Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

**E-ISSN:** 2278-4136
**P-ISSN:** 2349-8234
JPP 2019; 8(5): 1492-1496
Received: 13-07-2019
Accepted: 15-08-2019

**Kalyani A**
Department of Soil Science and Agricultural Chemistry, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra, India

**Sapkal SM**
Department of Soil Science and Agricultural Chemistry, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra, India

**Bhoyar**
Department of Soil Science and Agricultural Chemistry, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra, India

**PH Rathod**
Department of Soil Science and Agricultural Chemistry, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra, India

**Corresponding Author:**
**Kalyani A**
Department of Soil Science and Agricultural Chemistry, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Akola, Maharashtra, India

# Effect of organic sources on physico-chemical properties of soil and uptake of nutrients in cotton under rainfed conditions

**Kalyani A, Sapkal SM, Bhoyar and PH Rathod**

**Abstract**
The present experimentation entitled "Residual soil fertility and productivity of rainfed organic cotton in Vertisols" was conducted to study the effect of continuous use of organic manures on physical and chemical properties of soil after harvest of rainfed organic cotton at Cotton Research Unit (CRU) Central Research Station, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola in *kharif* 2017-18. There were eight treatments replicated three times in Randomized Block Design. The organic sources used were FYM, vermicompost, sunhemp and castor cake. The soil sample were collected from surface and subsurface layers for analyzing various physical and chemical properties of soils. The soils of experimental site were classified under order Vertisol. Initially (2010-11) soils were low, medium and high in available nitrogen, phosphorus and potassium, respectively. After 7$^{th}$ cycle of fixed frame plot experimentation, continuous incorporation of FYM @ 10 t ha$^{-1}$ showed significant improvement in soil physical and chemical properties as well as overall residual nutritional status of soil. Significantly lowest pH at surface and subsurface soils 7.81 and 7.91 and EC 0.11 and 0.12 dSm$^{-1}$ were observed respectively. Same treatment 10 t ha$^{-1}$ FYM showed significant improvement of organic carbon content of soils at surface (6.04 g kg$^{-1}$) and subsurface (5.64 g kg$^{-1}$) layers. A regards of physical properties of surface and subsurface soils significant improvement in BD (1.23 and 1.27 Mg kg$^{-1}$), HC (1.29 and 1.24 cm hr$^{-1}$), AWC (17.3 and 9.71%) and MWD (1.84 and 1.64 mm) was recorded due to bulk application of organic matter through FYM @ 10 t ha$^{-1}$. Significantly, higher and statistically equal seed cotton yield harvested under the treatment FYM 10 t ha$^{-1}$ (19.28 q ha$^{-1}$) and concentrate organic manure 500 kg ha$^{-1}$ (19.16 q ha$^{-1}$) which led to higher PRI under both the treatments i.e.175.27 and 174.18 q ha$^{-1}$ per cent due to their continuous use of seven years. Thus, after 7$^{th}$ cycle of the experimentation on organic cotton production, it can be concluded that, significant improvement of physical and chemical properties of Vertisols can be possible due to continuous use of organics as sources of nutrients to *deshi* cotton crop over the absolute control as well as initial status of soil. In general it was noticed that, surface soils showed more improvement as regards to all properties than the subsurface Vertisols. Furthermore, improvement of residual fertility status and was reflected on the productivity rating index of *deshi* cotton variety (AKA-8). However, as per the availability of bulky organic manure or concentrate organic manure either FYM @ 10 t ha$^{-1}$ or castor cake @ 500 kg ha$^{-1}$ can be used for obtaining optimum yield of deshi cotton in rainfed condition.

**Keywords:** Organic sources, physico-chemical, soil, uptake, nutrients, cotton

## Introduction

Cotton is the most in its agrarian and industrial economy, thus it is popularly known as "White Gold". It is the backbone of our textile industry, accounting for about 70% of total fibre consumption in textile sector, and 38% of the country's export, fetching over Rs. 42, 000 corers. The area under cotton cultivation in 8.9 million hectare which is the highest in the world i.e.25% of the world area and it employs 7 million people for their livelihood. Cotton is a very important cash crop for smallholder farmers, but also one of the most exigent crops in terms of agrochemical inputs which are responsible for adverse effects on human health and the environment (Forster *et al.* 2013). One of the major concerns in today's world is the pollution and contamination of the soil. The use of chemical fertilizers and pesticides has caused tremendous harm to the environmental ecosystem. Organic farming or natural farming is necessary to support the developing organic, sustainable and non-pollution agriculture. These methods are cost effective and eco-friendly in nature (Narasimha, 2013). The most of the cotton cultivated in India is 'eco-friendly' with little or no use of toxic chemicals in its production. Since people in advanced countries are very much health conscious, they demand for readymade cloths produced from certified organically grown cotton. But, maintaining soil fertility and soil productivity plays important role for sustainable production of organic cotton. Therefore, the need of the hour is to popularize environmental friendly and cost-effective organic manures, which are produced in the farm by the farmer himself.

In India 2016-17, cotton is being grown over an area of 122.5 lakh $ha^{-1}$ and all year annual production of 377 lakh bales of 170 kg with productivity 344 kg $ha^{-1}$. In Maharashtra cotton is grown on 41.98 lakh $ha^{-1}$ and annual production 85 lakh bales of 170 kg with productivity 344 kg $ha^{-1}$. (Anonymous 2017-18) [1]. Specially Vidarbha region in Maharashtra state representing the Deccan Plateau, is famous for growing cotton in black soil. From the view point of crop production, low organic matter is one of the major constraints in addition to low plant-available nutrients, particularly nitrogen (N), phosphorus (P), and zinc (Zn), thus affecting the productivity of these soils (Blaise, Majumdar, and Tekale 2005) [3]. In addition to poor fertility, limited soil moisture availability and poor drainage are the main soil-related problems in Vertisols. Poor management of these soils leads to further degradation. Vertisol soils, especially in a rainfed semi-arid tropical (SAT) environment, encounter many problems on account of physical, chemical, and biological soil quality and consequently result in poor crop yields. Some other reports reveal that the quality and productivity of black soils can be improved by adopting suitable practices such as inclusion of legumes or green mauring crop as intercrops or in rotation with cotton and other main crops. Use of organic manures, plays a key role in sustaining soil fertility and crop productivity, these sources are often cheaper and more efficient than inorganic compounds. Organic materials hold great promise as sources of multiple nutrients because of their ability to improve soil characteristics. The objective of this study, therefore, was to study the effect of organic sources on residual soil fertility and productivity of rainfed organic cotton in Vertisols.

## Materials and methods

The present investigation in relation to "Effect of organic sources on productivity and residual soil fertility in cotton under rainfed condition" was conducted during kharif season of 2017-18 at Cotton Research Unit (CRU), Central Research Station (CRS) Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. The details of material used and methods adopted during the period of experimentation are given below. The experimentation was superimposed on the on-going organic cotton experiment at CRU on "Technology for organic cotton production" and this is the seventh year (7th cycle) of experiment. There were eight treatments replicated three times in Randomized Block Design. The organic sources used were FYM, vermicompost, sunhemp and castor cake. Treatment combinations $T_1$-FYM @ 5 t $ha^{-1}$, $T_2$-Vermicompost @ 2.5 t $ha^{-1}$, $T_3$-FYM @10 t $ha^{-1}$, $T_4$-Vermicompost @ 5 t $ha^{-1}$, $T_5$- In-situ green manuring with sunhemp, $T_6$-Castor cake @ 500 kg $ha^{-1}$, $T_7$-FYM (source of 15 kg $P_2O_5$) + green manuring with sunhemp, $T_8$-Absolute Control.

The soil samples were collected from each plot a the depth of 0-20cm surface and 20-40 cm subsurface for analyzing physical and chemical properties. Core samples collected to estimate bulk density was determined by clod coating method (Blake and Hartze, 1986), Hydraulic conductivity was determined by constant head method (Klute and Dirksen, 1986), Mean wet diameter was determined by aggregate stability method Yoder (1936), Available water capacity was determined by pressure plate and membrane apparatus method (Richards 1943). The soil samples collected were air dried, mixed well, passed through 2-mm sieve for analyses. Soil pH and EC were measured in a 1:2 soil: water suspension using pH and conductivity meters. Soil organic carbon determined by wet oxidation method (Walkley and Black 1934) and were analysing available N by alkaline permanganate method (Subbiah and Asija 1965), avialble P (Olsen *et al.* 1954) [9] and available K (ammonium acetate extract using flame photometer) (Jackson, 1973) [7]. The data obtained various parameters were analysed in RBD statistical procedure (Panse and Sukhatme, 1984). The appropriate standard error of mean (S.E.m) and the critical difference (C.D.) were calculated at 5% level of probability.

## Result and Discussion

### Chemical properties

Physico-chemical properties pH, EC and organic carbon were studied after in 7th year experiment and there was statistically significant differences obtained in pH, EC as well as organic carbon of soil. Among, pH content was shown significant differences in Vertisol after harvest of crop. Among all organic sources the lowest pH value (7.81 and 7.91) surface and subsurface, respectively has observed under treatment FYM @ 10 t $ha^{-1}$. Same treatment also recorded lowest EC values (0.112 $dSm^{-1}$ and 0.115 $dSm^{-1}$) of surface and subsurface soils, respectively as well as significantly highest organic carbon was recorded at surface (6.04 g $kg^{-1}$) and (5.64 g $kg^{-1}$) at sub-surface soils. The highest pH content was observed in absolute control at surface (8.1) and subsurface (8.16). Same treatment also recorded highest EC value at surface (0.121 $dSm^{-1}$) and (0.122 $dSm^{-1}$) at sub-surface level. However, lowest organic carbon (5.21 g $kg^{-1}$ and 3.82 g $kg^{-1}$) surface and subsurface respectively was recorded under absolute control

### Physical properties

### Bulk density

Significant influence of various organic sources i.e. FYM, castor cake and green manuring with sunhemp on bulk density of surface (0-20 cm) and subsurface (20-40 cm) soils after harvest of cotton crop. Data revealed that, after harvest of cotton crop the bulk density of surface soil varied from 1.23 to 1.35 Mg $m^{-3}$. Significantly lowest bulk density 1.23 Mg $m^{-3}$ in surface soils was recorded by the treatment ($T_3$) FYM @ 10 t $ha^{-1}$,treatment ($T_5$) in-situ green manuring with sunhemp, vermicompost @ 5 t $ha^{-1}$, In-situ green manuring with sunhemp, castor cake @ 500 kg $ha^{-1}$ and FYM+ GM with sunhemp which were at par with each other. Whereas, the highest bulk density (1.35 Mg $m^{-3}$) at surface soils was observed in absolute control ($T_8$). In sub-surface soil layer bulk density varied from 1.27 to 1.39 Mg $m^{-3}$. Significantly the lowest bulk density was recorded in the well decomposed bulky organic manure, i.e. FYM @10 t $ha^{-1}$, treatment, treatment vermicompost @ 5 t $ha^{-1}$, FYM @ 5 t $ha^{-1}$, castor cake @ 500 kg $ha^{-1}$ and treatment FYM + GM with sunhemp which were at par with each other. Whereas, the highest bulk density was observed in treatment ($T_8$) absolute control. The above data clearly showed in general treatments comprising with bulky organic manures was recorded lower values of bulk density over concentrate organic manures and green manuring application. Significantly lowest bulk density 1.23 Mg $m^{-3}$ recorded by the application of FYM @ 10 t $ha^{-1}$ over control treatment noticed by Manchala *et al.* (2017) [8]. Similar results regarding significant reduction in bulk density of Vertisols with incorporation of FYM over control treatment was also reported by Verma *et al.* (2010) [14], Bandopadhyay *et al.* (2010) [2].

**Hydraulic conductivity**

Data revealed that, after harvest of crop significantly highest hydraulic conductivity (1.29 cm $hr^{-1}$) in surface soil of was recorded by treatment received FYM @ 10 t $ha^{-1}$ treatment and was on par with FYM + green manuring with sunhemp ($T_7$). The lowest hydraulic conductivity was observed under absolute control ($T_8$). Among all treatments applied with bulky organic manures showed higher hydraulic conductivity over concentrate organic manures and in-situ green manuring treatments. With respect to sub-surface soil the, hydraulic conductivity of the sub-surface soil varied from 0.69 to 1.24 cm $hr^{-1}$. Significantly lowest hydraulic conductivity was observed under treatment ($T_3$) i.e. FYM @10 t $ha^{-1}$. Whereas the highest hydraulic conductivity was recorded in absolute control ($T_8$) which was at par with treatment ($T_7$) FYM + GM with sunhemp. The data regarding hydraulic conductivity of the soil revealed that, incorporation of organic manures as a source of plant nutrient improved the drainability in Vertisols. Similar results were observed by Manchala *et al.* (2017) [8],

**Mean weight diameter (MWD)**.

Significant superior improvement in the MWD of vertisol over all treatments was reported by the incorporation of FYM @10 t $ha^{-1}$ which were at par with treatment ($T_4$) vermicompost @ 5 t $ha^{-1}$ (1.78 mm) and FYM 5 t $ha^{-1}$ (1.73 mm). Vermicompost @ 2.5 t $ha^{-1}$ (1.35 mm) recorded significantly improved MWD over the control. However, lowest 1.21 mm MWD in ($T_8$) estimated in absolute control treatment. With respect to sub-surface soil mean weight diameter ranged from 0.99 to 1.64 mm. The highest mean weight diameter of soil aggregates observed under the treatment ($T_3$) received @10 t FYM $ha^{-1}$. However, lowest MWD (0.99 mm) was observed in treatment absolute control ($T_8$). Further it was observed the MWD of surface soil was higher than the subsurface soil same results observed that, Chouhan *et al.* (2018) [5] mean weight diameter of soil aggregate in surface layer was bigger than the sub-surface soil and the least MWD of soil aggregate were obtained in control treatment at both the soil depths.

**Available water capacity (AWC)**

Data revealed that, after harvest of cotton crop the available water capacity of surface soil varied from 12.35 to 17.37%. The highest available water capacity was observed under the treatment ($T_3$) FYM @10 t $ha^{-1}$ followed by Vermicompost 5 t $ha^{-1}$(17.37%), FYM 5 t $ha^{-1}$(16.15%). However, lowest (12.35%) AWC was observed in treatment ($T_8$) absolute control. In respect to sub-surface soils available water capacity varied from 9.71 to 5.26%. The highest available water capacity was observed under the treatment ($T_3$) received @10 t FYM $ha^{-1}$ followed by Vermicompost 5 t $ha^{-1}$(7.36%), vermicompost 2.5 t $ha^{-1}$(6.05%). However, lowest (5.26%) AWC was observed in treatment (T8) absolute control. Tadesse *et al.* (2013) [13] reported that available water capacity showed significant response only to FYM application but not to the inorganic fertilizers and their interaction with FYM. Similar results observed, Chouhan *et al.* (2018) [5].

**Cotton yield**

Seed cotton yield was found statistically significant under different organic treatments. It was in ranged from 3.80 to 19.28 q $ha^{-1}$. Significantly highest seed cotton yield (19.28 q $ha^{-1}$) was recorded in the treatment received FYM 10 t $ha^{-1}$ and was at par with treatment castor cake @ 500 Kg $ha^{-1}$ (19.16 q $ha^{-1}$). Use of bulky organic manure may be FYM or vermicompost resulted in increased seed cotton yield per ha due to sufficient availability of nutrients (macro and micro) in the balanced form with good soil environment. The significantly lowest performance of cotton crop in respect of seed cotton yield (3.80 q $ha^{-1}$) was observed in the absolute control treatment over all organic sources treatments under experimentation.

These results are conformity with findings of Solunke *et al.* (2018) [11] reported, significantly higher seed cotton yield was recorded under treatment FYM @10 t $ha^{-1}$ followed by Vermicompost @ 2 t $ha^{-1}$ than control treatment. Similar results reported by Joga Rao *et al.* (2017) highest seed cotton yield was observed in 100% RD of NPK + FYM @10 t $ha^{-1}$ treated plot, due to the use of organic manures like FYM.

Significantly highest (47.41 q $ha^{-1}$) dry matter yield was recorded in the treatment of bulky organic matter i.e. FYM @ 10 t $ha^{-1}$ followed by castor cake @ 500 $kg^{-1}$ (46.32 q $ha^{-1}$), Vermicompost 5 t $ha^{-1}$ (41.09 q $ha^{-1}$), Vermicompost @ 2.5 t $ha^{-1}$ (39.09 q $ha^{-1}$). The lowest performance of cotton crop in respect of dry matter production (12.72 q $ha^{-1}$) was observed in the absolute control treatment. These results are conformity with findings of V.E.Bonge *et.al.* (2017) [4]

**Table 1:** Effect of different organic treatments on physio-chemical properties of vertisol under rainfed cotton

| Treatment | pH (1: 2.5) | | | EC ($dSm^{-1}$) | | | Organic Carbon (g $kg^{-1}$) | | |
|---|---|---|---|---|---|---|---|---|---|
| | Kharif 2016-17 | 2017-18 | | Kharif 2016-17 | 2017-18 | | Kharif 2016-17 | 2017-18 | |
| | | 0-20 cm | 20-40 cm | | 0-20 cm | 20-40 cm | | 0-20 cm | 20-40 cm |
| $T_1$ - FYM @5 t $ha^{-1}$ | 7.96 | 7.86 | 7.99 | 0.118 | 0.118 | 0.121 | 5.42 | 5.91 | 5.24 |
| $T_2$ - Vermicompost @ 2.5 t $ha^{-1}$ | 7.99 | 7.94 | 8.09 | 0.119 | 0.117 | 0.120 | 5.38 | 5.39 | 5.16 |
| $T_3$ - FYM @10 t $ha^{-1}$ | 7.89 | 7.81 | 7.91 | 0.113 | 0.112 | 0.115 | 5.69 | 6.04 | 5.64 |
| $T_4$ - Vermicompost @ 5 t $ha^{-1}$ | 7.93 | 7.90 | 7.96 | 0.115 | 0.114 | 0.117 | 5.45 | 5.98 | 5.37 |
| $T_5$ - In-situ green manuring with Sunhemp | 7.94 | 7.92 | 7.99 | 0.117 | 0.116 | 0.119 | 5.27 | 5.67 | 5.24 |
| $T_6$ - Castor cake @500kg $ha^{-1}$ | 8.02 | 7.89 | 8.04 | 0.116 | 0.115 | 0.118 | 5.34 | 5.78 | 5.31 |
| $T_7$ - FYM (source of 15 kg $P_2O_5$)+green manuring with sunhemp | 7.90 | 7.86 | 7.92 | 0.114 | 0.113 | 0.116 | 5.56 | 5.57 | 5.48 |
| $T_8$ - Absolute control | 8.14 | 8.1 | 8.16 | 0.121 | 0.121 | 0.122 | 3.86 | 5.21 | 3.82 |
| SE(m)± | 0.02 | 0.04 | 0.03 | 0.001 | 0.001 | 0.001 | 0.04 | 0.01 | 0.05 |
| CD at 5% | 0.05 | 0.13 | 0.10 | 0.042 | 0.005 | 0.004 | 0.12 | 0.04 | 0.16 |

**Table 2:** Effect of organic sources on Bulk density and Hydraulic conductivity in Vertisol

| Treatments | Bulk density (Mg $m^{-3}$) | | Hydraulic conductivity (cm $hr^{-1}$) | |
|---|---|---|---|---|
| | 0-20 cm | 20-40 cm | 0-20 cm | 20-40 cm |
| $T_1$- FYM @ 5 t $ha^{-1}$ | 1.25 | 1.30 | 1.11 | 1.05 |
| $T_2$- Vermicompost @ 2.5 t $ha^{-1}$ | 1.32 | 1.37 | 1.07 | 0.99 |
| $T_3$- FYM @10 t $ha^{-1}$ | 1.23 | 1.27 | 1.29 | 1.24 |
| $T_4$- Vermicompost @ 5 t $ha^{-1}$ | 1.24 | 1.29 | 1.13 | 1.08 |
| $T_5$- In-situ green manuring with sunhemp | 1.29 | 1.33 | 1.17 | 1.11 |
| $T_6$- Castor cake @500kg $ha^{-1}$ | 1.28 | 1.31 | 1.01 | 0.91 |
| $T_7$-FYM (source of 15 kg $P_2O_5$) + green manuring with sunhemp | 1.27 | 1.32 | 1.22 | 1.17 |
| $T_8$ –Absolute control | 1.35 | 1.39 | 0.77 | 0.69 |
| SE(m)± | 0.02 | 0.01 | 0.02 | 0.03 |
| CD at 5% | 0.06 | 0.05 | 0.06 | 0.11 |

**Table 3:** Effect of different organic sources on mean weight diameter and available water capacity in vertisol

| Treatments | Mean weight diameter (mm) | | AWC (%) | |
|---|---|---|---|---|
| | 0-20 cm | 20-40 cm | 0-20 cm | 20-40 cm |
| $T_1$ - FYM @ 5 t $ha^{-1}$ | 1.73 | 1.37 | 16.15 | 7.36 |
| $T_2$ - Vermicompost @ 2.5 t $ha^{-1}$ | 1.35 | 1.05 | 15.52 | 6.05 |
| $T_3$ - FYM @10 t $ha^{-1}$ | 1.84 | 1.64 | 17.37 | 9.71 |
| $T_4$ - Vermicompost @ 5 t $ha^{-1}$ | 1.78 | 1.47 | 16.87 | 6.82 |
| $T_5$ - In-situ green manuring with sunhemp | 1.45 | 1.20 | 16.10 | 5.62 |
| $T_6$ - Castor cake @ 500 kg $ha^{-1}$ | 1.41 | 1.13 | 15.08 | 5.19 |
| $T_7$ - FYM (source of 15 kg $P_2O_5$) + green manuring with sunhemp | 1.66 | 1.24 | 12.81 | 5.80 |
| $T_8$ – Absolute control | 1.21 | 0.99 | 12.35 | 5.26 |
| SE(m)± | 0.04 | 0.03 | - | - |
| CD at 5% | 0.13 | 0.09 | - | - |

**Table 4:** Effect of organic sources on yield performance of cotton in Vertisols

| Treatments | Seed cotton yield (q $ha^{-1}$) | Dry matter yield (q $ha^{-1}$) |
|---|---|---|
| $T_1$ - FYM @ 5 t $ha^{-1}$ | 16.80 | 38.84 |
| $T_2$ - Vermicompost @ 2.5 t $ha^{-1}$ | 15.20 | 39.09 |
| $T_3$ - FYM @10 t $ha^{-1}$ | 19.28 | 47.41 |
| $T_4$ - Vermicompost @ 5 t $ha^{-1}$ | 17.72 | 41.09 |
| $T_5$ - In-situ green manuring with sunhemp | 14.55 | 35.92 |
| $T_6$ - Castor cake @500kg $ha^{-1}$ | 19.16 | 46.32 |
| $T_7$ - FYM (source of 15 kg $P_2O_5$) + green manuring with Sunhemp | 16.44 | 38.09 |
| $T_8$ – Absolute control | 3.80 | 12.72 |
| SE(m)± | 0.51 | 0.33 |
| CD at 5% | 1.55 | 1.01 |

## Conclusion

Thus, after 7th cycle of the experimentation on organic cotton production, it can be concluded that, significant improvement of physico-chemical and chemical properties of Vertisols can be possible due to continuous use of organics as sources of nutrients to *deshi* cotton crop over the absolute control as well as initial status of soil. In general it was noticed that, surface soils showed more improvement as regards to all properties than the subsurface Vertisols. Furthermore, improvement of residual fertility status of *deshi* cotton variety (AKA-8). However, as per the availability of bulky organic manure or concentrate organic manure either FYM @ 10 t $ha^{-1}$ or castor cake @ 500 kg $ha^{-1}$ can be used for obtaining optimum yield of deshi cotton in rainfed condition.

## References


1. Anonymous. ICAR-All India Coordinated Research Project on Cotton – Annual Report, 2017-18.
2. Bandopadhyay KK, Misra AK, Ghosh PK, Hati KM. Effect of integrated use of farmyard manure and chemical fertilizers on soil physical properties and productivity of soybean. Soil & Tillage Research. 2010; 110:115-125.
3. Blaise D, Singh JV, Bonde AN, Tekale KU, Mayee CD. Effects of farmyard manure and fertilizers on yield, fibre quality and nutrient balance of rainfed cotton (*Gossypium hirsutum*) Bio resource Tech. 2005; 96(3):345-349.
4. Bonge VE, Khadse VA, Chavan AS. Response of Nitrogen through Organic Sources on Growth, Yield and Quality of Cotton. Int. J Curr. Microbiol. App. Sci. 2017; 6(9):2948-2952.
5. Chouhan BH, Rai K, Suryawanshi A, Subhash Mandloi, Pandey R. Characterization of physical properties of vertisols under long-term fertilizer experiment in soybean-wheat cropping system. J of Pharmacognosy and phytochemistry. 2018; 7(2):596-601.
6. Integrated nutrient management on properties of a Typic Haplustept under maize – wheat cropping system. J Indian Soc. Soil Sci, 58(3), 299-302.
7. Jackson ML. Soil chemical analysis prentice, Hall of India private LTD, New Delhi, 1973.
8. Manchala SK, Bhoyar SM, Deshmukh PW. Influence of organic manures on soil physical properties in cotton under rainfed condition. Int J of chemical studies. 2017; 5(5):832-835.
9. Olsen SR, Cole CV, Watanabe FS, Dean LA. Estimation of available phosphorus in soils by extraction with sodium bicarbonate, USDA circular 939, Washington, DC, 1954.

10. Panse VG, Sukhatme PN. Statistical methods for Agricultural Workers. ICAR, New Delhi, 1967.
11. Solunke PS, Fatak SU, Jayewar NE, Giri DG. Influence of organic, inorganics with and without plant protections on quality of *desi* cotton. Int. J Curr. Microbiol. App. Sci. 2018; 6:501-507.
12. Subbaih BV, Asija GL. Rapid procedure for the estimation of available nitrogen in soil. Current Sci. 1956; 125:259-260.
13. Tadesse T, Dechassa N, Bayu W, Gebeyehu S. Effects of Farmyard Manure and Inorganic Fertilizer Application on Soil Physico-Chemical Properties and Nutrient Balance in Rain-Fed Lowland Rice Ecosystem. Am. J of Plant Sci. 2013; 4:309-316.
14. Verma G, Mathur AK, Bhandari SC, Kanthaliya PC. Long-term effect of, 2010.
15. Walke N, Reddy GPO, Maji AK, Thayalan S. GIS-based multicriteria overlay analysis in soil-suitability evaluation for cotton (*Gossypium spp*.): A case study in the black soil region of Central India. Computers & Geosci. 2012; 41:108-118.
16. Yoder RE. A direct method of aggregate analyasis of soil and study of the physical nature of erosion losses. Agronomy Journal. 1936; 28:337-351.