrut (30 and 45DAS)	11.18	8.77	19.95
T_7 100% RDN through Compost + Jeevamrut (30 and 45 DAS)	8.79	5.72	13.91
T_8 100% RDN through Cotton stalk + Jeevamrut (30 and 45 DAS)	5.17	3.61	8.78
T_9 100% RDN through Wheat straw + Jeevamrut (30 and 45 DAS)	6.09	4.08	10.17
T_{10} 100% RDN through Soybean straw + Jeevamrut (30 and 45 DAS)	6.79	4.42	11.21
T_{11} Jeevamrut (30 and 45 DAS)	4.98	2.76	7.74
SE (m) ±	0.80	0.62	1.32
CD at 5%	2.38	1.81	3.95

Total uptake of phosphorus was calculated considering the phosphorus uptake by soybean grain as well as straw. The uptake of phosphorus was found statistically significant under different organic treatment.

The highest uptake of phosphorus in soybean grain was observed in treatment application of 100% RDN through vermicompost + jeevamrut (T_6) and which was statistically at par with treatment T_3, T_5 and T_2 over other treatments. Lowest uptake was found in control (T_1).

The highest uptake of phosphorus in soybean straw was observed in treatment application of 100% RDN through vermicompost + jeevamrut and which was statistically on par with treatment T_3, T_5 and T_2 over remaining treatments.

The total uptake of phosphorus was observed in treatment applications of 100% RDN through vermicompost + jeevamrut (T_6) and which was statistically at par with treatment T_3, T_5 and T_2 over remaining treatments.

The similar results reported by Rajkhowa *et al.* (2003) reported that the significant increase in phosphors uptake by combine use of fertilizer with vermicompost. Gosavi *et al.* (2009), also reported that total uptake of phosphorus is increased due to application of 15 t FYM ha^{-1} and was significantly superior over 10t FYM ha^{-1} and Kadam *et al.* (2010) reported that application of 100% N through vermicompost along with fulvic acid sprays recorded significantly higher P uptake of soybean.

4.4.3 Uptake of potassium by soybean

The data pertaining to the uptake of potassium as affected by various organic treatments are presented in Table 8 and depicted in Fig. 3 are discussed as under.

Table 8. Effect of organic sources on uptake of potassium by soybean

Treatment	Potassium uptake (Kg ha^{-1})		
	Grain	Straw	Total
T_1 Control	2.98	25.88	28.86
T_2 100% RDN through FYM	7.65	48.63	56.28
T_3 100% RDN through Vermicompost	8.41	52.97	61.38
T_4 100% RDN through Compost	5.97	41.41	47.38
T_5 100% RDN through FYM + Jeevamrut (30 and 45 DAS)	8.04	49.63	57.67
T_6 100% RDN through Vermicompost + Jeevamrut (30 and 45DAS)	9.35	52.37	61.72
T_7 100% RDN through Compost + Jeevamrut (30 and 45 DAS)	6.84	43.78	50.62
T_8 100% RDN through Cotton stalk + Jeevamrut (30 and 45 DAS)	3.94	33.34	37.28
T_9 100% RDN through Wheat straw + Jeevamrut (30 and 45 DAS)	4.83	36.36	41.19
T_{10} 100% RDN through Soybean straw + Jeevamrut (30 and 45 DAS)	5.41	38.01	43.42
T_{11} Jeevamrut (30 and 45 DAS)	3.56	27.70	31.26
SE (m) ±	0.59	2.76	3.19
CD at 5%	1.74	8.14	9.43

Total uptake of potassium was calculated considering the potassium uptake by soybean grain as well as straw. The uptake of potassium was found statistically significant under different organic treatment.

The highest uptake of potassium in soybean grain was observed in treatment, application of 100% RDN through vermicompost + jeevamrut (T_6) and which was statistically at par with treatment T_3, T_5 and T_2 over other treatments. Lowest uptake was found in control (T_1).

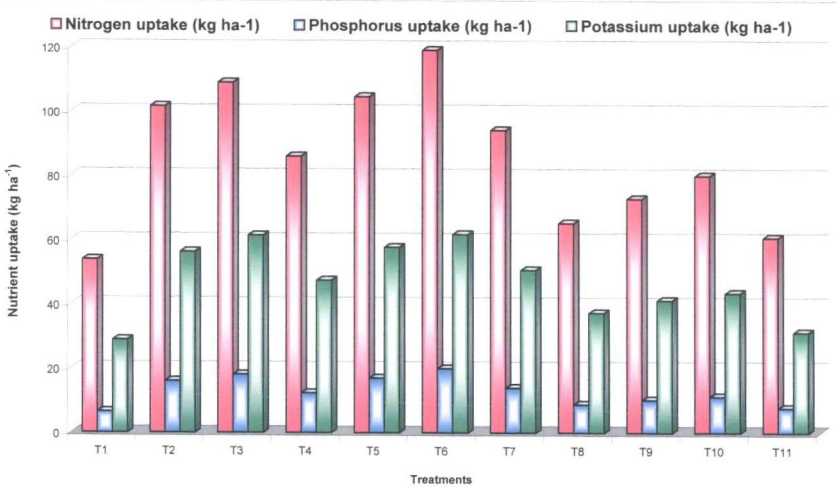


Fig. 3. Effect of organic sources on uptake of nutrients by soybean

The highest uptake of potassium in soybean straw was observed in treatment application of 100% RDN through vermicompost + jeevamrut and which was statistically at par with treatment T_3, T_5 and T_2 over other treatments.

The total uptake of potassium was observed in treatments application of 100% RDN through vermicompost + jeevamrut (T_6) and which was statistically at par with treatment T_3, T_5 and T_2 over other treatments.

The similar result reported by Kadam *et al.* (2010), reported that application of 100% N through vermicompotst along with fulvic acid sprays recorded significantly higher K uptake of soybean and Gosavi *et al.* (2009) also reported that, total uptake of potassium is increased due to application of 15 t FYM ha^{-1} and was significantly superior over 10 t FYM ha^{-1}.

4.5 Effect of organic sources on quality parameters of soybean

The data pertaining to the test weight, oil and protein content as influenced by various organic treatments are presented in Table 9.

4.5.1 Test weight

Test weight (100 seed) was increased due to application of organic sources over control. Highest test weight was recorded in treatment application of 100% RDN through vermicompost + jeevamrut (T_6) and which was statistically at par with treatment T_3, T_5, T_2, T_4 and T_7 over other treatments.

The results are in agreement with the findings of Marimuthu *et al.* (2002), reported that application of vermicompost @ 12.5t ha^{-1} recorded highest 100 seed weight and pod yield of groundnut.

Table 9. Effect of organic sources on test weight, oil and protein content of soybean

Treatment	Test weight (g)	Oil (%)	Protein (%)
T_1 Control	15.17	19.14	36.18
T_2 100% RDN through FYM	16.58	19.68	39.27
T_3 100% RDN through Vermicompost	17.41	19.95	39.82
T_4 100% RDN through Compost	16.31	19.64	38.93
T_5 100% RDN through FYM + Jeevamrut (30 and 45 DAS)	17.31	19.74	39.43
T_6 100% RDN through Vermicompost + Jeevamrut (30 and 45DAS)	17.47	20.10	39.87
T_7 100% RDN through Compost + Jeevamrut (30 and 45 DAS)	16.46	19.66	39.60
T_8 100% RDN through Cotton stalk + Jeevamrut (30 and 45 DAS)	15.53	19.22	38.87
T_9 100% RDN through Wheat straw + Jeevamrut (30 and 45 DAS)	19.74	19.31	38.62
T_{10} 100% RDN through Soybean straw + Jeevamrut (30 and 45 DAS)	15.81	19.36	38.81
T_{11} Jeevamrut (30 and 45 DAS)	15.24	19.13	38.24
SE (m) ±	0.40	1.57	9.26
CD at 5%	1.17	-	-

More *et al.* (2008) reported that maximum number of grains per pod as well as test weight (g) with the application of FYM @ 5 t ha^{-1} + *Rhizobium* + PSB + Amrutpani over FYM @ 5t ha^{-1} alone in soybean crop.

4.5.2 Oil content

The oil content in soybean grain was observed in the range between 19.14 to 21.10%. There is no significant result were found by using various sources of organic manures. The oil content in soybean grain was highest (20.10%) in the receiving treatment application of 100%

RDN through vermicompost + jeevamrut (T_6) followed by treatment application of 100% RDN through vermicompost (T_3). The application of organic sources i.e. vermicompost, FYM and compost reported highest oil content as compared to other treatments like soybean straw, wheat straw and cotton stalk as well as jeevamrut. Increase in oil content might be due to higher percentage of unsaturated fatty acid with organic sources may be attributed to the balanced nutrition of the crop. It seems to be involved in and increased conversation and primary fatty acid metabolits to end products of fatty acid increased activity of acetyl co-A resulting in higher oil content Chaturvedi et al. (2010) and Sonkamble *et al.* (2010) also similar results reported by application of organic manure alone or in combination with *Rhizobium* inoculation shown maximum seed oil content.

4.5.3 Protein content

The protein content in soybean grain was observed in the range between 36.18 to 39.87%. There is no significant result were found by using various sources of organic manures. The protein content in soybean grain was highest (39.87%) in the receiving treatment application of 100% RDN through vermicompost + jeevamrut (T_6), followed by treatment application of 100% RDN through vermicompost (T_3). The application of organic sources i.e. vermicompost, FYM and compost were found highest protein content as compared to other treatments like soybean straw, wheat straw and cotton stalk as well as jeevamrut application.

The protein content of seed increased with the increase in nitrogen levels from organic sources. This may be due to its being the constituents of amino acids which over the building blocks of protein.

Similar finding quoted by Sonkamble *et al.* (2010) who reported that application of organic manure alone or in combination with

Rhizobium inoculation shown maximum seed protein content. Aruna and Reddy (1999) also found that, application of organic manure@ 15 t ha^{-1} produced maximum protein in soybean seed.

4.6 Effect of organic sources on soil properties

4.6.1 Effect of organic sources on physical properties of soil

The data pertaining to the physical properties of soil as influenced by various organic treatments are presented in Table 10.

Table 10. Effect of organic sources on physical properties of soil

Treatment	B.D ($Mg\ m^{-3}$)	H.C ($cm\ hr^{-1}$)	MWD (mm)	AWC (%)
T_1 Control	1.32	0.60	0.34	18.97
T_2 100% RDN through FYM	1.29	0.66	0.44	20.63
T_3 100% RDN through Vermicompost	1.28	0.67	0.46	20.78
T_4 100% RDN through Compost	1.30	0.65	0.40	20.10
T_5 100% RDN through FYM + Jeevamrut (30 and 45 DAS)	1.28	0.66	0.45	20.08
T_6 100% RDN through Vermicompost + Jeevamrut (30 and 45DAS)	1.27	0.68	0.47	22.12
T_7 100% RDN through Compost + Jeevamrut (30 and 45 DAS)	1.30	0.67	0.40	21.38
T_8 100% RDN through Cotton stalk + Jeevamrut (30 and 45 DAS)	1.31	0.62	0.38	19.71
T_9 100% RDN through Wheat straw + Jeevamrut (30 and 45 DAS)	1.31	0.63	0.39	19.79
T_{10} 100% RDN through Soybean straw + Jeevamrut (30 and 45 DAS)	1.30	0.64	0.40	19.96
T_{11} Jeevamrut (30 and 45 DAS)	1.31	0.61	0.36	19.35
SE (m) ±	0.01	0.004	0.012	0.62
CD at 5%	-	0.014	0.037	1.83

4.6.1.1 Bulk density

The bulk density of soil was determined after harvest of soybean and data presented in Table 10 under various treatments and it was raised from 1.27 to 1.32 Mg m^{-3}.

Lower bulk density of a soil was found in treatment application of 100% RDN through vermicompost + jeevamrut (T_6) over other treatments and control.

In comparison between vermicompost, FYM, compost cotton stalk, wheat straw and soybean straw were observed slightly reduction in bulk density as compared to control.

Bulk density decrease might be due to organic sources application and also decomposition of organic material, so that porosity increase, bullk density decrease. As lower bulk density is supposed to be good characteristic. There is no significant difference were observed in organic sources with jeevamrut over without jeevamrut. Similar results were recorded by Vasanthi and Kumarswami (1999), reported that significant reduction in bulk density was observed in the treatment that received vermicompost along with N, P and K than in the treatment along with N, P and K alone.

Badanur *et al.* (1990), Bellakki and Badnur (1994), reported that significantly decrease in bulk density with the application of FYM either alone or in combination with fertilizer over fertilizer application and control.

4.6.1.2 Hydraulic conductivity

The hydraulic conductivity of soil was determined after harvest of soybean and data presented in Table 10 under various treatments and it was raised from 0.60 to 0.68cm hr^{-1}. Hydraulic conductivity of soil was found statistically significant in treatment application

of organic sources over control. Significantly highest value of hydraulic conductivity was recorded by the treatment receiving the application of 100% RDN through vermicompost + jeevamrut (T_6) and it was at par with treatment T_2, T_3, T_5 and T_7 over other treatments. The data clearly indicate that, the values of hydraulic conductivity is increase might be due to porous nature of surface soil as a result of continuous tillage and comparatively higher organic matter status. There is no significant difference observed in organic sources with jeevamrut and without jeevamrut treatment.

Similar result also reported by Marathe and Bharambe (2005) significant improvement in hydraulic conductivity due to different treatment, highest values were observed with the application of FYM (to supply 100 % N) followed by application of wheat straw (to supply 50% N) + 50% RDF over other treatments.

4.6.1.3 Mean weight diameter

Mean weight diameter (MWD) varied from 0.34 to 0.47mm under various treatments. MWD of soil was found statistically significant under different organic treatment. Highest mean weight diameter value of 0.47mm was found in sources application of 100% RDN through vermicompost + jeevamrut (T_6) and it was statistically at par with treatment T_2, T_3 and T_5 over other treatments.

Highest MWD were observed in application of organic sources like vermicompost, FYM, compost over crop residues like cotton stalk, wheat straw, soybean straw. There is no significant difference was observed in organic sources with jeevamrut over without jeevamrut.

Kurval and Tripathi (1990) and Taywade (1996) were reported that use of 50% NPK combined with 50% N through organic FYM, wheat straw and green manure or 75% NPK through fertilizer combined

with 25% N through wheat straw or green manure are equally effective in having increased mean weight diameter.

4.6.1.4 Available water capacity

The value for available water capacity (AWC) was found statistically significant under effect of organic sources. The value of available water capacity between 18.97 to 22.12%. Significantly highest AWC value was found in treatment application of 100% RDN through vermicompost + jeevamrut (T_6) and which was statistically at par with treatment T_3, T_5, T_2 and T_7 over other treatments. Use of organic sources was found statistically superior over the use of crop residues and jeevamrut. In respect of AWC, Badanur *et al.* (1990) reported that incorportation of sorghum stubbles and safflower stalk @ 5t ha^{-1} significantly increased the available water capacity as compared with fertilizer treatment. Venkatesh *et al.* (1992) reported that FYM treated plot (100% NPK + FYM) showed comparatively high available water capacity than other fertilizer treatments.

4.6.2 Effect of organic sources on chemical properties of soil

The data pertaining to the chemical properties of soil as influenced by various organic treatments are presented in Table 11.

4.6.2.1 Effect of various treatment on pH and EC

The results regarding pH and EC after harvest of soybean are presented in Table 11. The changes in pH and EC due to application of organic sources were non-significant. The pH value varied from 7.4 to 8.1 which is found maximum in control and minimum in plot were organic sources is added. Electrical conductivity of soil showed slightly changes but non significant than initial values. The EC varied from 0.24 to 0.26 dSm^{-1}. Higher pH and EC was recorded in control and lower pH and EC was observed in treatment application of various organic sources and crop

residues. The organic manures and crop residues are organic in nature and during their decomposition in soil, release organic acid in soil, may help to reduction in pH and EC.

Table 11. Effect of organic sources on chemical properties of soil

Treatments	pH (1: 2.5)	EC (dSm-1)	$CaCO_3$ (%)
T_1 Control	8.1	0.26	6.5
T_2 100% RDN through FYM	7.6	0.25	6.1
T_3 100% RDN through Vermicompost	7.4	0.25	6.0
T_4 100% RDN through Compost	7.6	0.25	6.2
T_5 100% RDN through FYM + Jeevamrut (30 and 45 DAS)	7.5	0.24	5.9
T_6 100% RDN through Vermicompost + Jeevamrut (30 and 45DAS)	7.4	0.24	5.9
T_7 100% RDN through Compost + Jeevamrut (30 and 45 DAS)	7.7	0.25	6.2
T_8 100% RDN through Cotton stalk + Jeevamrut (30 and 45 DAS)	7.8	0.26	6.4
T_9 100% RDN through Wheat straw + Jeevamrut (30 and 45 DAS)	8.1	0.25	6.3
T_{10} 100% RDN through Soybean straw + Jeevamrut (30 and 45 DAS)	7.9	0.25	6.3
T_{11} Jeevamrut (30 and 45 DAS)	8.0	0.26	6.5
SE (m) ±	0.11	0.01	0.4
CD at 5%	-	-	-

The similar results found by Tyagi and Bhardwaj (1994), continuous use of manures and fertilizers had not affected the EC of soil. Ismail *et al.* (1998) reported that significant reduction in pH value of vertisol with application of FYM@ 30Mg ha^{-1} over control within one year. Bellakki and Badanur (1994) noticed that the soil pH and EC were not influenced

significantly with the incorporation of sorghum stubbles alone or in combination with cellulolytic organisms A and B and other treatments.

4.6.2.2 Calcium carbonate

The results regarding $CaCO_3$ after harvest of soybean is presented in Table 11. The changes in $CaCO_3$ due to application of organic sources is found non-significant. The calcium carbonate values varied from 5.9 to 6.5 per cent. Higher $CaCO_3$ was recorded in control and lower $CaCO_3$ was observed in treatment application of various organic sources and crop residues.

The similar results found by Lohakare (1980) reported that long term use of FYM and fertilizers did not affect the $CaCO_3$ content to a noticeable level.

4.6.3 Effect of organic sources of biological properties of soil

The data pertaining to the microbial population in soil as influenced by various organic treatments are presented in Table 12.

The population of bacteria, fungi and actinomycetes were found significantly superior in treatment application of organic manures over control. Value of bacteria population varied from 23 – 38 cfu x 10^8 g^{-1} soil, fungi population varied from 11 - 23 cfu x $10^5 g^{-1}$ soil and actinomycetes varied from 14 – 26 cfu x 10^6 g^{-1} soil,

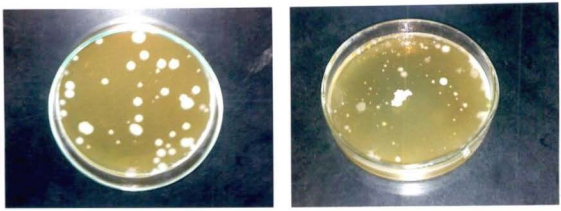
In treatment application of 100% RDN through vermicompost + jeevamrut (T_6) was recorded the highest population of bacteria, fungi and actinomycetes and statistically at par with treatment application of 100% RDN through vermicompost (T_3) and 100% RDN through FYM + jeevamrut (T_5) over remaining treatments and lowest microbial population was observed in control.

Table 12. Effect of organic sources on microbial population in soil

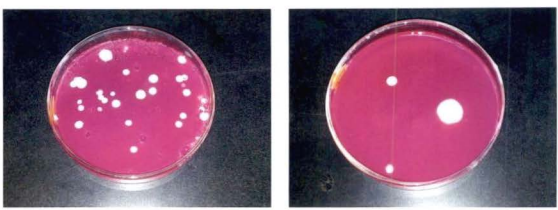
Treatments	Bacteria (cfu $x10^8$ g^{-1})	Fungi (cfu $x10^5$ g^{-1})	Actinomycetes (cfu x 10^6 g^{-1})
T_1 Control	23.00	11.00	14.00
T_2 100% RDN through FYM	34.00	19.00	23.00
T_3 100% RDN through Vermicompost	35.00	21.00	25.00
T_4 100% RDN through Compost	32.00	17.00	21.00
T_5 100% RDN through FYM + Jeevamrut (30 and 45 DAS)	36.00	21.00	24.00
T_6 100% RDN through Vermicompost + Jeevamrut (30 and 45DAS)	38.00	23.00	26.00
T_7 100% RDN through Compost + Jeevamrut (30 and 45 DAS)	33.00	18.00	21.00
T_8 100% RDN through Cotton stalk + Jeevamrut (30 and 45 DAS)	28.00	13.00	17.00
T_9 100% RDN through Wheat straw + Jeevamrut (30 and 45 DAS)	29.00	14.00	18.00
T_{10} 100% RDN through Soybean straw + Jeevamrut (30 and 45 DAS)	30.00	16.00	19.00
T_{11} Jeevamrut (30 and 45 DAS)	26.00	12.00	16.00
SE (m) ±	1.06	0.78	0.69
CD at 5%	3.16	2.34	2.07

In comparison between organic sources (FYM, compost, vermicompost) and crop residues (soybean straw, wheat starw, cotton stalk), organic sources give the better response in microbial population over crop residues. In case of jeevamrut, application of oraganic sources with jeevamrut give the better response of microbial population over without application of jeevamrut.

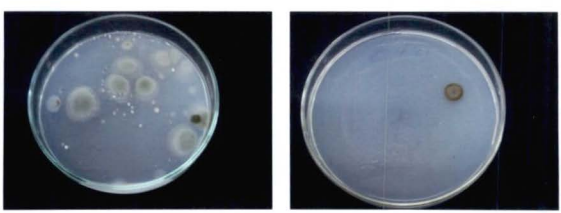
Similar, results were found by Hangare et al. (2004) reported that microbial population was significantly enhanced due to application of



T_6 Bacterial Count T_1



T_6 Fungal Count T_1



T_6 Actinomycetes Count T_1

Plate 2. Soil microbial population

vermicompost and coir pith compost each alone and in combination with either other organic and inorganic fertilizers over control. Selvi *et al.* (2004) also concluded that bacteria fungi and actinomycetes proliferated well under continuous application of FYM and NPK.

4.7 Effect of organic sources on fertility status of soil

The data pertaining to the fetility status of soil as influenced by various organic treatments are presented in Table 13. Organic carbon, available N, P and K were found statistically significant under different organic treatments.

Table 13. Effect of organic sources on fertility status of soil

Treatment	O.C. (g kg^{-1})	Available Nutrients (kg ha^{-1})		
		N	P	K
T_1 Control	4.2	204.2	16.82	328.3
T_2 100% RDN through FYM	5.0	222.1	20.56	342.6
T_3 100% RDN through Vermicompost	5.1	223.2	21.66	343.2
T_4 100% RDN through Compost	4.9	216.9	20.54	337.2
T_5 100% RDN through FYM + Jeevamrut (30 and 45 DAS)	5.0	223.1	21.08	343.5
T_6 100% RDN through Vermicompost + Jeevamrut (30 and 45DAS)	5.1	226.2	21.68	346.1
T_7 100% RDN through Compost + Jeevamrut (30 and 45 DAS)	5.0	218.9	20.56	338.5
T_8 100% RDN through Cotton stalk + Jeevamrut (30 and 45 DAS)	4.6	210.1	18.69	333.1
T_9 100% RDN through Wheat straw + Jeevamrut (30 and 45 DAS)	4.8	211.1	19.88	334.5
T_{10} 100% RDN through Soybean straw + Jeevamrut (30 and 45 DAS)	4.9	213.1	20.12	339.9
T_{11} Jeevamrut (30 and 45 DAS)	4.4	208.3	18.14	331.7
SE (m) ±	0.13	1.41	0.43	1.32
CD at 5%	0.39	4.31	1.26	3.90

long term fertilizer application of 100% recommended dose of NPK with 10t FYM ha^{-1} enhanced spectacularly the amount of available nitrogen content of soil.

4.7.3 Available phosphorus

Available phosphorus status of soil after harvest of soybean was significantly increased with use of organic sources. Application of 100% RDN through vermicomost + jeevamrut (T_6) showed highest available P content in soil which was statistically at par with treatment T_3, T_5, T_2, T_7, T_4 and lowest was found in treatment control (T_1).

Similar findings are reported by Vasanthi and Kumarswami (1999), who revealed that available phosphorus status was higher in the treatments that received vermicompost plus N,P and K than in the treatment with N,P and K alone Babhulkar *et al.* (2000) also reported that available P of soil was found to significantly increased by the application of higher rate of FYM.

4.7.4 Available potassium

Available K content in soil after harvest of soybean was significantly increased with use of organic sources. Application of 100% RDN through vermicompost + jeeevamrut (T_6) showed highest available K content in soil which was statistically at par with treatment T_5, T_3, T_2, T_4 and lowest was found in treatment control (T_1).

Similar findings are reported by Vasanthi and Kumarswami (1999), who revealed that available potassium status of soil was significantly higher in the treatments receiving vermicompost than any other organic material besides NPK. Bharambe and Tomar (2004)also reported that application of NPK fertilizer with FYM significantly increased the available potassium content in soil over that of without FYM.

4.7.5 Effect of organic sources on micronutrient status of soil

The data pertaining to the micronutrient status of soil as influenced by various organic treatments are presented in Table 14.

Treatment difference was statistically non significant in case of micronutrients availability in soil after harvest of soybean.

Table 14. Effect of organic sources on micronutrient status of soil

Treatment	Micronutrients (ppm)			
	Zn	Fe	Cu	Mn
T_1 Control	0.61	5.75	0.54	4.1
T_2 100% RDN through FYM	0.66	6.14	0.79	4.8
T_3 100% RDN through Vermicompost	0.65	6.09	0.74	4.6
T_4 100% RDN through Compost	0.64	5.98	0.69	4.6
T_5 100% RDN through FYM + Jeevamrut (30 and 45 DAS)	0.68	6.15	0.82	4.8
T_6 100% RDN through Vermicompost + Jeevamrut (30 and 45DAS)	0.67	6.13	0.78	4.7
T_7 100% RDN through Compost + Jeevamrut (30 and 45 DAS)	0.65	6.02	0.71	4.6
T_8 100% RDN through Cotton stalk + Jeevamrut (30 and 45 DAS)	0.62	5.86	0.61	4.4
T_9 100% RDN through Wheat straw + Jeevamrut (30 and 45 DAS)	0.63	5.88	0.63	4.4
T_{10} 100% RDN through Soybean straw + Jeevamrut (30 and 45 DAS)	0.6.	5.91	0.67	4.5
T_{11} Jeevamrut (30 and 45 DAS)	0.61	5.79	0.58	4.2
SE (m) ±	0.014	0.07	0.017	0.06
CD at 5%	-	-	-	-

4.7.5.1 Available zinc

The zinc content of soil was observed in the range between 0.61 to 0.68 ppm. The zinc content in soil was highest (0.68 ppm) in the treatment application of 100% RDN through FYM+ jeevamrut (T_5) followed by treatment application of 100% RDN through FYM (T_2).similar results were also recorded by Mohanty *et al.* (2007), who revealed that organic

manure had significant effect on zinc uptake as compared to inorganics and control.

Prakash *et al.* (2002) reported that zinc content was significantly higher in FYM treated plot as compared to all commercial manures (vermicompost, neem cake and oil pellets), chemical fertilizers and control.

4.7.5.2 Available iron

The iron content of soil was observed in the range between 5.75 to 6.15ppm. The iron content in soil was highest (6.15ppm) in the receiving treatment application of 100% RDN through FYM + jeevamrut (T_5) followed by treatment application of 100% RDN through FYM (T_2).

Similar results reported by Selvi *et al.* (2002), who revealed that application of 100% NPK + FYM increased DTPA-Fe content in the soil. Prakash *et al.* (2002) also reported that, Fe content was significantly higher in FYM treated plot as compared to all commercial manures (vermicompost, neem cake and oil pellets), chemical fertilizers and control.

4.7.5.3 Available copper

The copper content of soil was observed in the range between 0.54 to 0.82 ppm. The Copper content in soil was highest (0.82 ppm) in the receiving treatment with application of 100% RDN through FYM + jeevamrut (T_5) followed by treatment application of 100% RDN through FYM (T_2).

Similar results quoted by Ismail *et al.* (2002), a significant build up of Cu in vertisol in the treatment receiving 50% RDF + 5Mg FYM ha^{-1} as compared to application of RDF or FYM alone. Prakash *et al.* (2002) reported that copper content was significantly higher in FYM treated plot as compared to all commercial manures (vermicompost, neem cake and oil pellets), chemical fertilizers and control. Their was no significant difference in micronutrients availability in the soil within the organic sources application.

4.7.5.4 Available manganese

The Mn content of soil was observed in the range between 4.1 to 4.8 ppm. The manganese content in soil was highest (4.8 ppm) in the receiving treatment application of 100% RDN through FYM + jeevamrut (T_5) followed by treatment application of 100% RDN through FYM (T_2).

Reddy *et al.* (1998) reported that the available Mn in soil was influenced due to different organic sources (vermicompost, poultry manure, biogas slurry and FYM).

4.8 Effect of organic sources on economics of soybean

Net monitory returns and benefit : cost ratio are the ultimate source to measure the economy of input used (Table 15).

Table 15. Effect of organic sources on economics of soybean

Treatments	GMR	NMR	B:C Ratio
T_1 Control	19446	6891	0.54
T_2 100% RDN through FYM	34507	17623	1.14
T_3 100% RDN through Vermicompost	36508	18452	0.93
T_4 100% RDN through Compost	29220	12915	0.79
T_5 100% RDN through FYM + Jeevamrut (30 and 45 DAS)	35522	18469	1.08
T_6 100% RDN through Vermicompost + Jeevamrut (30 and 45DAS)	39767	19884	1.00
T_7 100% RDN through Compost + Jeevamrut (30 and 45 DAS)	32034	14731	0.85
T_8 100% RDN through Cotton stalk + Jeevamrut (30 and 45 DAS)	22689	7636	0.51
T_9 100% RDN through Wheat straw + Jeevamrut (30 and 45 DAS)	25252	9199	0.57
T_{10} 100% RDN through Soybean straw + Jeevamrut (30 and 45 DAS)	27554	10251	0.59
T_{11} Jeevamrut (30 and 45 DAS)	21307	7752	0.57

The data in respect of net monitory returns and benefit cost ratio (B:C ratio) as influenced by organic sources for soybean are presented in Table 13 and the details of cultivation and selling price of soybean is presented in Annexure I.

The highest gross monitory returns of the soybean was recorded in the treatment application of 100% RDN through vermicompost + jeevamrut (₹ 39,767/-) which was followed by treatment 100% RDN through vermicompost (₹ 36,508/-) and 100% RDN through FYM + Jeevamrut (₹ 35,522/-).

The highest net monitory return of the soybean was recorded in the treatment 100% RDN through vermicompost + jeevamrut (₹ 19,884/-) which was attributed to maximum yield recorded in this treatment. This treatment was followed by treatment 100% RDN through FYM (₹ 18,452/-). The lowest net monitory returns were recorded in the treatment control (T_1).

The highest benefit cost ratio was recorded in the treatment application of 100% RDN through FYM (1.14) which was followed by treatment 100% RDN through FYM + jeevamrut (1.08).

The similar results reported by Shwetha *et al.* (2009), treatment receiving compost + vermicompot + GLM has recorded higher net monitary return which could attributed to lower production cost. Balsubramaian and Palaniappan (1994), reported that maximum B:C ratio with FYM + Rhizobium + PSB over FYM alone treatment in groundnut crop. Paslawar *et al.* (2007) reported that GMR was recorded in the INM treatment *Viz.*, 50 % RDF + Vermicompost @ 3 t ha^{-1} + Bio-fertilizers.

CHAPTER V

SUMMARY AND CONCLUSION

An investigation entitled "Effect of different organic sources on soil fertility, nutrient uptake and yield of soybean" was conducted under rainfed condition during Kharif 2010-11 at the Research Farm, Department of Agronomy, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. The soil of experimental site was fine montmorillonitic hyperthermic family of typic haplustepts.

The experiment was laid out in randomized block design with eleven treatments, with application of different organic sources. The organic sources used are FYM, vermicompost, compost, cotton stalk, wheat straw, soybean straw and jeevamrut. The physical properties namely bulk density, hydraulic conductivity, mean weight diameter, available water capacity and chemical properties like pH, EC, organic carbon, $CaCO_3$ available N, P_2O_5 and K_2O were determined before sowing and after harvest of soybean. Biological properties like microbial count was determined at grand growth stage of crop. The nutrient content and uptake of nutrient (NPK) as influenced by different organic sources were also recorded.

5.1 Yield of soybean

The significantly highest soybean yield of grain (16.70 q ha^{-1}) and straw (30.27 q ha^{-1}) were recorded by the treatment application of 100% RDN through vermicompost + jeevamrut (T_6) and which was statistically at par with the treatment application of 100% RDN through vermicompost (T_3), 100% RDN through FYM + jeevamrut (T_5) and 100%

RDN through FYM (T_2) which were significantly superior over other treatments, whereas lowest yield was obtained in control (T_1).

5.2 Content and uptake of nutrient by soybean

Content of nutrients (NPK) by soybean in grain and straw was highest in treatment, application of 100% RDN through vermicompost + jeevamrut (T_6) which was followed by treatment application of 100% RDN through vermicompost (T_3). Higher nutrient content were observed in treatment application of organic sources over crop residues and only jeevamrut application.

Uptake of nutrients (NPK) by soybean in grain, straw and total were observed in treatment, application of 100% RDN through vermicompost + jeevamrut (T_6) which was statistically par with treatment T_3, T_5, T_2 and T_7 over other treatments. Application of organic sources like FYM, compost and vermicompost were show better response in uptake of nutrient over application of crop residues and only jeevamrut application.

5.3 Quality parameters of soybean

The treatment difference was statistically significant in case of test weight while non-significant in case of oil and protein content. The test weight, oil and protein content in soybean has been increased due to use of different organic sources over crop residues and only jeevamrut application. The highest test weight, oil and protein content was recorded by the treatment application of 100% RDN through vermicompost + jeevamrut followed by the treatment 100% RDN through vermicompost.

Application of organic sources (FYM, compost and vermicompost) were showed good performance in test weight, oil and protein content of soybean over crop residues (cotton stalk, wheat straw and soybean straw) and only jeevamrut application.

5.4 Properties of soil

The bulk density of soil at harvest and it was ranged from 1.27 to 1.32 Mg m^{-3}. The maximum bulk density was found in control. The significant decrease in bulk density was found with the use of different organic sources. The minimum bulk density was found in treatment application of 100% RDN through vermicompost + jeevamrut (T_6).

The significantly highest value of hydraulic conductivity of soil was recorded by the treatment T_6 (100% RDN through vermicompost + jeevamrut) followed by treatment T_3 (100% RDN through vermicompost) and it was found statistically par with the treatment T_2 , T_3 , T_5 and T_7

The significantly highest value of mean weight diameter of soil was recorded by the treatment T_6 (100% RDN through vermicompost + jeevamrut) followed by treatment T_3 (100% RDN through vermicompost) and it was found statistically par with the treatment T_2 , T_3 and T_5.

The significantly highest value of available water capacity of soil was recorded by the treatment T_6 (100% RDN through vermicompost + jeevamrut) followed by T_3 (100% RDN through vermicompost) and it was found statistically at par with the treatment T_2 , T_3 , T_5 and T_7.

The change in pH due to use of different organic sources were non-significant. The pH value varied from 7.4 to 8.1 which is found minimum in treatment is receiving 100% RDN through vermicompost + jeevamrut.

Electrical conductivity and calcium carbonate content in soil showed slightly changes but non-significant than initial values.

Application of different organic sources helped in increase microbial population over control. The treatment application of 100% RDN through vermicompost + jeevamrut was recorded higher population of

bacteria, fungi and actinomycetes. Among there micro-organism, bacterial population predominated over fungi and actinomycetes.

5.5 Fertility status of soil

Organic carbon content in the soil after harvest of soybean under the influence of different organic sources were significant. The highest organic carbon content in soil was recorded with the application of 100% RDN through vermicompost + jeevamrut followed by 100% RDN through vermicompost.

Available N, P and K content in soil after harvest of soybean was significantly increased with the use of different organic sources. Application of 100% RDN through vermicompost + jeevamrut showed higher values of available N, P and K content in soil followed by 100% RDN through vermicompost.

The available micronutrients *viz.* Zn, Fe, Cu and Mn were significantly increased due to use of different organic sources. The highest content of Zn, Fe, Cu and Mn was observed in the treatment receiving 100% RDN through FYM + jeevamrut.

5.6 Economics of soybean

Benefit: Cost ratio is the ultimate source to measure the economy of inputs used. The highest B:C ratio was found in treatment application of 100% RDN through FYM, followed by treatment application of 100% RDN through FYM + jeevamrut. The highest GMR and NMR was found in the treatment application of 100% RDN through vermicompost + jeevamrut which was followed by the treatment application of 100% RDN through vermicompost.

5.7 Conclusion

Application of 100% RDN through vermicompost + jeevamrut followed by 100% RDN through vermicompost was found beneficial for soybean production, quality, and nutrient uptake. Use of organic sources not only increased the production but also helps in build up of the fertility status as well as improves the physical, chemical and biological properties of soil.

5.8 Implications

The present investigation concluded that the use of organic sources like FYM, vermicompost, compost, crop residues like cotton stalk, wheat straw, soybean straw and jeevamrut are very well known to improve the soil health.

In future, shortage of chemical fertilizers and increase in prices day by day have generated serious interest in the use of organic sources for supplementing inorganic fertilizers.

CHAPTER VI

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VITA

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Sr. No.	Name of Degrees awarded	Year in which obtained	Division/ Class	Name of awarding University	Subjects
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6. Research papers published (if any) : - NIL
7. Field of Interest (in which you desire to work) : Research and Development

Place : Akola
Date : 25/05/2011

Signature of Student
(Patil D. U.)

Appendix - I

Rates of Inputs and labourers used for cost of cultivation

Sr. No.	Particular of expenditure	Rates
1.	**Bullock pair (₹/day)**	200.00
2.	**Laboures**	
	Male (₹/day)	100.00
	Female (₹/day)	65.00
3.	**Cost of organic added**	
	FYM (₹/q)	150.00
	Vermicompost (₹/q)	300.00
	Compost (₹/q)	125.00
	Cotton stalk (₹/q)	60.00
	Wheat straw (₹/q)	125.00
	Soybean starw (₹/q)	100.00
	Jeevamrut (₹/ha)	450.00
4.	**Cost of seed** (₹/ha)	1500.00
5.	**Interest on working capital** (% per annum)	7.00
6.	**Selling price** (₹/q)	2200.00

APPENDIX - II

Table Monthly weather data for the year 2010 recorded at Meteorological Observatory, Department of Agronomy, Dr. PDKV, Akola

N = Normal (1971-2006)
A = Actual (2010)

Month	T MAX (°C)		T MIN (°C)		BSH (hrs)		Ws (km/hr)		RHI (%)		RHII (%)		Evap (mm)		RF (mm)		CRF (mm)	Rainy Days	
	N	A	N	A	N	A	N	A	N	A	N	A	N	A	N	A		N	A
January, 2010	29.8	28.2	11.4	11.3	8.8	6.7	5.3	1.4	68	79	29	28	4.8	4.1	9.0	30.9	30.9	0.9	2
February, 2010	32.5	32.2	13.3	16.1	9.4	5.4	6.2	2.3	57	62	22	25	6.6	5.7	10.2	1.3	32.2	0.8	0
March, 2010	37.3	38.6	17.8	20.6	9.6	6.6	7.2	3.6	41	51	19	24	6.0	9.8	9.5	15.9	48.1	0.7	1
April, 2010	41.2	42.6	23.2	26.2	10.0	7.5	9.0	6.6	35	39	14	19	13.7	14.9	3.1	2.8	50.9	0.4	1
May, 2010	42.5	43.5	27.0	29.5	9.9	6.7	14.2	10.3	46	38	18	15	16.8	17.0	16.6	0.0	50.9	1.1	0
June, 2010	37.2	37.8	25.6	27.2	7.2	4.9	14.9	9.7	71	67	41	44	10.9	11.4	150.5	173.2	224.1	7.9	5
July, 2010	32.5	31.4	23.7	24.0	4.5	3.1	11.9	6.2	84	90	61	67	5.5	4.3	212.2	345.3	569.4	12.6	16
August, 2010	30.4	30.1	23.0	23.3	4.1	3.0	11.4	4.2	87	92	68	69	4.4	3.6	215.7	279.2	848.6	9.3	11
September, 2010	32.5	31.6	22.2	23.2	6.6	5.4	7.9	4.0	84	87	57	54	5.0	4.6	111.1	128.1	976.7	7.5	6
October, 2010	33.7	33.3	18.6	21.4	8.4	5.4	4.8	2.2	76	85	39	43	5.5	5.0	52.3	41.2	1017.9	2.3	4
November, 2010	31.6	31.2	14.1	19.8	8.7	5.3	4.7	2.2	70	90	31	48	4.8	4.7	20.0	39.5	1057.4	1.2	1
December, 2010	28.3	28.3	10.6	12.2	8.8	5.7	4.6	1.5	70	84	30	33	4.3	3.9	8.4	0.0	1057.4	0.9	0