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Impact of Soil and Water Conservation Structures on Microbial Population in Different Depths of Soil

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Abstract:
A study was conducted to assess the enumeration of microbial population in different soil and water conservation structures in a watershed area of Mysore district during the year 2012. Contour bund recorded highest Azotobacter population in 0-15 cm, 15-30 cm and 30-45 cm depths (40.66, 38.89 and 23.81 x10^5 CFU g^{-1}, respectively). Highest PSP population was recorded at the depth of 0-15 cm in Boulder bund(31.52x10^5 CFU g^{-1} soil) structure followed by Contour bund (30.89x10^5 CFU g^{-1} soil). AM fungi population was highest in Boulder bund with 70.69 spore count 50 g^{-1} soil followed by Contour bund (65.43 spore count 50 g^{-1} soil). Highest mean population of Azospirillum was recorded in Boulder bund with 24.68 x10^{5}CFU g^{-1}. Bacterial population was highest in Contour bund (32.56 x10^5 CFU g^{-1}). Actinomycetes population was highest in Boulder bund (9.67 x10^3 CFU g^{-1} of soil) which was followed by Contour bund with 8.88 x10^{3}CFU g^{-1}. In the present study, surface/shallow depths of soil recorded higher microbial population as compared to deeper depths of the soil irrespective of soil and water conservation structures associated with organic matter. It is revealed that, Contour bund, Boulder bund, Rock fill dam can accumulate higher organic matter and resulted in higher, population of microflora.

Keywords*: Contour bund, Boulder bund, Rock fill dam, Check dam, Nala bund, Microorganisms, Watershed*

1. Introduction

Microbes in the soil play an important role in nutrient solubilization, mobilization and recycling. They have very wide potential as they control soil-borne pathogens, stimulate plant growth, increase nutrient availability and accelerate decomposition of organic materials and are anticipated to increase crop production. Soil microflora plays a pivotal role in evaluation of soil conditions and in stimulating plant growth (Kiran Singh *et al*., 1999). Microorganisms are beneficial in increasing the soil fertility and plant growth as they are involved in several biochemical transformation and mineralization activities in soils. Type of cultivation and crop management practices found to have greater influence on the activity of soil microflora (Mc Gill *et al*, 1980). According to Six *et al*, (2006) soil microbes improve soil aggregation and therefore, WSA may be used as an indirect measure of enzyme activity. The health of the soil is chiefly determined by its resident microbial flora. Sustainable agriculture involves successful management of agricultural resources to satisfy changing human needs while maintaining or enhancing the environmental quality and conserving natural resources. A better understanding of microbial activity is also important for management of carbon and nitrogen stocks in soils (Allison *et al*., 2005). Continuous decline in soil organic matter levels due to uncontrolled soil erosion, continuous cropping without recycling enough crop or animal residues and insufficient application of nutrients has led to serious nutrient imbalances, impaired soil health and declining factor productivity.

Soil structure is important in attainment of adequate aeration for aerobic microorganisms whose activities maintain such higher plant nutrients as sulphur, phosphorus, and nitrogen in a highly oxidized and thus readily available state. The soil and water conservation structures like contour bunds, Boulder bunds, Rock fill dams, Check dam, Nala bund and Farm ponds constructed across the slope. These structures helped in controlling erosion and reducing soil loss rather than increasing crop yields through additional moisture conservation. Present investigation was initiated to know the demography of soil microflora viz., bacteria, actinomycetes and fungi among different soil conservation structures in different depths of soil.

2. Material and Methods

- **Study area**: The study area selected in Doddamaragowdanahalli village, Yeluvala hobli, Mysore district and rainfall ranges from 900 to 1000 mm. The soil of the watershed area was characterized by light textured red sandy loam. The soil samples of different depths viz., 0-15 cm, 15-30 cm, 30-45 cm and 45-60 cm were collected.

- **Sample collection:** 50 grams of soil sample collected in different depths of soil and water conservation structures like Contour bund, Boulder bund, Rock fill dam, Check dam, Nala bund, Farm pond and control plot.
- **Enumeration of beneficial microorganisms at different soil depth with conservation structures**
  The microbial population in the soil was determined by standard dilution plate count method. 10 grams of pooled soil weighed and mixed in 90 ml sterilized water blank to give 10^1 dilutions. Subsequent dilutions upto 10^6 were made by transferring serially 1 ml of each dilution to 9 ml sterilized water blanks. The population of *bacteria*, *fungi*, *actinomycetes*, phosphate solubilizing microorganism (*PSB) and Azospirillum* were estimated by taking 1 ml from selected of 10^3,10^4,10^5,10^6 dilution were transferred aseptically to petridishes and the appropriate media were added to their respective dilutions. Plating on appropriate media viz., soil extract agar for soil bacteria (10^6), Martins Rose Bengal agar for fungi (10^3), Kustras agar for actinomycetes (10^4), Pikovskaya's media for PSB (10^5) and Dobreiner *et al* medium for *Azospirillum* (10^5) was used in the study. The inoculated plates were kept for incubation at 30 ^{0}C ± 1 ^{0}C for a week time and emerged colonies were counted.

3. Results and Discussion

- **Azotobacter:** Among the different soil and water conservation structures, Contour bund recorded highest Azotobacter population in 0-15 cm 15-30 cm and 30-45 cm depths (40.66, 38.89 and 23.81 x10^5 CFU g^{-1}, respectively) and it was significantly superior over all the other structures. This was followed by boulder bund (31.63, 31.51 and 22.77 x10^5 CFU g^{-1} soil respectively). But, at the depth of 45-60 cm highest population was recorded in Nala bund (7.74x10^5CFU g^{-1}) followed by Rock fill dam (7.02 x10^5 CFU g^{-1}). Significantly highest mean population of Azotobacter was recorded by Contour bund (27.30 x10^5 CFU g^{-1}) followed by Boulder bund (22.59 x10^5 CFU g^{-1}). Presence of higher number of Azotobacter might be due to more organic matter accumulation in the soil conservation structures like Contour bund and Boulder bunds (Latha and Gopal, 2010).
- **Phosphate Solubilizing Bacteria (PSB):** Highest population was recorded at the depth of 0-15 cm in Boulder bund structure followed by Contour bund (30.89x10^5 CFU g^{-1} soil), Rock fill dam(28.07x10^5 CFU g^{-1} soil), Check dam(24.97x10^5 CFU g^{-1} soil), Nala bund(12.70x10^5 CFU g^{-1} soil), Farm pond(19.17x10^5 CFU g^{-1} soil) and Control(14.04x10^5 CFU g^{-1} soil). At a depth of 15-30 cm, higher population of PSB was recorded in Contour bund (25.10 x10^5 CFU g^{-1}), which was on par with Rock fill dam (24.97x10^5 CFU g^{-1}). At the depth of 30-45 cm, Rock fill dam was recorded numerically highest population of PSB with 16.69 x10^5 CFU g^{-1} followed by Boulder bund (16.09 x10^5CFU g^{-1}) which were on par with each other. Similarly, at the depth of 45-60 cm highest population was recorded in Boulder bund (5.01x10^5CFU g^{-1}). Boulder bund was recorded highest mean population of PSB (18.92 x10^5 CFU g^{-1}) followed by Contour bund (18.46 x10^5 CFU g^{-1}) which were on par with each other.
- **Arbuscular mycorrhizal (AM) Fungi :** Significantly higher mean population (Table-2) of AM fungi was recorded in Boulder bund (70.69 spore count 50 g^{-1} soil) followed by Contour bund (65.43 spore count 50 g^{-1} soil). However, lowest spore count was recorded in control cultivated land which was recorded (27.81 spore count 50 g^{-1} soil). From the Table-2, it was revealed that, shallow depths (0-15 and 15-30 cm) have shown significantly higher spore count compared to deeper soil depths like 30-45 and 45-60 cm. This may be due to the decrease of organic matter in the deeper layer of soil. These results are in conformity with the results of Rudramurthy and Gurumurthy (2007).
- **Azospirillum:** Highest mean population of azospirillum was recorded in Boulder bund with 24.68 x10^5 CFU g^{-1} (Table-2) followed by Contour bund and Rock fill dam with 20.74 16.46 x10^5 CFU g^{-1}, respectively. However, significantly lowest population was recorded in control (4.17 x10^5 CFU g^{-1}).
- **Fungi:** Highest mean population of fungi was recorded in Boulder bund with 21.80 x10^3 CFU g^{-1} (Table-3) which was followed by Contour bund with 19.33 x10^3 CFU g^{-1}.
- **Bacteria**: Numerically highest bacterial mean population was recorded from Contour bund which was recorded 32.56 x10^5 CFU g^{-1} (Table-3) which was followed by Boulder bund and Rock fill dam with 27.33 and 27.10 x10^5 CFU g^{-1} which were on par with each other.
- **Actinomycetes:** Mean population of Actinomycetes was highest in Boulder bund which was recorded 9.67 x10^3 CFU g^{-1} of soil which was followed by Contour bund with 8.88 x10^3 CFU g^{-1} of soil. Lowest population was recorded in control and Farm pond with 2.0 x10^5 CFU g^{-1} and 3.24 x10^5 CFU g^{-1} respectively.

4. Conclusion

From the present study it is revealed that, irrespective of soil conservation structures, the activity of soil microflora (bacteria, actinomycetes and fungi) was comparatively higher in surface soil than in subsurface horizons and decreased with depth due to decrease in organic matter. Further, Contour bund, Boulder bund and Rock fill dam accumulate higher organic matter and increase the population of microflora in the accumulated soil.

Soil and water conservation measures	Azotobacter population (cfu x $10^5 g^{-1}$ soil) in different depth of soil (cm)					PSB population (cfu x $10^5 g^{-1}$ soil) in different depth of soil (cm)				
	0-15	15-30	30-45	45-60	Mean	0-15	15-30	30-45	45-60	Mean
Contour bund	40.66	38.89	23.81	5.84	**27.30**	30.89	25.10	15.14	2.69	**18.46**
Boulder bund	31.63	31.51	22.77	4.45	**22.59**	31.52	23.05	16.09	5.01	**18.92**
Rock fill dam	24.03	20.74	13.67	7.02	**16.36**	28.07	24.97	16.69	2.47	**18.05**
Check dam	23.84	19.12	13.84	3.38	**15.04**	24.10	20.29	12.39	1.78	**14.64**
Nala bund	17.69	16.14	10.73	7.74	**13.08**	20.14	16.03	12.40	2.23	**12.70**
Farm Pond	16.86	13.83	8.41	5.00	**11.02**	19.17	12.71	7.43	1.73	**10.26**
Control	15.11	11.05	8.27	2.00	**9.11**	14.04	7.27	5.95	1.33	**7.15**
Mean	**24.26**	**21.61**	**14.50**	**5.06**		**23.99**	**18.49**	**12.30**	**2.46**	
Particular	Sem		CD@1%		CV	Sem		CD@1%		CV
Depth	0.31		0.88		8.71	0.33		0.94		10.61
Conservation structure	0.41		1.17			0.44		1.24		
Interaction	0.82		2.33			0.88		2.49		

Table 1: Population of Azotobacter and Population of Phosphate Solubilizing Bacteria (PSB) in different soils and water conservation measures during Kharif season in different depth of soil.

Soil and water conservation measures	Population of AM fungal spore count/50gm soil at different depths (cm)					*Azospirillum* population (cfu x $10^5 g^{-1}$ soil) in different depth of soil (cm)				
	0-15	15-30	30-45	45-60	Mean	0-15	15-30	30-45	45-60	Mean
Contour bund	155.23	98.89	5.79	1.81	**65.43**	37.50	30.89	11.83	2.73	**20.74**
Boulder bund	168.43	105.13	7.06	2.13	**70.69**	43.77	35.18	13.79	5.97	**24.68**
Rock fill dam	128.32	76.08	8.14	4.58	**54.28**	31.94	18.04	11.70	4.16	**16.46**
Check dam	129.52	79.58	5.13	1.95	**54.04**	26.36	17.40	10.39	2.52	**14.17**
Nala bund	117.46	61.19	5.83	1.69	**46.55**	17.71	10.12	6.09	4.56	**9.62**
Farm Pond	81.27	41.87	6.15	1.50	**32.70**	13.75	8.16	5.78	1.93	**7.40**
Control	70.11	36.76	3.87	0.48	**27.81**	8.21	5.01	1.98	1.47	**4.17**
Mean	**121.48**	**71.36**	**6.00**	**2.02**		**25.60**	**17.83**	**8.79**	**3.33**	
Particular	Sem		CD@1%		CV	Sem		CD@1%		CV
Depth	0.54		1.54		4.94	0.32		0.90		10.43
Conservation structure	0.72		2.03			0.42		1.19		
Interaction	1.43		4.06			0.84		2.37		

Table 2: Population of AM fungal spore count and Azospirillum in different soil and water conservation measures during Kharif season at different depths of soil

Soil and water conservation measures	Fungi population (cfu x $10^3 g^{-1}$ soil) in different depth of soil (cm)					Bacteria population (cfu x $10^5 g^{-1}$ soil) in different depth of soil (cm)				
	0-15	15-30	30-45	45-60	Mean	0-15	15-30	30-45	45-60	Mean
Contour bund	40.88	29.64	5.10	1.70	**19.33**	55.13	46.25	20.73	8.13	**32.56**
Boulder bund	44.16	32.60	7.75	2.69	**21.80**	47.15	41.17	16.09	4.92	**27.33**
Rock fill dam	20.01	15.45	4.02	1.34	**10.21**	45.83	37.77	18.93	5.87	**27.10**
Check dam	19.05	12.83	3.37	1.68	**9.23**	37.42	30.08	15.45	4.83	**21.95**
Nala bund	13.12	8.88	4.71	2.01	**7.18**	24.79	20.79	12.13	6.44	**16.04**
Farm Pond	7.81	4.57	2.40	0.69	**3.87**	21.25	17.91	6.85	2.83	**12.21**
Control	5.96	2.07	1.35	1.17	**2.64**	16.17	14.10	6.77	2.00	**9.76**
Mean	**21.57**	**15.15**	**4.10**	**1.61**		**35.39**	**29.72**	**13.85**	**5.00**	

Particular	Sem	CD@1%	CV	Sem	CD@1%	CV
Depth	0.29	0.82	12.55	0.32	0.91	7.04
Conservation structure	0.38	1.09		0.43	1.21	
Interaction	0.77	2.18		0.85	2.42	

Table 3: Population of Fungi and Bacteria in different soil and water conservation measures during Kharif season in different depth of soil

Soil and water conservation measures	Population (cfu x $10^3 g^{-1}$ soil) in different depth of soil (cm)				
	0-15	**15-30**	**30-45**	**45-60**	**Mean**
Contour bund	20.95	8.73	3.60	2.13	**8.85**
Boulder bund	21.23	12.17	4.12	1.17	**9.67**
Rock fill dam	17.79	10.95	3.18	0.00	**7.98**
Check dam	16.25	7.32	2.58	0.33	**6.62**
Nala bund	10.80	5.45	1.60	0.00	**4.46**
Farm Pond	7.12	4.62	1.13	0.10	**3.24**
Control	5.07	2.13	0.80	0.00	**2.00**
Mean	**14.17**	**7.34**	**2.43**	**0.53**	
Particular	**Sem**		**CD@1%**		**CV**
Depth	0.26		0.75		19.76
Conservation structure	0.35		0.99		
Interaction	0.70		1.98		

Table 4: Population of Actinomycetes in different soil and water conservation measures during Kharif season in different depth of soil

5. References

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