



## Organic manures: A way to improve rhizosphere microflora under rainfed organic cotton cultivation in vertisols

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**ABSTRACT :** A field experiment was conducted consecutive *kharif* seasons of 2013-2014 and 2014-2015, at Central Research Station, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (M.S.) to assess the effect of different organic manures on bacteria, fungi and actinomycetes population in the rhizosphere of *G. arboreum* cotton var AKA 8 grown in rainfed condition. There were total eight treatments replicated thrice in RBD in Vertisols, out of which seven were sole organic treatments comprises of FYM, vermicompost, cotton cake and *in situ* green manuring with sunhemp and eighth treatment was absolute control. Treatmentwise rhizosphere soil samples at flowering and boll bursting stage of cotton during both the year of experimentation were taken and used for determination of microfloral population by using serial dilution technique followed by plating on different agar medium. Significantly highest rhizosphere microbial population was recorded in the treatment received FYM @ 10 t/ha at flowering stage as well as at boll bursting stage of cotton. However, significantly lowest *i.e.* almost 50 per cent to all organic treatments at both growth stages was observed in absolute control. Mean of two year data revealed that, at flowering stage rhizosphere population of bacteria was  $94.83 \times 10^{-6}$  cfu/g soil, fungi  $50.67 \times 10^{-6}$  cfu/g soil and actinomycetes  $112.34 \times 10^{-4}$  cfu/g soil and was suppressed up to bacteria  $54.34 \times 10^{-6}$  cfu/g soil, fungi  $35.00 \times 10^{-6}$  cfu/g soil and actinomycetes  $69.83 \times 10^{-4}$  cfu/g at boll bursting stage of cotton. In general, organic manures had a significant effect on the rhizosphere bacteria, fungi and actinomycetes population. Colonization trend of bacteria, fungi and actinomycetes under organic treatments was castor cake > GM with sunhemp > vermicompost > FYM, this might be due to availability of highly carbonaceous organics to fulfill their demands of food and energy. Rhizosphere microbial population was higher at flowering stage (initial growth stage) as compared to boll bursting stage (later growth stage) of cotton as soil moisture is the major constraint for rainfed farming in vertisols in semi arid tropics.

**Key words :** *Actinomycetes, bacteria, fungi, organic cotton, rhizosphere*

Rhizosphere microbial population plays a key role in soil nutrient recycling. However, the residual toxic effect of inorganic fertilizers on rhizosphere microbial population is a matter

of great concern. Extensive use of inorganics has often resulted in a marked decrease in rhizosphere microbial population. The application of organics favorably help in

augmentation of beneficial microbial population and their activities such as organic matter decomposition, biological nitrogen fixation, phosphorus solubilization and availability of plant nutrients through mineralization. The FYM serves as an excellent food for microorganisms. The biological activity of a soil is the function of number of organisms present in soil and their physiological efficiency. All biological reactions in soils are catalyzed by enzymes and soil microbes are important source of soil enzymes and have major role in nutrient transformation. Increment in the bacterial population due to increments in doses of organic sources might be the fact that organic material acts as food for bacteria and as the quantity of food increased there was increased in their colonization of microbes for their energy requirement. Sharma *et al.* (2000) reported highest population of bacteria and fungi in FYM treated plots followed by incorporation of crop residues and lowest population of microorganism were observed in only chemical fertilizer plots. Halemani *et al.* (2004), significantly highest population of bacteria, fungi and actinomycetes with application of FYM alone @ 10 t/ha followed by FYM @ 5 t + cotton stalk residues 2.5 t/ha and FYM @ 5 t + vermicompost. Hence the present investigation was under taken to assess the influence of different organic manures as a source of nutrients to cotton on rhizosphere microbial population under semi arid conditions.

#### **MATERIALS AND METHODS**

Organic cotton experiment was initiated in 2010-11 at experimental field of Cotton Research Unit, Central Research Station, Dr.

Panjabrao Deshmukh Krishi Vidyapeeth, Akola. Present investigation was conducted during 3<sup>rd</sup> and 4<sup>th</sup> cycle of the experimentation in *Kharif* season of 2013-2014 and 2014-2015. The organic cotton experiment (*G. arboreum* var AKA 8) was laid out in RBD with eight treatments replicated thrice. Treatment comprises of T1- FYM 5 t/ha, T2- Vermicompost 2.5 t/ha, T3- FYM 10 t/ha; T4- Vermicompost 5 t/ha, T5 – *in situ* green manuring with sunhemp, T6 - Castor cake @ 500 kg/ha, T7 - Sunhemp + FYM (source of 15 kg P<sub>2</sub>O<sub>5</sub>) and T8 – Absolute control. Seed treatment of *Azotobacter* and *PSB* each @ 25 g/kg was given to all treatments except absolute control and treatmentwise organic manures were applied as basal dose. Soils of the experimental site was deep, high clay content with typical swell-shrink characteristic, classified as Vertisol. Soil samples from the rhizosphere of cotton were collected at 50 per cent flowering and 50 per cent boll bursting stage to assess soil bacterial, fungal and actinomycetes population. Soil microbial count were determined by serial dilution technique (Dhingra and Sinclair, 1993) by using nutrient agar, potato dextrose agar and kenknight agar media for plating of microflora followed by an incubation at 28°C± 2 for 2-3 days. Microbial colonies on plates were counted by using colony counter.

#### **RESULTS AND DISCUSSION**

In general data presented in Table 1, 2 and 3 regarding bacteria, fungi and actinomycetes population, respectively in the rhizosphere of rainfed cotton revealed that, there was significant improvement in the microbial

population due to addition of all organic resources viz., bulky organic manure (FYM and VC), concentrate organic manure (Castor cake) and *in situ* green manuring (Sunhemp) over control. Population trend of bacteria, fungi and actinomycetes under organic treatments was castor cake > GM with sunhemp > vermicompost > FYM. Rhizosphere microbial population was higher at flowering stage i.e. initial stage of crop as compared to boll bursting stage of cotton i.e. later stage of crop. Furthermore, as the doses of FYM and vermicompost increases there was increment on the soil microbial population and significantly highest colonies of bacteria, fungi and actinomycetes were recorded in FYM @ 10 t/ha treatment. Chandramohan *et al.*, (2002) also reported that the population of fungi, actinomycetes and bacteria were higher during vegetative and flowering stage as compare to harvest stage and lowest population was observed in treatment receiving inorganic sources of nitrogen.

**Bacteria population :** From the data (Table 1) indicated that the mean bacterial

population at flowering stage of cotton ranges from  $36.50 \times 10^{-6}$  cfu/g soil to  $94.83 \times 10^{-6}$  cfu/g soil and at boll bursting stage it was from  $19.84 \times 10^{-6}$  cfu/g soil to  $54.34 \times 10^{-6}$  cfu/g soil. Significantly highest soil bacterial population at flowering (89.33 and  $100.33 \times 10^{-6}$  cfu/g soil) as well as boll bursting stage ( $52.67$  and  $56.00 \times 10^{-6}$  cfu/g soil) of cotton was recorded in treatment received FYM @ 10 t/ha, which was significantly superior over all other all other treatments in first year of experimentation, however during second year it was statistically equal with the application of Vermicompost @ 5 t/ha. Among all organic manure application treatments lowest bacterial population was recorded in castor cake @ 500 kg/ha at flowering stage, whereas at boll bursting stage it was in-situ GM treatment. Significantly, lowest bacterial population at both stages under study was recorded in absolute control ( $35.33$  and  $19.67 \times 10^{-6}$  cfu/g soil). The results are in line with findings reported by Ghodpage *et al.*, (2009), Chatto *et al.*, (2010) and Shwetha *et al.*, (2011).

**Fungi population :** Data presented in

**Table 1:** Effect of organic sources on rhizospheral bacterial population of cotton in Vertisol

Treatments	Bacteria (cfu $10^{-6}$ /g soil)					
	At flowering stage			At boll bursting stage		
	2013-2014	2014-2015	Mean	2013-2014	2014-2015	Mean
<b>T1</b> FYM 5 t/ha	67.33	89.56	<b>78.45</b>	33.33	49.33	<b>41.33</b>
<b>T2</b> VC 2.5 t/ha	61.33	82.56	<b>71.95</b>	34.67	50.67	<b>42.67</b>
<b>T3</b> FYM 10 t/ha	89.33	100.33	<b>94.83</b>	52.67	56.00	<b>54.34</b>
<b>T4</b> VC 5 t/ha	73.00	93.00	<b>83.00</b>	49.00	51.33	<b>50.17</b>
<b>T5</b> <i>In situ</i> GM with sunhemp	73.33	82.56	<b>77.95</b>	34.00	50.00	<b>42.00</b>
<b>T6</b> Castor cake @500 kg/ha	58.00	70.67	<b>64.34</b>	36.00	50.67	<b>43.34</b>
<b>T7</b> Sunhemp + FYM	81.67	90.00	<b>85.84</b>	51.33	52.67	<b>52.00</b>
<b>T8</b> Control	37.67	35.33	<b>36.50</b>	20.00	19.67	<b>19.84</b>
SE (m)±	1.84	2.58	-	1.37	3.07	-
CD (p=0.05)	5.47	7.66	-	4.06	9.13	-

**Table 2:** Effect of organic sources on rhizospheral fungal population of cotton in Vertisol

Treatments	Fungi (cfu 10 <sup>-4</sup> /g soil)					
	At flowering stage			At boll bursting stage		
	2013-2014	2014-2015	Mean	2013-2014	2014-2015	Mean
<b>T1</b> FYM 5 t/ha	43.67	43.67	<b>43.67</b>	25.33	32.00	<b>28.67</b>
<b>T2</b> VC 2.5 t/ha	37.33	41.33	<b>39.33</b>	22.67	31.33	<b>27.00</b>
<b>T3</b> FYM 10 t/ha	48.67	52.67	<b>50.67</b>	31.00	39.00	<b>35.00</b>
<b>T4</b> VC 5 t/ha	42.00	39.00	<b>40.50</b>	28.00	37.67	<b>32.84</b>
<b>T5</b> <i>In situ</i> GM with sunhemp	37.00	38.33	<b>37.67</b>	23.00	33.33	<b>28.17</b>
<b>T6</b> Castor cake @500 kg/ha	31.00	37.67	<b>34.34</b>	28.33	30.00	<b>29.17</b>
<b>T7</b> Sunhemp + FYM	38.67	42.33	<b>40.50</b>	30.67	37.00	<b>33.84</b>
<b>T8</b> Control	23.00	20.00	<b>21.50</b>	13.67	12.00	<b>12.84</b>
SE (m)±	1.42	1.62	-	0.85	1.57	-
CD (p=0.05)	4.23	4.81	-	2.52	4.66	-

Table 2, showed that the mean fungal population at flowering stage of cotton ranges from 21.50 x 10<sup>-4</sup> cfu/g soil to 50.67 x 10<sup>-4</sup> cfu/g soil and at boll bursting stage it was from 12.84 x 10<sup>-4</sup> cfu/g soil to 35.00 x 10<sup>-4</sup> cfu/g soil. Significantly highest rhizosphere fungal population at flowering (48.67 and 52.67 x 10<sup>-4</sup> cfu/g soil) as well as boll bursting stage (31.00 and 39.00x 10<sup>-4</sup> cfu/g soil) of cotton was recorded in treatment received FYM @ 10 t/ha. During 2014-15 tria FYM @ 10 t/ha application recorded significant superiority over all other treatments at flowering stage and was at par with VC @ 5 t/ha as well as GM

Sunhemp+FYM treatment. Significantly lowest fungal population was recorded in absolute control treatment at flowering stage (23.00 and 20.00 x 10<sup>-4</sup> cfu/g soil) as well as boll bursting stage (13.67 and 12.00 x 10<sup>-4</sup> cfu/g soil) of cotton in both year of study, respectively. Among all organic manure treatments lowest fungi colonies was observed in castor cake @ 500 kg ha<sup>-1</sup> treatment at both the grand growth stage, whereas *in situ* GM of sunhemp in combination with FYM showed higher fungal population over *in-situ* GM of sunhemp alone. It might be due to addition of organic matter into the soil. Fungi

**Table 3:** Effect of organic sources on rhizospheral actinomycetes population of cotton in Vertisol

Treatments	Actinomycetes (cfu 10 <sup>-4</sup> /g soil)					
	At flowering stage			At boll bursting stage		
	2013-2014	2014-2015	Mean	2013-2014	2014-2015	Mean
<b>T1</b> FYM 5 t/ha	91.00	107.67	<b>99.34</b>	56.33	62.67	<b>59.50</b>
<b>T2</b> VC 2.5 t/ha	94.00	103.33	<b>98.67</b>	58.65	61.61	<b>60.13</b>
<b>T3</b> FYM 10 t/ha	110.00	114.67	<b>112.34</b>	67.00	72.65	<b>69.83</b>
<b>T4</b> VC 5 t/ha	103.67	112.33	<b>108.00</b>	64.33	68.33	<b>66.33</b>
<b>T5</b> <i>In situ</i> GM with sunhemp	91.00	95.33	<b>93.17</b>	56.33	61.68	<b>59.01</b>
<b>T6</b> Castor cake @500 kg/ha	85.00	89.62	<b>87.31</b>	51.62	56.61	<b>54.12</b>
<b>T7</b> Sunhemp + FYM	92.31	96.33	<b>94.32</b>	61.33	66.33	<b>63.83</b>
<b>T8</b> Control	34.00	33.66	<b>33.83</b>	21.33	18.00	<b>19.67</b>
SE (m)±	1.20	1.91	-	1.21	1.11	-
CD (p=0.05)	3.56	5.66	-	3.61	3.29	-

grow rapidly and their population is almost double to control due to organic treatments. Similar results were also reported by Badole and More (2001) who reported that organic treatment recorded higher microbial population than inorganic treatments or absolute control. The results are in line with findings reported by Ghodpage *et al.*, (2009), Chatto *et al.*, (2010) and Shwetha *et al.*, (2011).

**Actinomycetes population :** Data in Table 3 indicated that the mean actinomycetes population at flowering stage of cotton ranges from  $33.66 \times 10^{-4}$  cfu/g soil to  $114.67 \times 10^{-4}$  cfu/g soil and at boll bursting stage it was from  $19.67 \times 10^{-4}$  cfu/g soil to  $69.83 \times 10^{-4}$  cfu/g soil. Significantly highest soil bacterial population during experimentation at flowering ( $110.00$  and  $114.67 \times 10^{-4}$  cfu/g soil) as well as boll bursting stage ( $67.00$  and  $68.33 \times 10^{-6}$  cfu/g soil) of cotton was recorded in treatment received FYM @  $10 \text{ t ha}^{-1}$ , which was *at par* with VC @  $5 \text{ t/ha}$  treatment at flowering stage and significantly superior over all other treatments during 2014-2015. Castor cake @  $500 \text{ kg/ha}$  recorded lowest actinomycetes population among all organic treatment, whereas, significantly lowest actinomycetes colonies at both stages ( $34.33$  and  $33.66 \times 10^{-4}$  cfu/g at flowering stage and  $21.33$  and  $18.00 \times 10^{-4}$  cfu/g at boll bursting stage) was observed in absolute control treatment. Results were in agreement with the finding of Singh *et al.*, (2007) who reported that soil microbial population enhanced due to application of organic amendments in comparison to absolute control.

## CONCLUSION

In general results of consecutive two year organic cotton experimentation stated that, organic manures had a significant effect on the rhizosphere bacteria, fungi and actinomycetes population. Colonization trend of bacteria, fungi and actinomycetes under organic treatments was castor cake > GM with sunhemp > vermicompost > FYM, this might be due to availability of highly carbonaceous organics to fulfill their demands of food and energy. Bulky organic manure like FYM and vermicompost being a good source of carbon helps to multiply bacteria, fungi and actinomycetes which ultimately led to significantly highest rhizosphere microbial population in the treatment received FYM @  $10 \text{ t/ha}$ . Rhizosphere microbial population was higher at flowering stage (initial growth stage) as compared to boll bursting stage (later growth stage) of cotton as soil moisture is the major constraint for rainfed farming in vertisols in semi arid tropics.

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**Received for publication : March 4, 2018**

**Accepted for publication : May 18, 2018**