Plant Archives Vol. 14 No. 1, 2014 pp. 193-196 ***ISSN 0972-5210***

EFFECT OF DIFFERENT NUTRIENT MANAGEMENT AND CROPPING SYSTEM ON SOIL MICROBIAL GROWTH AND RICE EQUIVALENT YIELD IN DIFFERENT RICE BASED CROPPING SYSTEMS

Megha Dubey*, K. K. Agrawal, S. K. Vishwakarma and Suchi Gangwar

Department of Agronomy, College of Agriculture, Jawaharlal Nehru Krishi Vishwa Vidhyalaya, Jabalpur-482004 (Madhya Pradesh), India.

Abstract

A field experiment was conducted during 2010-11 to 2012-13 at Jabalpur, Madhya Pradesh (India) to study the effect of nutrient management and cropping system on productivity and soil microbial growth under different rice based cropping systems in Madhya Pradesh. The 4 different cropping systems (CS_1-Green manuring sunhemp-Rice-Wheat, CS_2-Rice-Chickpea-Sesame, CS_3-Rice-Berseem, CS_4-Rice-Veg. pea-Sorghum) and three nutrient managements M_1- 100% Organic(1/3 N through each of FYM, Vermicompost and Neem oil cake), M_2 -100% Inorganic (100% NPK through fertilizers), M_3-INM (50% NPK through fertilizer + 50% N through organic sources) with 3 replications in Strip plot design. The soil of the experimental field was sandy clay loam in texture, neutral in reaction (7.3), normal EC (0.52), low in OC (0.72%), medium in available N (264.05kg/ha) and P(12.8 kg/ha) and high in K (285.2 kg/ha). The growth of bacteria (47.80×10^5), fungi (41.12×10^3), actinomycetes (25.50×10^3), azatobacter (13.42×10^3) and phosphorous solublizing bacteria (16.40×10^3) cfu g^{-1} soil was maximum in 100% inorganic nutrient management in rice berseem cropping system during the experiment and improved the rice equivalent yield of this cropping system.

Key words : Cropping systems, economic status, agronomic management, soil quality, yield.

Introduction

Rice and wheat are grown in a sequence on an area about 2.7 million hectares in Punjab and contribute 80% in the total food pool of the state of Punjab (DAGP, 2011). Madhya Pradesh is relatively underdeveloped with regards to agricultural productivity rural employment and economic status as compared to most of the Indian states. With the development of agricultural production, fertilization has been widely used as a common management practice to maintain soil fertility and crop yields (Shen, 2010). Long-term field experiments using different agronomic management can provide direct observations of changes in soil quality and fertility and can be predictions of future soil productivity and soil environment interactions. Over past decades, a great number of long-term experiments were initiated to examine the effects of fertilization on soil fertility in the world. Some studies have documented that the use of fertilizers was necessary and that continuous fertilizer application increased the concentrations of soil organic carbon, total nitrogen and other nutrients in plough layers compared with the initial value at the beginning of the experiment (Huang *et al*., 2010). Manure amendments markedly increased the contents of soil organic carbon, total nitrogen and other available nutrients and reduced soil acidification (Li *et al*., 2011). However, other studies have shown that the continued use of fertilizers may result in the decline of soil quality and productivity (Kumar *et al*., 2001). Long-term application of fertilizer helps to maintain the growth of micro organism growth in soil in rice-wheat cropping system (Bahadur *et al*., 2012).

Materials and Methods

The present study was conducted during 2011-12 to 2012-13 at the Research Farm of Jawaharlal Nehru Krishi Vishwa Vidhyalaya, Jabalpur (M.P.), India on a sandy clay loam soil. The soil of the experimental site had a pH 7.4, EC 0.51 dS/m and organic carbon 0.7%. The available soil nitrogen, phosphorus and potash were 264,12.6 and 282 kg/ha, respectively. The bulk density of the soil was 1.35 Mg/m^3. The factors studied included 3

****Author for correspondence :*** E-mail : meghadubey33@yahoo.com

nutrient management practices *viz.*, 100% organic (NM_1), 100% inorganic (NM_2) and integrated nutrient (NM_3) and 4 cropping systems *viz.*, CS_1 green manuring- rice-durum wheat, CS_2- rice-chickpea-sesame, CS_3- rice-berseem (fodder + seed), CS_4 - rice-vegetable pea-sorghum (fodder) in strip plot design with 3 replication. The crop varieties grown were Pusa sugandha Basmati-5 in rice, MPO-1106 in durum wheat, JG-24 for gram, JB-1 for berseem, Arkel for vegetable pea during winter season and TKG-55 in sesame and MP Chari in sorghum during summer season. These crops were raised with recommended agronomic practices.

In organic manure treatment nutrients were applied through farm yard manure. The manure was applied on the nitrogen equivalent basis for each crop. The nutrient composition of FYM was 0.5, 0.25, 0.5% N, P_2O_5 and K_2O respectively. For the weed management, mechanical measures were adopted and for insect pest management, neem oil (Azadiractin 0.03%) was applied as and when required under organic nutrient management. In chemical fertilizer treatment, nutrient were applied through chemical fertilizers *viz.*, urea, single super phosphate muriate of potash while plant protection was done through recommended pesticides, when required. The recommended dose of fertilizers for rice, wheat, chickpea, sesame, vegetable pea, sorghum and berseem. 120:26.4:33.3, 120:26.4:33.3, 20:60:30, 30:60:30, 20:26.4:16.6, 100:22:25 and 20:26.4:16.6 kg N:P:K/ha.

Results and Discussion

Effect on total bacterial count

The microbial population of the experimental soil accelerated upon receiving nutrients either through chemical fertilizer, organic manure or integrated nutrient management (table 1). The population of total bacteria ranged from 42.18 × 10^5 to 45.50 × 10^5 cfu g^{-1} soil. Significant increase in bacterial population was recorded under 100% inorganic NM_2 plots. As such maximum population of total bacterial count was observed in 100% inorganic NM_2 (47.80 and 46.50 × 10^5 cfu g^{-1} soil) followed by integrated NM_3 (46.05 and 45.94×10^5 cfu g^{-1} soil) during both the years. The population of total bacterial count was minimum (45.50 and 44.20 × 10^5 cfu g^{-1} soil) in 100% organic NM_1, respectively.

The growth of total bacterial count was influenced by different cropping systems. The maximum growth of total bacterial count was observed in CS3 rice-berseem cropping system (46.88 and 46.90 × 10^5 cfu g^{-1} soil) followed by all other treatments. The growth of total bacterial count was similar in rice-vegetable pea-sorghum CS_4, green manuring-rice-wheat cropping system CS_1 and rice-chickpea-sesame cropping system CS_2 and did not showed marked difference. Therefore, in this treatments the population of bacteria was improved over initial.

Effect on fungi

Growth of fungi was significantly affected due to different nutrient management practices during both the years. It was observed that when the plots were applied with 100% inorganic NM_2 the population of fungi was maximum (41.12 and 40.78 × 10^3 cfu g^{-1} soil). Whereas, similar growth of fungi was observed in integrated NM_3 and 100% organic NM_1 during both the years. The different cropping showed remarkable decrease in population of fungi during both the years. The maximum growth of fungi was observed in (42.06 and 42.47 × 10^3 cfu g^{-1} soil) CS_3 rice-berseem cropping system which was at par to all other treatments. The other cropping systems CS_4, CS_1 and CS_2 did not marked any significant differences. The minimum growth of fungi was observed under CS_2 rice-chickpea-sesame cropping system (38.17 and 38.34 × 10^3 cfu g^{-1} soil). On an average the growth was more during second year as compared to first year but more as compared to initial.

Effect on azatobacter

The nutrient management did not recorded much effect on growth of azatobacter. Whereas, maximum population of azatobacter was observed under 100% inorganic NM_2 (25.50 and 25.57 × 10^3 cfu g^{-1} soil), which was followed by integrated NM_3 (25.10 and 25.12 × 10^3 cfu g^{-1} soil). The minimum growth of azatobacter was observed in 100% organic NM_1 (23.32 and 23.40 × 10^3 cfu g^{-1} soil) during both the years which was more than initial value. The rice-berseem cropping system CS_3 recorded the maximum growth of azotobacter (25.40 and 25.50 × 10^3 cfu g^{-1} soil) which was superior over all other cropping systems but similar to CS_4 rice-vegetable pea-sorghum (25.32 and 25.42 × 10^3 cfu g^{-1} soil). The CS_1 and CS_2 system had relatively similar growth of azotobacter.

Effect on actinomycetes

The actinomycetes showed adverse effect on its population due to different nutrient management practices. The maximum population of actinomycetes was observed in 100% inorganic NM_2 (13.42 and 13.52 × 10^3 cfu g^{-1} soil) during both the years. Whereas, its growth decreased in other nutrient management practices NM_3 and NM_1. The maximum population of actinomycetes was observed in CS_3 rice-berseem cropping system

Table 1. Effect of nutrient management and cropping system on microbial population in soil after harvest and rice equivalent yield (mean of two years)

Treatments	Total bacterial count (10^5 x cfu/g soil		Fungi (10^3 x cfu/g soil)		Azatobacter (10^3 x cfu/g soil)		Actinomycetes (10^3 x cfu/g soil)		PSB (10^3 x cfu/g soil)		Rice equivalent yield (q ha^{-1})
	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13	
Nutrient management											
NM_1-100% Organic (1/3 N through each of FYM, Vermicompost and Neem oil cake)	45.50	44.20	40.70	40.24	23.32	23.40	11.54	11.60	14.43	14.21	60.18
NM_2 -100% Inorganic (100% NPK through fertilizers)	47.80	46.50	41.12	40.78	25.50	25.57	13.42	13.52	16.40	16.22	68.23
NM_3-Integrated Nutrient Management (50% through fertilizer + 50% through organic sources)	46.05	45.94	40.96	40.67	25.10	25.12	12.45	12.67	15.55	13.67	66.07
SEm±	1.62	1.58	1.62	1.58	0.82	0.77	0.91	0.61	0.65	0.69	2.48
CD(P=0.05)	4.86	4.74	4.86	4.74	2.46	2.31	2.27	1.52	1.62	1.72	9.19
Mean	46.45	45.55	40.93	40.56	24.64	24.69	12.47	12.59	15.46	14.7	—
Cropping System											
CS_1 – Green manuring (sunhemp)- rice (Pusa Sugandha 5)- wheat (MPO 1106)	42.50	42.64	38.52	38.67	23.79	23.86	11.40	11.68	15.22	15.45	61.41
CS_2- Rice (Pusa Sugandha 5)- chickpea (JG 322)-sesame (TKG 55)	42.18	42.22	38.17	38.34	23.54	23.66	11.25	11.30	15.44	14.60	52.23
CS_3- Rice (Pusa Sugandha 5)-berseem (JB 5)	46.88	46.90	42.06	42.47	25.40	25.50	13.60	13.72	16.48	16.70	77.46
CS_4- Rice (Pusa Sugandha 5)-vegetable pea (Arkel)-sorghum (MP Chari)	45.52	45.60	40.94	41.10	25.32	25.42	12.44	12.52	14.41	15.50	68.21
SEm±	1.68	1.62	1.64	1.56	0.63	0.66	0.86	0.90	1.05	1.14	9.19
CD(P=0.05)	5.04	4.86	4.92	4.68	1.89	1.98	2.15	2.25	2.62	2.85	22.51
Mean	44.27	44.34	39.92	40.14	24.51	24.61	12.17	12.30	15.39	15.57	—
Initial value	44.56		40.50		22.20		10.30		13.50		——

(13.60 and 13.72 × 10^3 cfu g^{-1} soil). Minimum growth of actinomycetes was observed in CS_2 rice-chickpea-sesame cropping system (11.25 and 11.30 × 10^3 cfu g^{-1} soil).

Effect on PSB

The PSB showed adverse effect on its population due to different nutrient management practices. The maximum population of actinomycetes was observed in 100% inorganic NM_2 (16.40 and 16.22 × 10^3 cfu g^{-1} soil) during both the years. Whereas, its growth decreased in other nutrient management practices NM_3 and NM_1. The maximum population of actinomycetes was observed in CS_3 rice-berseem cropping system (16.48 and 16.70 × 10^3 cfu g^{-1} soil). Minimum growth of actinomycetes was observed in CS_2 rice-chickpea-sesame cropping system (15.44 and 14.60 × 10^3 cfu g^{-1} soil).

Effect on rice equivalent yield

The growth of different soil micro organisms showed remarkable influence on yield of different crops. Thus due to this the yield of different crops was influenced under different nutrient management and cropping systems. The maximum rice equivalent yield was observed in 100% inorganic NM_2 (68.23 q ha^{-1}), which was at par to integrated NM_3 (66.07 q ha^{-1}) and 100% organic NM_1 (60.18 q ha^{-1}). The maximum rice equivalent yield was obtained in rice-berseem cropping system CS_3 (77.46 q ha^{-1}) and minimum in CS2 rice-chickpea-sesame cropping system (52.23 q ha^{-1}). And the yield in CS_4 and CS_1 were more than CS_2.

Conclusion

The nutrient management and cropping system effected the growth of micro organisms and it ultimately resulted in increasing the crop yield in different cropping systems. Therefore, it can be concluded that 100% inorganic NM_2 in rice-berseem cropping system CS_3 was superior over all other treatments.

References

Bahadur, L., D. D. Tiwari, J. Mishra and B. R. Gupta (2012). Effect of Integrated Nutrient Management on yield, microbial population and changes in soil properties under rice-wheat cropping system in sodic soil. *Journal of Indian Society of Soil Science*, **60(4)** : 326-329.

DAGP (2011). Agriculture at a glance. 2010-11. Information service, Department of Agriculture, Government of Punjab.

Shen, J. P, L. M. Zhang, J. F. Guo, J. L. Ray and J. Z. He (2010). Impact of long-term fertilization practices on the abundance and composition of soil bacterial communities in Northeast China. *Applied Soil Ecology*, **46** : 119–124.

Li, B. Y., S. M. Huang, M. B. Wei, H. L. Zhang and A. L. Shen (2010). Dynamics of soil and grain micronutrients as affected by long-term fertilization in an aquic Inceptisol. *Pedosphere*, **20** : 725–735.

Kumar, A. and D. S. Yadav (2001). Long-term effects of fertilizers on the soil fertility and productivity of a rice–wheat System. *Journal of Agronomy and Crop Science*, **186** : 47–54.