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Microbial Load of Soil under Aerobic Rice Based Intercropping in Southern Transition Zone of Karnataka

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ABSTRACT

An experiment on microbial load of soil under aerobic rice based intercropping was conducted with two land configuration method and five rice based intercropping systems in Southern Transition Zone of Karnataka under drip fertigation during the Kharif 2016 and 2017 on sandy loam soils at College of Agriculture, Shimoga. Microbial population showed significant variations due to land configuration methods and intercropping systems in paired row of rice. Raised bed method of land configuration registered significantly higher microbial population of bacteria, fungi and actinomycetes at harvest (33.98 x 10^{-5}, 31.98 x10^{-6}, 24.33 x10^{-3}, 23.50 x10^{-4}, 21.15 x10^{-2} and 19.60 x10^{-3}cfu g^{-1} of soil, respectively) and among the intercropping system aerobic rice with soybean witnessed significantly higher population of bacteria, fungi and actinomycetes (38.06x10^{-5}, 35.95x10^{-6}, 26.39x10^{-3}, 25.24x10^{-4}, 22.26x10^{-2} and 20.86x10^{-3} cfu g^{-1} of soil, respectively). From this experiment it can be concluded that cultivation of rice under raised bed along with intercropping with soybean and fertigation through drip can helps to enhance microbial load of the soil.

Key words: *Microbial load, Bacteria, Fungi, Actinimycities, Rice, Kharif.*

INTRODUCTION

Aerobic rice is broadly defined as "a production system in which, direct seeding of high yielding and input responsive rice cultivars grown in non-puddled, non-flooded and non-saturated soil during the entire growing cycle". It is a new concept of reducing water requirement for rice in which rice is grown like an upland crop with supplementary irrigations, when rainfall is insufficient Rohit *et al*[1]. Development of suitable land configuration techniques could improve the water and nutrients use efficiency by reducing the loss of above two resources in the soil. As water is becoming scarce all around the World, direct dry seeding by configuring the land either on flatbed or raised bed is gaining immense popularity in most of the rice growing areas of Asia. Rice crop under aerobic cultivation is sown at a little wider spacing of either 25 cm X 25 cm or 30 cm X 30 cm provides very good scope to lay in drip irrigation system[2].

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Establishment of drip fertigation system under paired row arrangement with altered rice crop geometry could reduce initial installation cost of drip system per unit area. Further, space between paired rows of rice can be used to introduce short duration intercrops for efficient use of all the resources besides giving additional income to the farmers Ramadass and Ramanathan[3]. Proper selection of various intercrops in drip fertilized aerobic rice would provide many advantages including reduction in the weed population which is one of the major problem in aerobic rice. Soil microorganisms respond quickly to environmental changes (e.g., method of crop production, application of fertilizer or herbicide, tillage, crop rotation and seasonal variation *etc*.,), resulting in dynamic changes in microbial population in the soil, activity, diversity, abundance and composition Sparling *et al*[4]. Microbial biomass, activity and diversity are effective indicators of soil quality and health Bending *et al*[5]. Therefore, understanding the shifts of microbial population or load at various crop growth stages influences the crop growth and development. Hence, following different agricultural management practices is important for selecting suitable management strategies to improve ecosystem service of rice under aerobic condition. Keeping these points in view, field experiment was conducted to know the effect of land configuration techniques and different intercrops under fertigation on microbial load of aerobic rice and intercrop indices.

MATERIAL AND METHODS

The field experiment was conducted during *Kharif* season of 2015 and 2016 at College of Agriculture, UAHS, Shivamogga. The experimental site was situated at 14^0 to 14^0.1 I North latitude and 75^0.45 I to 75^0.42I East longitude with an altitude of 65^0 meters above from mean sea level and is located under Southern Transition Zone of Karnataka. The experiment was laid out in split plot design by keeping two land configuration techniques, *viz*. M_1: raised bed method and M_2: flatbed method as a main plot and five different aerobic rice based intercropping systems *i.e*. S_1: paired row of aerobic rice + french bean, S_2: paired row of aerobic rice + soybean, S_3: paired row of aerobic rice + carrot, S_4: paired row of aerobic rice + ragi and S_5 : paired row of aerobic rice (sole crop) as a sub-plot and was replicated thrice. The cultivars used were, MAS 946-1 variety of rice, Arka Komal variety of French bean, GPU-28 variety of ragi, JS-335 variety of soybean and new kuroda variety of carrot.

The land was ploughed once with disc plough followed by two harrowings with the onset of monsoon to bring the seedbed to fine tilth. Within the plot area raised beds were formed manually with a height of 15 cm and spacing followed was 20X40/20 cm for paired row arrangement, aerobic rice seeds were dibbled at 20 cm X 20 cm paired rows and one inter crop row were introduced in between vacant space of two paired rows. Recommended doses of NPK (100:50:50 kg ha^{-1}) to aerobic rice was applied using water soluble fertilizers through drip-fertigation method by using ventury system, fertigation schedule was started one week after sowing and was continued up to 81 days after sowing in nine days interval. Further, for inter crops no separate fertilizers were applie.

All the observation are recorded as per the standard procedures and methodologies. Soil samples were collected from the rhizosphere of the plants. The soil samples collected were placed in a polyethylene bag and brought to the laboratory and stored in refrigerator at 5^0 C until used for analysis. Microbial population in respect of total bacteria, fungi and actinomycetes were assessed initially at 45, 90 DAS and at harvest by serial dilution pour plate method using specific media *viz*., Nutrient Agar (NA) for bacteria, Martin's Rose Bengal Agar (MRBA) for fungi and Kuster's Agar (KA) for actinomycetes. Further, statistical analysis of the data was carried out as per the method suggested by Gomez and Gomez[6].

RESULTS AND DISCUSSION

Intercropping of aerobic rice along with legumes favours the growth and development of rice. Because leguminous crop helps to increase the soil fertility by nitrogen fixation and also increase the microbial activity in the soil, thus provided suitable condition for rice to grow especially during reproductive stage Venkatesha[7] and Jadeye Gowda[8]. In the present experiment the data on microbial load at 45, 90 DAS and at harvest are presented in the Table 1, 2 and 3. Microbial population showed significant variations due to land configuration methods and intercropping systems in paired row of rice.

At 45 DAS between land management practices, raised bed method registered significantly higher population (Table 1) of bacteria, fungi and actinomycetes (21.09x10^{-5}, 18.36x10^{-6}, 14.97x10^{-3}, 13.76x10^{-4}, 9.99x10^{-2}, 9.01x10^{-3} *cfu* g^{-1} of soil, respectively) than flatbed method (19.10x10^{-5}, 16.62x10^{-6}, 13.88x10^{-3}, 12.88x10^{-4}, 9.31x10^{-2}, 8.37x10^{-3} *cfu* g^{-1} of soil, respectively). Aeration and moisture status under raised bed method facilitated good microbial growth in the soil which led to improved growth and development of rice cropn Sparling *et al*.,[4]. Microorganisms play a key role in biochemical functions during process of organic matter decomposition in the soil system Sinsabaugh *et al*[9].

Among the intercropping systems, intercropping of paired rows of aerobic rice with soybean witnessed significantly higher population of bacteria, fungi and actinomycetes at 45 DAS (25.17x10^{-5}, 21.92x10^{-6}, 17.52x10^{-3}, 16.24x10^{-4}, 11.60x10^{-2} and 10.22x10^{-3}, *cfu* g^{-1} of soil, respectively) and it was comparable with rice+french bean intercropping systems (25.00x10^{-5}, 21.68x10^{-6}, 16.78x10^{-3}, 15.55x10^{-4}, 11.27x10^{-2} and 10.05x10^{-3}, *cfu* g^{-1} of soil, respectively). However, lowest number of bacteria, fungi and actinomycetes at 45 DAS recorded under sole crop of aerobic rice in paired row (15.43x10^{-5}, 13.47x10^{-6}, 12.10x10^{-3}, 11.00x10^{-4}, 7.85x10^{-3} and 6.98 x 10^{-2} *cfu* g^{-1} of soil, respectively). Similar trend was followed at 90 DAS and at harvest (Table 2 and 3), between land management practices, raised bed method recorded significantly higher population of bacteria, fungi and actinomycetes (32.5x10^{-5}, 28.70x10^{-6}, 22.20x10^{-3},19.56x10^{-4}, 17.38x10^{-2}, 15.43x10^{-3} and 33.98x10^{-5}, 31.98x10^{-6}, 24.33x10^{-3}, 23.50x10^{-4}, 21.15x10^{-2}, 19.60x10^{-3} *cfu* g^{-1} of soil, at 90 DAS and at harvest, respectively) than flatbed method (30.21x10^{-5}, 26.87x10^{-6}, 21.18x10^{-3}, 18.58x10^{-4}, 16.57x10^{-2}, 14.68x10^{-3} and 31.99x10^{-5}, 30.04x10^{-6}, 23.33x10^{-3}, 22.37x10^{-4}, 20.31x10^{-2}, 18.96x10^{-3} *cfu* g^{-1} of soil, at 90 DAS and at harvest respectively). Interactive effects of land configuration technique and inter cropping system found non-significant during both the years of experimentation. Microorganisms are important in catalysing several vital reactions necessary for life process in soil *viz.*, decomposition of organic wastes, organic matter formation and nutrient cycling which aims at stabilization of soil structure hence playing an important role in agriculture Adikant *et al*.[10]. Higher grain yield under raised bed method is further attributed to increased microbial population of bacteria, fungi and actinomycetes in raised bed method of land configuration at harvest (33.98x10^{-5}, 31.98x10^{-6}, 24.33x10^{-3}, 23.50x10^{-4}, 21.15x10^{-2} and 19.60x10^{-3} *cfu* g^{-1} of soil, respectively) which helped in faster decomposition of FYM applied to the field, mineralization and release of nutrients for crop growth by enhanced enzyme activities Ramadass, S. and Ramanathan[11]. This may be attributed for less competition index of carrot due to higher dominance and suppressive effect of rice and as carrot is a short statured root crop, it might have created a favourable environment for rice crop to utilize available water and nutrients without any competition Venkatesha[12].

Table 1: Microbial load of soil (*cfu* g^{-1} of soil) at 45 DAS as influenced by aerobic rice based intercropping system through fertigation under flat and raised bed method

Treatments	2015						2016						Pooled					
	Bacteria		Fungi		Actinomycetes		Bacteria		Fungi		Actinomycetes		Bacteria		Fungi		Actinomycetes	
	10^{-5}	10^{-6}	10^{-3}	10^{-4}	10^{-2}	10^{-3}	10^{-5}	10^{-6}	10^{-3}	10^{-4}	10^{-2}	10^{-3}	10^{-5}	10^{-6}	10^{-3}	10^{-4}	10^{-2}	10^{-3}
Land configuration techniques (M)																		
M_1	19.92	17.22	14.28	13.34	8.99	8.57	22.25	19.50	15.66	14.19	10.99	9.46	21.09	18.36	14.97	13.76	9.99	9.01
M_2	17.93	15.48	13.25	12.46	8.31	7.92	20.26	17.76	14.51	13.31	10.31	8.81	19.10	16.62	13.88	12.88	9.31	8.37
S. Em.±	**0.31**	**0.33**	**0.19**	**0.10**	**0.04**	**0.04**	**0.31**	**0.33**	**0.22**	**0.10**	**0.04**	**0.04**	**0.31**	**0.33**	**0.20**	**0.10**	**0.04**	**0.04**
CD (P=0.05)	**1.89**	**2.01**	**1.17**	**0.60**	**0.24**	**0.26**	**1.89**	**2.01**	**1.36**	**0.60**	**0.24**	**0.26**	**1.89**	**2.01**	**1.22**	**0.60**	**0.24**	**0.26**
Intercrops (S)																		
S_1	23.83	20.54	16.14	15.13	10.27	9.78	26.16	22.82	17.42	15.98	12.27	10.66	25.00	21.68	16.78	15.55	11.27	10.05
S_2	24.00	20.78	16.88	15.82	10.60	10.11	26.34	23.07	18.16	16.67	12.60	11.00	25.17	21.92	17.52	16.24	11.60	10.22
S_3	18.22	15.69	12.75	11.95	8.42	8.03	20.56	17.98	14.15	12.80	10.42	8.91	19.39	16.83	13.45	12.37	9.42	8.47
S_4	14.30	12.41	11.77	11.03	7.12	6.79	16.64	14.69	12.77	11.88	9.12	7.67	15.47	13.55	12.27	11.45	8.12	7.23
S_5	14.27	12.33	11.27	10.57	6.85	6.53	16.60	14.61	12.93	11.42	8.85	7.42	15.43	13.47	12.10	11.00	7.85	6.98
S. Em.±	**0.75**	**0.64**	**0.34**	**0.32**	**0.24**	**0.22**	**0.75**	**0.64**	**0.24**	**0.32**	**0.24**	**0.22**	**0.75**	**0.64**	**0.26**	**0.32**	**0.24**	**0.22**
CD (P=0.05)	**2.24**	**1.90**	**1.03**	**0.96**	**0.71**	**0.66**	**2.24**	**1.90**	**0.72**	**0.96**	**0.71**	**0.66**	**2.24**	**1.90**	**0.78**	**0.96**	**0.71**	**0.66**
Interactions (M X S)																		
$M_1 S_1$	24.63	21.42	16.66	15.60	10.43	9.93	26.96	23.71	17.72	16.45	12.43	10.82	25.79	22.57	17.19	16.03	11.43	10.37
$M_1 S_2$	25.88	22.24	17.63	16.54	11.07	10.55	28.22	24.52	19.40	17.39	13.07	11.44	27.05	23.38	18.51	16.96	12.07	11.00
$M_1 S_3$	19.64	16.92	13.29	12.22	8.51	8.12	21.97	19.20	14.39	13.07	10.51	9.01	20.80	18.06	13.84	12.65	9.51	8.56
$M_1 S_4$	14.80	12.83	12.00	11.25	7.58	7.22	17.13	15.11	13.65	12.10	9.58	8.11	15.96	13.97	12.73	11.67	8.58	7.66
$M_1 S_5$	14.66	12.69	11.81	11.09	7.36	7.02	17.00	14.98	13.15	11.94	9.36	7.91	15.83	13.83	12.58	11.52	8.36	7.47
$M_2 S_1$	23.38	20.14	15.63	14.65	10.11	9.62	25.71	22.42	17.11	15.50	12.11	10.51	24.55	21.28	16.37	15.08	11.11	10.06
$M_2 S_2$	21.78	18.83	16.13	15.10	10.13	9.66	24.11	21.12	16.92	15.95	12.13	10.55	22.94	19.97	16.53	15.52	11.13	10.11
$M_2 S_3$	16.81	14.47	12.21	11.67	8.32	7.93	19.14	16.75	13.90	12.52	10.32	8.82	17.97	15.61	13.06	12.09	9.32	8.38
$M_2 S_4$	13.87	11.99	11.54	10.80	6.66	6.36	16.20	14.27	12.40	11.65	8.66	7.24	15.04	13.13	11.97	11.23	7.66	6.80
$M_2 S_5$	13.81	11.96	10.74	10.06	6.34	6.04	16.14	14.25	12.21	10.91	8.34	6.93	14.98	13.10	11.47	10.48	7.34	6.49
S. Em.±	**1.06**	**0.90**	**0.49**	**0.46**	**0.33**	**0.31**	**1.06**	**0.90**	**0.34**	**0.46**	**0.33**	**0.31**	**1.06**	**0.90**	**0.37**	**0.46**	**0.33**	**0.31**
CD (P=0.05)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
CV (%)	**10.65**	**10.47**	**6.75**	**6.74**	**7.35**	**7.21**	**9.48**	**9.19**	**4.31**	**6.32**	**5.97**	**6.51**	**10.03**	**9.79**	**4.90**	**6.52**	**6.59**	**6.84**

Note: DAS: days after sowing, NS: Non Significant

Table 2: Microbial load of soil (*cfu* g^{-1} of soil) at 90 DAS as influenced by aerobic rice based intercropping system through fertigation under flat and raised bed method

Treatments	2015						2016						Pooled					
	Bacteria		Fungi		Actinomycetes		Bacteria		Fungi		Actinomycetes		Bacteria		Fungi		Actinomycetes	
	10^{-5}	10^{-6}	10^{-3}	10^{-4}	10^{-2}	10^{-3}	10^{-5}	10^{-6}	10^{-3}	10^{-4}	10^{-2}	10^{-3}	10^{-5}	10^{-6}	10^{-3}	10^{-4}	10^{-2}	10^{-3}
Land configuration techniques (M)																		
M_1	30.70	27.70	21.70	18.96	16.52	15.06	33.59	29.70	22.70	20.16	18.23	15.80	32.15	28.70	22.20	19.56	17.38	15.43
M_2	28.76	25.87	20.68	17.98	15.72	14.31	31.65	27.87	21.68	19.18	17.43	15.05	30.21	26.87	21.18	18.58	16.57	14.68
S. Em.±	**0.32**	**0.29**	**0.18**	**0.16**	**0.03**	**0.02**	**0.32**	**0.29**	**0.18**	**0.16**	**0.03**	**0.02**	**0.32**	**0.29**	**0.18**	**0.16**	**0.03**	**0.02**
CD (P=0.05)	**1.95**	**1.76**	**1.10**	**0.97**	**0.18**	**0.12**	**1.95**	**1.76**	**1.10**	**0.97**	**0.18**	**0.12**	**1.95**	**1.76**	**1.10**	**0.97**	**0.18**	**0.12**
Intercrops (S)																		
S_1	34.49	31.27	23.77	20.90	17.67	16.26	37.38	33.27	24.77	22.10	19.38	17.00	35.93	32.27	24.27	21.50	18.53	16.63
S_2	34.68	31.44	24.50	21.59	18.33	16.79	37.57	33.44	25.50	22.79	20.03	17.53	36.12	32.44	25.00	22.19	19.18	17.16
S_3	29.05	26.13	19.53	16.90	15.83	14.42	31.94	28.13	20.53	18.10	17.53	15.16	30.49	27.13	20.03	17.50	16.68	14.79
S_4	25.23	22.57	19.40	16.80	14.53	13.12	28.12	24.57	20.40	18.00	16.24	13.86	26.67	23.57	19.90	17.40	15.38	13.49
S_5	25.21	22.51	18.78	16.19	14.26	12.85	28.11	24.17	19.78	17.39	15.97	13.59	26.61	23.51	19.28	16.79	15.11	13.22
S. Em.±	**0.75**	**0.67**	**0.54**	**0.36**	**0.32**	**0.30**	**0.75**	**0.67**	**0.54**	**0.36**	**0.32**	**0.30**	**0.75**	**0.67**	**0.54**	**0.36**	**0.32**	**0.30**
CD (P=0.05)	**2.25**	**2.00**	**1.60**	**1.09**	**0.96**	**0.88**	**2.25**	**2.00**	**1.60**	**1.09**	**0.96**	**0.88**	**2.25**	**2.00**	**1.60**	**1.09**	**0.96**	**0.88**
Interactions (M X S)																		
$M_1 S_1$	35.28	32.04	24.28	21.37	17.83	16.42	38.17	34.04	25.28	22.57	19.54	17.16	36.73	33.04	24.78	21.97	18.69	16.79
$M_1 S_2$	36.48	33.14	25.25	22.31	19.11	17.44	39.37	35.14	26.25	23.51	20.82	18.18	37.92	34.14	25.75	22.91	19.96	17.81
$M_1 S_3$	30.44	27.42	19.92	17.25	15.92	14.51	33.33	29.42	20.92	18.45	17.63	15.25	31.88	28.42	20.42	17.85	16.77	14.88
$M_1 S_4$	25.60	22.88	19.63	17.02	14.99	13.58	28.49	24.88	20.63	18.22	16.69	14.32	27.04	23.88	20.13	17.62	15.84	13.95
$M_1 S_5$	25.71	23.02	19.44	16.86	14.77	13.36	28.60	25.02	20.44	18.06	16.48	14.10	27.16	24.02	19.94	17.46	15.62	13.73
$M_2 S_1$	32.50	29.40	23.25	20.42	17.51	16.10	35.39	31.40	24.25	21.62	19.22	16.84	33.94	30.40	23.75	21.02	18.37	16.47
$M_2 S_2$	34.08	30.85	23.74	20.87	17.54	16.13	36.97	32.85	24.74	22.07	19.25	16.87	35.52	31.85	24.24	21.47	18.39	16.50
$M_2 S_3$	27.66	24.84	19.13	16.54	15.73	14.32	30.55	26.84	20.13	17.74	17.44	15.06	29.11	25.84	19.63	17.14	16.58	14.69
$M_2 S_4$	24.83	22.14	19.17	16.57	14.07	12.66	27.72	24.14	20.17	17.77	15.78	13.40	26.28	23.14	19.67	17.17	14.92	13.03
$M_2 S_5$	24.74	22.12	18.13	15.51	13.75	12.34	27.63	24.12	19.13	16.71	15.45	13.08	26.19	23.12	18.63	16.11	14.60	12.71
S. Em.±	**1.07**	**0.95**	**0.76**	**0.51**	**0.45**	**0.42**	**1.07**	**0.95**	**0.76**	**0.51**	**0.45**	**0.42**	**1.07**	**0.95**	**0.76**	**0.51**	**0.45**	**0.42**
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
CV (%)	**6.83**	**6.74**	**6.81**	**5.30**	**5.37**	**5.43**	**6.23**	**6.27**	**6.51**	**4.97**	**4.86**	**5.17**	**6.52**	**6.50**	**6.66**	**5.13**	**5.10**	**5.29**

Note: DAS: Days after sowing, NS: Non significant

Table 3: Microbial load of soil (*cfu* g^{-1} of soil) at harvest as influenced by aerobic rice based intercropping system through fertigation under flat and raised bed method

Treatments	2015						2016						Pooled					
	Bacteria		Fungi		Actinomycetes		Bacteria		Fungi		Actinomycetes		Bacteria		Fungi		Actinomycetes	
	10^{-5}	10^{-6}	10^{-3}	10^{-4}	10^{-2}	10^{-3}	10^{-5}	10^{-6}	10^{-3}	10^{-4}	10^{-2}	10^{-3}	10^{-5}	10^{-6}	10^{-3}	10^{-4}	10^{-2}	10^{-3}
Land configuration techniques (M)																		
M_1	33.26	30.70	23.88	23.00	20.90	19.30	34.70	33.25	24.77	23.99	21.40	19.90	33.98	31.98	24.33	23.50	21.15	19.60
M_2	31.27	28.76	22.89	21.87	20.06	18.66	32.71	31.31	23.77	22.86	20.56	19.26	31.99	30.04	23.33	22.37	20.31	18.96
S. Em.±	**0.31**	**0.32**	**0.16**	**0.21**	**0.13**	**0.10**	**0.31**	**0.32**	**0.16**	**0.21**	**0.13**	**0.10**	**0.31**	**0.32**	**0.16**	**0.21**	**0.13**	**0.10**
CD (P=0.05)	**1.89**	**1.95**	**0.98**	**1.30**	**0.77**	**0.62**	**1.89**	**1.95**	**0.98**	**1.30**	**0.77**	**0.62**	**1.89**	**1.95**	**0.98**	**1.30**	**0.77**	**0.62**
Intercrops (S)																		
S_1	37.17	34.49	26.69	26.01	22.77	20.69	38.61	37.04	27.57	27.00	23.27	21.29	37.89	35.76	27.13	26.50	23.02	20.86
S_2	37.34	34.68	25.95	24.74	22.01	20.57	38.78	37.23	26.83	25.73	22.51	21.16	38.06	35.95	26.39	25.24	22.26	20.99
S_3	31.56	29.05	21.71	20.71	20.16	18.85	33.00	31.60	22.59	21.70	20.66	19.45	32.28	30.32	22.15	21.21	20.41	19.15
S_4	27.60	25.22	21.51	20.59	18.87	17.64	29.04	27.77	22.40	21.58	19.37	18.24	28.32	26.49	21.96	21.09	19.12	17.94
S_5	27.64	25.23	21.08	20.13	18.60	17.16	29.08	27.78	21.96	21.12	19.10	17.76	28.36	26.50	21.52	20.62	18.85	17.46
S. Em.±	**0.75**	**0.75**	**0.49**	**0.48**	**0.43**	**0.31**	**0.75**	**0.75**	**0.49**	**0.48**	**0.43**	**0.31**	**0.75**	**0.75**	**0.49**	**0.48**	**0.43**	**0.31**
CD (P=0.05)	**2.24**	**2.25**	**1.46**	**1.43**	**1.27**	**0.93**	**2.24**	**2.25**	**1.46**	**1.43**	**1.27**	**0.93**	**2.24**	**2.25**	**1.46**	**1.43**	**1.27**	**0.93**
Interactions (M X S)																		
$M_1 S_1$	37.96	35.28	26.46	25.24	22.17	20.72	39.40	37.83	27.35	26.23	22.67	21.31	38.68	36.56	26.91	25.73	22.42	21.02
$M_1 S_2$	39.22	36.48	27.43	27.26	23.67	20.93	40.66	39.03	28.32	28.25	24.17	21.52	39.94	37.75	27.88	27.76	23.92	21.23
$M_1 S_3$	32.97	30.44	22.10	21.09	20.26	18.95	34.41	32.99	22.98	22.08	20.76	19.54	33.69	31.71	22.54	21.59	20.51	19.25
$M_1 S_4$	28.13	25.71	21.62	20.82	19.32	18.06	29.57	28.15	22.69	21.81	19.82	18.66	28.85	26.99	22.25	21.32	19.57	18.36
$M_1 S_5$	28.00	25.60	21.81	20.61	19.11	17.87	29.44	28.26	22.50	21.60	19.61	18.46	28.72	26.87	22.06	21.10	19.36	18.17
$M_2 S_1$	35.11	32.50	25.43	24.25	21.85	20.41	36.55	35.05	26.32	25.24	22.35	21.01	35.83	33.77	25.88	24.75	22.10	20.71
$M_2 S_2$	36.72	34.08	25.94	24.75	21.88	20.46	38.16	36.63	26.82	25.74	22.38	21.05	37.44	35.35	26.38	25.25	22.13	20.75
$M_2 S_3$	30.14	27.66	21.31	20.34	20.07	18.76	31.58	30.21	22.20	21.33	20.57	19.36	30.86	28.94	21.76	20.83	20.32	19.06
$M_2 S_4$	27.21	24.83	21.22	20.37	18.41	17.22	28.65	27.38	22.10	21.36	18.91	17.82	27.93	26.11	21.66	20.86	18.66	17.52
$M_2 S_5$	27.15	24.74	20.54	19.65	18.08	16.46	28.59	27.29	21.43	20.64	18.58	17.05	27.87	26.02	20.99	20.14	18.33	16.76
S. Em.±	**1.06**	**1.07**	**0.69**	**0.68**	**0.60**	**0.44**	**1.06**	**1.07**	**0.69**	**0.68**	**0.60**	**0.44**	**1.06**	**1.07**	**0.69**	**0.68**	**0.60**	**0.44**
CD (P=0.05)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
CV (%)	**6.25**	**6.83**	**5.62**	**5.76**	**5.60**	**4.39**	**5.98**	**6.29**	**5.42**	**5.52**	**5.47**	**4.26**	**6.11**	**6.55**	**5.52**	**5.64**	**5.53**	**4.33**

Note: DAS: Days after sowing, NS: Non significant

CONCLUSION

Raised bed method of land configuration and intercropping of aerobic rice with soybean registered significantly higher microbial population of bacteria, fungi and actinomycetes at harvest. Hence, establishment of rice crop under aerobic situation along with soybean as intercrop in raised bed method helps to increase the yield by 11 %.

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