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Original Research Article

Soil Available Nutrients and Microbial Populations as Influenced by Groundnut Based Diversified Cropping Systems

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A B S T R A C T

The experiment was conducted to study the soil available nutrients and microbial populations as influenced by groundnut based diversified cropping systems at MPKV, Rahuri. The results indicated that, at the end of two years of cropping systems, Application of fertilizer as per soil test or recommended dose of fertilizer to *kharif* groundnut followed by 100 per cent or 75 per cent recommended dose of fertilizer to succeeding crop onion, wheat and chickpea during *rabi* season was found most suitable nutrient management in groundnut based diversified cropping systems for improving in soil chemical properties (N, P, K and DTPA Mn, Cu, Fe, Zn) and biological properties. The groundnut-chickpea cropping system found superior in improving the soil microbial population (fungi, bacteria and actinomycetes) than groundnut-onion and groundnut-wheat cropping systems.

Keywords

Fungi, Bacteria and Actinomycetes, Nutrient management, Cropping system

Introduction

Continuous cropping of cereal-cereal crop sequence over a long period of time reduces productivity and soil fertility. Sustainable groundnut production can be achieved by diversifying the groundnut based cropping system and nutrient management. Inclusion of legume in a crop sequence not only takes care of soil health but also gives higher yield and helps to increase soil nutrient status.

Soils containing a high microbial diversity are characteristic of a healthy soil-plant relationship, whereas those with low microbial diversity are characterized as an unhealthy soil than often hardly responds to environmental changes (Tajeda, *et al.*, 2011). The microbial population dynamics is governed by interaction between plant type, climate and management practices. The microbiological and biochemical conditions of soil can serve as a marker of the soil status and is closely linked to its natural soil fertility. The objective of this study was to evaluate the microbial dynamics and soil available nutrients as influenced by groundnut based diversified cropping systems.

Materials and Methods

Site description and field experiment

The study was conducted during 2011-12 and 2012-13 at Post Graduate Research Farm, Department of Agronomy, MPKV., Rahuri (19° 48' N and 19° 57' N latitude, 74° 32' E and 74° 19' E longitude and 495 to 569 m above MSL). The weekly mean

maximum and minimum temperature during the experimentation ranged from 33° to 43°C and 6° to 18°C, respectively. The experiment was carried out on sandy clay loam soil with low in available nitrogen (172.11 kg ha^{-1}), medium in available phosphorus (18.02 kg ha^{-1}) and high in available potassium (427.0 kg ha^{-1}) and moderate in Fe (6.89 µg g^{-1} soil), Mn (9.51 µg g^{-1} soil), Zn (0.62 µg g^{-1} soil) and Cu (3.41 µg g^{-1} soil). The soil was moderately alkaline in reaction (pH 8.2). The electrical conductivity, organic carbon and $CaCO_3$ were 0.29 dSm^{-1}, 0.54 and 4.50 per cent, respectively.

Experimental design and treatments

The experiment was laid out in a strip plot design with three replications. The treatment consist of three cropping systems *viz.*, C_1-groundnut-onion, C_2-groundnut-wheat and C_3-groundnut-chickpea with four nutrient management treatments *viz.*, T_1-recommended dose of fertilizer, T_2-fertilizer dose as per soil test, T_3-fertilizer dose as per STCR equations and T_4-control as main plot treatment whereas three fertilizer levels *viz.*, F_1-100 % RDF, F_2-75% RDF and F_3- 50 % RDF as sub plot treatments. Groundnut- JL-501, onion- N 2-4-1, wheat- Trimbak and chickpea- Digvijay cultivars were used during *kharif* and *rabi* seasons, respectively. Both the years of crop seasons were favourable to grow the *kharif* and *rabi* crops. The recommended package of practices were adopted to grow the crops and fertilizers were applied as per treatment.

Soil sampling

Initial soil samples were collected in June-2011 prior to the start of the experiment and after harvest of each crop during *kharif* and *rabi* seasons. Soil samples were taken as per treatment wise from the surface layer (0-30 cm) of with three replications for soil chemical analysis during 2011-12 and 2012-13. For soil microbial analysis soil samples were collected treatment wise from the surface layer (0-15 cm) during flowering stage of groundnut (*kharif*), wheat, chickpea (*rabi*) and vegetative growth stage in onion (*rabi*) during both the years. These soil samples were kept at 4.0°C in plastic bags for a few days to stabilize the microbiological activity disturbed during soil sampling and handling and then analysed. Total fungi, bacteria and actinomycetes were estimated by the standard procedure of Serial Dilution Plate Technique (Dhingra and Sinclair,1993).

Results and Discussion

Soil chemical properties

Groundnut-onion cropping system

In residual effect of *kharif* groundnut, application of recommended dose of fertilizer to preceding crop *kharif* groundnut registered significantly maximum soil available nitrogen (190.45, 201.40 kg ha^{-1}) phosphorus (20.61, 19.67 kg ha^{-1}) and potassium (302.00, 352.11 kg ha^{-1}) during both the years. However, it was at par with fertilizer dose as per soil test and fertilizer dose as per STCR equation in respect of nitrogen during first year, whereas during second year, it was also at par with fertilizer dose as per soil test in respect of nitrogen and phosphorus. The DTPA soil micronutrients *viz.*, Fe, Mn, Zn and Cu were not influenced significantly except Fe during both the years. Application of fertilizer dose as per soil test to preceeding crop registered significantly higher values of Fe (6.87 and 6.91 µg g^{-1} soil) than rest of the treatments during both the years (Table 2). Maximum soil available nutrients were observed in recommended dose of fertilizer because of less production of biomass and yield because of lesser removal of nutrients from soil. Similar findings were reported by

Ndakidemi (2006), Tomar *et al.,* (2007) and Propavai *et al.,* (2011).

In fertilizer levels, application of 100 per cent recommended dose of fertilizers to *rabi* onion registered significantly higher soil available nitrogen, phosphorus and potassium and at par with 75 per cent recommended dose of fertilizer in respect of potassium during first year. The soil micronutrients were not influenced significantly except Fe during both the years. Application of 100 per cent recommended dose of fertilizer to onion crop recorded significantly higher Fe (6.87 and 6.85 µg g^{-1} soil) than 50 per cent recommended dose of fertilizer. However it was at par with 75 per cent recommended dose of fertilizer during both the years (Table1). These results are in accordance with Ramamoorthy *et al.,* (2009), Propavai *et al.,* (2011) and Vidyavathi *et al.,* (2011)

Groundnut-wheat cropping system

In residual effect of *kharif* groundnut, application of fertilizer to wheat during *rabi* season as per soil test registered significantly maximum soil available nitrogen (185.01 kg ha^{-1}) during first year. While during second year it was significantly maximum with recommended dose of fertilizer (209.21 kg ha^{-1}). The soil available phosphorus (20.22 and 19.73 kg ha^{-1}) and potassium (319.56 and 274.33 kg ha^{-1}) were also significantly maximum under recommended dose of fertilizer during both the years. Among micronutrients, the fertilizer dose as per soil test to preceding crop recorded significantly higher Fe (6.86 and 6.87 µg g^{-1} of soil) and Mn (9.42 and 9.46 µg g^{-1} of soil) than rest of treatments and at par with fertilizer dose as per STCR equation during both the years.

In fertilizer levels, application of 100 per cent recommended dose of fertilizer registered significantly maximum soil available nitrogen (179.27 and 191.67 kg ha^{-1}), phosphorus (18.86 and 18.84 kg ha^{-1}) and potassium (318.50 and 268.83 kg ha^{-1}) during both the years. The higher dose of fertilizer recorded significantly higher Fe (6.84 and 6.86 µg g^{-1} of soil) and Mn (9.69 and 9.71 µg g^{-1} of soil) than 50 per cent recommended dose of fertilizer (Table 2).

Groundnut-chickpea cropping system

Application of fertilizer as per recommended dose of fertilizer recorded significantly higher soil available nitrogen (187.02 and 204.05 kg ha^{-1}), phosphorus (20.05 and 20.19 kg ha^{-1}) and potassium (324.22 and 281.89 $kgha^{-1}$) after harvest of crop during both the years. Among the micro nutrients, application of fertilizer as per soil test to preceding crop registered significantly higher Fe (8.04 and 8.05 µg g^{-1} of soil) and Mn (9.59 and 9.60 µg $g^{-1}$of soil) than rest of treatments. However, it was at par with recommended dose of fertilizer and fertilizer dose as per soil test during both the years. This clearly revealed that, groundnut in rotation helps to maintain the soil organic matter and increases the availability of nutrients for *rabi* crops.

Application of 100 per cent recommended dose of fertilizer to chickpea during *rabi* season registered significantly maximum soil available nitrogen (188.68 and 202.23 kg ha^{-1}), phosphorus (19.27 and 19.31 kg ha^{-1}) and potassium (322.01 and 279.83 $kgha^{-1}$) than 75 and 50 per cent recommended dose of fertilizer during both the years. The soil micronutrients Fe (7.85 and 7.89 µg g^{-1} of soil) and Mn (9.66 and 9.62 µg $g^{-1}$of soil) were significantly higher under 100 per cent recommended dose of fertilizer than 50 per cent recommended dose of fertilizer and at par with 75 per cent fertilizer levels during both the years (Table 3).

Table.1 Soil chemical properties after harvest of onion in groundnut-onion cropping system as influenced by different treatments (2011-13)

Treatment	Soil chemical properties						Soil DTPA micronutrients (µg g^{-1} soil)							
	N (kg ha^{-1})		P (kg ha^{-1})		K (kg ha^{-1})		Fe		Mn		Zn		Cu	
	Ist year	IInd year	Ist year	IInd year	Ist year	IInd year	Ist year	IInd year	Ist year	IInd year	Ist year	IInd year	Ist year	IInd year
A. Nutrient management (*Kharif* groundnut)														
T_1 – Recommended dose of fertilizer	190.45	201.40	20.61	19. 67	302.00	352.11	6.56	6.59	9.30	9.36	0.59	0.60	3.51	3.53
T_2 –Fertilizer dose as per soil test	184.61	197.23	19.15	20.03	321.89	312.44	6.87	6.91	9.47	9.53	0.61	0.63	3.58	3.59
T_3- Fertilizer dose as per STCR eq^{n} (25 qha^{-1})	184.01	183.28	19.07	19.01	269.07	305.89	6.67	6.68	9.38	9.43	0.60	0.61	3.54	3.57
T_4-Control (No fertilizer)	164.10	165.82	14.72	12.89	281.01	268.56	6.63	6.55	9.35	9.34	0.58	0.56	3.41	3.39
SEm ±	1.91	1.76	0.29	0.36	4.92	4.35	0.06	0.06	0.09	0.09	0.04	0.03	0.06	0.07
C.D. at 5%	6.62	6.10	1.00	0.90	17.01	15.07	0.19	0.21	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
B. Fertilizer levels (Onion)														
F_1-100% of RDF (100:50:50 N,P_2O_5,K_2O kg ha^{-1})	183.26	193.40	19.65	19.41	329.42	325.25	6.87	6.85	9.66	9.69	0.60	0.61	3.59	3.59
F_2-75% of RDF (75:37.5:37.5 N,P_2O_5,K_2O kg ha^{-1})	177.74	185.48	18.23	18.01	317.33	311.00	6.77	6.78	9.61	9.63	0.60	0.60	3.51	3.53
F_3-50% of RDF (50:25:25 N,P_2O_5,K_2O kg ha^{-1})	179.09	181.92	17.87	16.20	293.67	303.01	6.40	6.42	8.91	8.95	0.59	0.60	3.42	3.44
SE m ±	1.05	1.28	0.25	0.15	6.34	2.74	0.04	0.04	0.14	0.11	0.02	0.02	0.06N	0.05
C.D. at 5%	4.42	5.02	0.98	0.58	24.91	10.76	0.15	0.16	N.S.	N.S.	N.S.	N.S.	.S.	N.S.
Initial soil status	168.41	168.41	15.69	15.69	427.0	497.15	6.89	6.89	9.51	9.51	0.58	0.58	3.41	3.41

Table.2 Soil chemical properties after harvest of wheat in groundnut-wheat cropping system as influenced by different treatments (2011-13)

Treatment	Soil chemical properties						Soil DTPA micronutrients (µg g^{-1} soil)							
	N (kg ha^{-1})		P (kg ha^{-1})		K (kg ha^{-1})		Fe		Mn		Zn		Cu	
	I^{st} year	II^{nd} year	I^{st} year	II^{nd} year	I^{st} year	II^{nd} year	I^{st} year	II^{nd} year	I^{st} year	II^{nd} year	I^{st} year	II^{nd} year	I^{st} year	II^{nd} year
A. Nutrient management (*Kharif* groundnut)														
T_1 – Recommended dose of fertilizer	182.47	209.21	20.22	19.73	319.56	274.33	6.54	6.56	9.27	9.29	0.57	0.60	3.06	3.07
T_2 –Fertilizer dose as per soil test	185.01	184.61	19.01	19.55	297.11	269.89	6.86	6.87	9.42	9.46	0.61	0.62	3.14	3.14
T_3- Fertilizer dose as per STCR eq^n ($_{25\ qha^{-1}}$)	179.55	183.62	18.94	18.90	272.38	264.78	6.69	6.71	9.33	9.39	0.58	0.61	3.08	3.09
T_4-Control (No fertilizer)	144.83	164.07	13.81	12.64	282.43	239.22	6.53	6.51	9.21	9.18	0.56	0.53	3.02	3.01
SEm ±	1.24	0.97	0.10	0.24	1.18	4.24	0.06	0.07	0.06	0.06	0.03	0.03	0.07	0.09
C.D. at 5%	4.29	3.35	0.33	0.83	4.08	14.6	0.19	0.26	0.15	0.14	N.S.	N.S.	N.S.	N.S.
B. Fertilizer levels (Wheat)														
F_1-100% of RDF (100:50:50 N,P_2O_5,K_2O kg ha^{-1})	179.27	191.67	18.86	18.84	318.50	268.83	6.84	6.86	9.69	9.71	0.60	0.61	3.19	3.19
F_2-75% of RDF (75:37.5:37.5 N,P_2O_5,K_2O kg ha^{-1})	173.77	185.69	17.85	17.81	292.80	264.01	6.75	6.75	9.45	9.46	0.58	0.60	3.07	3.08
F_3-50% of RDF (50:25:25 N,P_2O_5,K_2O kg ha^{-1})	165.84	178.82	17.36	16.46	284.36	253.32	6.38	6.37	8.78	8.83	0.56	0.58	2.97	2.97
SE m ±	1.07	0.79	0.13	0.09	1.72	2.23	0.04	0.05	0.09	0.08	0.03	0.02	0.08	0.08
C.D. at 5%	4.21	3.12	0.52	0.35	6.75	8.77	0.16	0.18	0.27	0.30.	N.S.	N.S.	N.S.	N.S.
Initial soil status	168.41	168.41	15.69	15.69	497.15	497.15	6.89	6.89	9.51	9.51	0.62	0.62	3.41	3.41

Table.3 Soil chemical properties after harvest of chickpea in groundnut-chickpea cropping system as influenced by different treatments

(2011-13)

Treatment	Soil chemical properties						Soil DTPA micronutrients (µg g^{-1} soil)							
	N (kg ha^{-1})		P (kg ha^{-1})		K (kg ha^{-1})		Fe		Mn		Zn		Cu	
	I^{st} year	II^{nd} year	I^{st} year	II^{nd} year	I^{st} year	II^{nd} year	I^{st} year	II^{nd} year	I^{st} year	II^{nd} year	I^{st} year	II^{nd} year	I^{st} year	II^{nd} year
A. Nutrient management (*Kharif* groundnut)														
T_1 – Recommended dose of fertilizer	187.02	204.05	20.05	20.19	324.22	281.89	7.95	7.96	9.46	9.48	0.59	0.60	3.13	3.14
T_2 –Fertilizer dose as per soil test	182.77	201.62	19.56	19.75	319.44	273.01	8.04	8.05	9.59	9.60	0.61	0.61	3.19	3.21
T_3- Fertilizer dose as per STCR eq^n ($25\ qha^{-1}$)	180.06	192.97	19.35	19.05	312.89	269.10	7.89	7.92	9.42	9.45	0.60	0.59	3.14	3.16
T_4-Control (No fertilizer)	179.68	169.41	14.70	13.14	299.54	257.10	6.73	6.68	9.37	9.32	0.58	0.56	3.11	3.08
SEm ±	1.07	0.80	0.17	0.31	1.95	2.63	0.06	0.06	0.06	0.05	0.03	0.02	0.05	0.06
C.D. at 5%	3.71	2.76	0.59	1.08	6.73	9.10	0.21	0.20	0.16	0.18	N.S.	N.S	N.S.	N.S.
B. Fertilizer levels (Chickpea)														
F_1-100% of RDF (100:50:50 N,P_2O_5,K_2O kg ha^{-1})	188.68	202.23	19.27	19.31	322.01	279.83	7.85	7.89	9.66	9.62	0.60	0.60	3.24	3.23
F_2-75% of RDF (75:37.5:37.5 N,P_2O_5,K_2O kg ha^{-1})	182.59	189.71	18.29	18.27	312.193	270.92	7.79	7.80	9.61	9.64	0.60	0.59	3.16	3.17
F_3-50% of RDF (50:25:25 N,P_2O_5,K_2O kg ha^{-1})	175.89	184.09	17.69	16.52	07.80	260.08	7.47	7.49	9.11	9.11	0.58	0.57	3.02	3.05
SE m ±	1.35	1.15	0.15	0.10	1.50	1.98	0.04	0.05	0.07	0.06	0.02	0.03	0.11	0.08
C.D. at 5%	5.42	4.50	0.58	0.37	5.88	7.76	0.13	0.14	0.21	0.21	N.S.	N.S.	N.S.	N.S.
Initial soil status	168.41	168.41	15.69	15.69	497.15	497.15	6.89	7.65	9.51	9.51	0.62	0.62	3.41	3.41

Table.4 Soil microbial population as influenced by different treatments

(2011-13)

Treatment	Groundnut-onion						Groundnut-wheat											
	Fungi ($cfuX10^4$ g^{-1} of soil)		Bacteria ($cfuX10^5$ g^{-1} of oil)		Actinomycetes (cfu X 10^6 g^{-1} of soil)		Fungi ($cfuX10^4$ g^{-1} of soil)		Bacteria ($cfuX10^5$ g^{-1} of oil)		Actinomycetes (cfu X 10^6 g^{-1} of soil)		Fungi ($cfuX10^4$ g^{-1} of soil)		Bacteria ($cfuX10^5$ g^{-1} of oil)		Actinomycetes (cfu $X10^6$ g^{-1} of soil)	
	I^{st} year	II^{nd} year	I^{st} year	II^{nd} year	I^{st} year	II^{nd} year	I^{st} year	II^{nd} year	I^{st} year	II^{nd} year	I^{st} year	II^{nd} year	I^{st} year	II^{nd} year	I^{st} year	II^{nd} year	I^{st} year	II^{nd} year
A. Nutrient managt.																		
T_1	8.91	9.94	10.19	10.84	5.36	5.63	7.62	8.79	10.35	10.95	4.92	5.63	9.62	9.94	11.76	11.88	5.77	6.09
T_2	9.89	10.47	11.47	12.03	5.74	6.03	8.36	9.57	11.17	11.34	5.67	6.03	10.93	10.99	12.01	12.13	6.65	6.96
T_3	9.73	10.35	11.29	11.56	5.68	5.82	8.06	9.41	11.13	11.29	5.61	5.96	10.68	10.97	11.82	11.98	6.59	6.93
T_4	7.57	7.28	8.24	8.52	3.67	4.58	5.18	5.32	7.98	8.01	3.36	4.12	8.24	8.48	8.66	8.87	4.37	4.54
SEm $\pm$	0.21	0.15	0.14	0.13	0.16	0.17	0.20	0.41	0.35	0.31	0.20	0.07	0.30	0.23	0.29	0.23	0.31	0.21
C.D. at 5%	0.73	0.54	0.49	0.46	0.57	0.57	0.68	0.84	1.23	1.06	0.69	0.20	1.05	0.81	0.98	0.78	1.09	0.72
B. Fertilizer levels																		
F_1	9.08	9.72	10.23	11.13	5.56	5.86	7.52	8.35	10.59	11.14	5.11	5.63	9.92	10.52	11.87	12.06	6.03	6.49
F_2	9.44	10.34	10.99	11.18	5.77	5.96	7.72	8.92	10.92	12.12	5.19	5.73	10.62	10.59	11.95	12.09	6.09	6.50
F_3	9.17	8.47	10.19	9.68	5.49	4.73	6.98	7.79	9.96	11.03	4.87	4.96	9.07	9.18	9.37	9.50	5.41	6.40
SE m $\pm$	0.18	0.23	0.28	0.15	0.16	0.16	0.22	0.09	0.19	0.18	0.15	0.09	0.23	0.15	0.38	0.12	0.15	0.13
C.D. at 5%	0.72	0.91	0.91	0.68	0.52	0.52	0.86	0.37	0.76	0.72	0.48	0.28	0.89	0.58	1.11	0.45	0.58	0.50

Soil microbial population

Groundnut-onion cropping system

Application of fertilizer as per soil test to *kharif* groundnut observed significantly maximum number of fungi (9.89 and 10.47 cfu $X10^4$ g^{-1} of soil), bacteria (11.47 and 12.03 cfu $X10^5$ g^{-1} of soil) and actinomycetes (5.74 and 6.03 cfu $X10^6$ g^{-1} of soil) and at par with fertilizer dose as per STCR equation in respect of fungi, bacteria and actinomycetes during first year, while during second year it was at par with fertilizer dose as per STCR equation in respect of fungi and actinomycetes and recommended dose of fertilizers in respect of actinomycetes (Table 4).

Application of 75 per cent recommended dose of fertilizer to *rabi* onion recorded significantly maximum number of fungi (9.44 and 10.34 cfu $X10^4$ g^{-1} of soil), bacteria (10.99 and 11.18 cfu $X10^5$ g^{-1} of soil) and actinomycetes (5.77 and 5.96 cfu $X10^6$ g^{-1} of soil) than 100 per cent and 50 per cent recommended dose of fertilizer during both years.

The soil biological properties in terms of fungi, bacteria and actinomycetes were favourably improved with application fertilizer as per soil test to preceding *kharif* groundnut, similarly the balanced nutrition through STCR equation found equally beneficial for improving microbial population of soil after harvest succeeding onion crop. This clearly revealed that, groundnut in rotation helps to maintain the soil organic matter and increases the availability of nutrients for *rabi* crops. Soil microbial mass is the index of soil fertility which depends upon nutrient fluxes. Similar findings were postulated by Walia *et al.*, (2010), Propavai *et al.*, (2011) and Bagayoko (2012).

Groundnut-wheat cropping system

Application of fertilizer dose as per soil test were recorded significantly higher microbial population of fungi (8.36 and 9.57cfu x 10^{-4} g^{-1} of soil), bacteria (11.17 and 11.34 x10^{-5} cfu g^{-1} of soil) and actinomycetes (5.67 and 6.03 cfu x 10^{-6} g^{-1} of soil) compared to rest of nutrient management treatments during both years, but at par with fertilizer dose as per STCR equation in respect of fungi, bacteria and actinomycetes during first year. While during second year almost similar trend was observed in respect of fungi and actinomycetes, in addition to that it was at par with recommended dose of fertilizer and fertilizer dose as per soil test in respect of bacteria. Similar findings were reported by Ganeshamurthy and Shrinivasarao (2009), Prasad *et al.*, (2011) and Propavai *et al.*, (2011).

Application of 75 per cent recommended dose of fertilizer to wheat during *rabi* season observed significantly higher number of fungi (7.72 and 8.92 cfu x 10^{-4} g^{-1} of soil), bacteria (10.92 and 12.12 cfu X 10^{-6} g^{-1} of soil) and actinomycetes (5.19 and 5.73 cfu x 10^{-4} g^{-1} of soil) during both the years and at par with 100 per cent recommended dose of fertilizer in respect of fungi, bacteria and actinomycetes during both years. These results are in accordance with Varalakshmi *et al.*, (2005), Propavai *et al.*, (2011) and Vidyavathi *et al.*, (2011)

Groundnut-chickpea cropping system

In application of fertilizer as per soil test recorded maximum population of fungi (10.93 and 10.99 cfu X 10^4 g^{-1} of soil), bacteria (12.01 and 12.13 cfu $X10^5$ g^{-1} of soil) and actinomycetes (6.65 and 6.96 cfu X 10^6 g^{-1} of soil) in a soil compared to rest of nutrient management treatments during both the years. However, it was at par with

fertilizer dose as per STCR equations in respect of fungi and bacteria during first year, while in respect of fungi and actinomycetes during second year of experiment. Soil microbial mass is the index of soil fertility which depends upon nutrient fluxes. Similar findings were postulated by Mohammad *et al.*, (2008), Walia *et al.*, (2010), Propavai *et al.*, (2011) and Ullah *et al.*, (2013).

Application of 75 per cent recommended dose of fertilizer to chickpea during *rabi* season observed significantly higher population of fungi (10.62 and 10.59 cfu X 10^4 g^{-1} of soil), bacteria (11.95 and 12.09 cfu X 10^6 $g^{-1}$of soil) and actinomycetes (6.09 and 6.50 cfu X10^4 g^{-1} of soil) and at par with 100 per cent recommended dose of fertilizer during both the years. This might be because of the residual effect of *kharif* groundnut improve the soil physical structure, organic matter content and part of fixed nitrogen through symbiosis remains in soil, subsequently during *rabi* season, growing of chickpea crop also fixes the atmospheric nitrogen and helps in improving the soil physical properties and organic matter, it creates congenial condition for increasing the soil microbial population (Table 4). These results are in agreement with those reported Deshmukh (2004), Ndakidemi (2006) and Prasad *et al.*, (2011).

On the basis of two years of experiment, it could be concluded that, application of fertilizer as per soil test crop response equation(STCR)to preceding crop *kharif* groundnut and 75 per cent recommended dose of fertilizer to onion during *rabi* season was beneficial in groundnut-onion cropping system for improving soil nutrient status of soil. It also shows that, the groundnut-chickpea cropping system found superior in improving the soil microbial population (fungi, bacteria and actinomycetes) than groundnut-onion and groundnut-wheat cropping systems.

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