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RICE-BERSEEM CROPPING SYSTEM INFLUENCED A REMARKABLE EFFECT ON GROWTH OF DIFFERENT SOIL MICRO ORGANISMS IN DIFFERENT RICE BASED CROPPING SYSTEMS

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Abstract

Soil microbes play very important role in enhancing the productivity of crop. But due to different nutrient management practices their growth is suppressed. To evaluate their effect the field investigation was conducted during 2011-12 and 2012-13 at Jawaharlal Nehru Krishi Vishwa Vidhyalaya, Jabalpur (M.P.), India, under various rice based cropping systems in Madhya Pradesh to study the effect of different nutrient management practices and cropping systems on growth of soil micro organisms. The 4 different cropping systems are Green manuring (Sunhemp) –rice (cv. Pusa Sugandha 5) -wheat (cv. MPO 1106), rice (Pusa Sugandha 5) –chickpea (cv. JG 24)-sesame (cv. TKG 55), Rice (cv. Pusa Sugandha 5) –berseem (cv. JB 5) (green fodder+seed) and rice (cv. Pusa Sugandha 5) -vegetable pea (cv. Arkel)-sorghum (cv. MP chery) (green fodder) and three nutrient managements *viz*., 100% organic manure through farm yard manure, vermicompost and neem oil cake, 100% Inorganic manure through fertilizers and Integrated nutrient management with 3 replications in strip plot design. The investigation revealed that maximum population of total bacterial count (45.50 and 45.82) × 10^5 cfu g^{-1} soil, fungi (41.12 and 40.78) × 10^3 cfu g^{-1} soil and azatobacter (25.50 and 25.57) × 10^3 cfu g^{-1} soil was noted under 100% organic nutrient management. The growth of these micro organisms helped in improving the soil health in different rice based cropping systems, which increased the yield. This improved yield of different crops in 100% organic nutrient management recorded maximum gross monetary return of 184870 Rs ha^{-1} $year^{-1}$. Among the treatment combinations rice-berseem (green fodder + seed) cropping system with 100% organic nutrient management fetched the highest benefit among all other cropping systems.

Key words : Rice-berseem, nutrient management, cropping system, bacteria, fungi, azatobacter.

Introduction

Different nutrient management practices also enhance the growth of these microbes. Organic manures provide better and improved growth of soil microbe due to addition of various types of organic matter like FYM, vermicompost, neem oil cake etc. Similarly, the growth of soil microbes is influenced due to different cropping systems whether, it may be rice-wheat or rice-berseem. As the crops add organic matter to the soil. The leguminous crops help in fixation of atmospheric nitrogen in soil. This result in increase in population of bacteria, fungi and azotobacter in soil. On account of continuing world energy crisis and spiraling price of chemical fertilizer, the use of organic manure as a renewable source of plant nutrients is assuming importance. In this endeavor proper blend of organic and inorganic fertilizer is important not only for increasing yield, but also for sustaining soil health (Weber *et al*., 2007 and Pullicinoa *et al*., 2009). Generally, it is common thinking that yield of several crops reduces during the initial years under the organic farming, but high market values of such produce may be able to compensate the losses in yield (Mahapatra, 2006). Therefore, it is imperative to compare the production efficiency of different rice based cropping systems under organic, inorganic and integrated (organic + inorganic) nutrient management practices and its beneficial effect on microbial growth. On going through the above facts, in mind, the present investigation "Effect of different nutrient management practices and cropping systems on growth of soil micro organisms" has been started in the Department of Agronomy, Jawaharlal Nehru Krishi Vishwa Vidhyalaya, Jabalpur (Madhya Pradesh), India; since *kharif* 2004-05 and is still going on during 2012-13.

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Materials and Methods

Experiment was conducted during 2011-12 and 2012-13 at College of Agriculture, J.N.K.V.V, Jabalpur (M.P.), India, in an unreplicated split plot design. The soil of the experimental field was sandy clay loam with a pH of 7.4, electrical conductivity 0.51dS/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 treatments studied included three nutrient management practices *viz*., 100% organic manures, 100% inorganic manures and integrated nutrient management along with four cropping systems *viz*., green manuring- rice- durum wheat, rice-chickpea-sesame, rice-berseem (fodder + seed) and rice-vegetable pea-sorghum (fodder). The crop varieties grown were Pusa Sugandha 5 in rice during *kharif* season, 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, vermicompost and neem oil cake. The manure was applied on the nitrogen equivalent basis for each crop. The nutrient composition of FYM was 0.50, 0.25, 0.5% N, P_2O_5 and K_2O, respectively. In inorganic manure treatment, nutrient were applied through chemical fertilizers *viz*., urea, single super phosphate and muriate of potash. The standard methods were followed and the microbial growth of total bacterial count, fungi and azotobacter was calculated using standard agar media, respectively.

Results and Discussion

Effect on growth of total bacterial count

Application of 100% organic nutrient management contributed significantly in enhancing the microbial growth of total bacterial count (45.50 and 45.82) × 10^5 cfu g^{-1} soil as represented in table 1. In general, there has been an decreasing trend in values of total bacterial count as we go for application of integrated and 100% inorganic nutrient management. The organic manures provided better nutrients for the growth of bacteria in soil. Whereas, in case of different cropping systems the rice-berseem (fodder + seed) cropping system recorded the maximum population of total bacterial count (46.88 and 46.90) x 10^5 cfu g^{-1} soil. As when the crop is taken for seed production purpose the leaves which shed during seed formation add a lot of organic matter to the soil. Along with it a lot of carbon and moisture is added to the soil. The growth of berseem also improved the microbial growth of bacteria due to its leguminous nature and vigorous growth. The total bacterial count increased during second year (44.22 and 44.34) × 10^5 cfu g^{-1} soil as compared to (43.33 and 44.27) × 10^5 cfu g^{-1} soil during first year in case of different nutrient management and cropping system. The above findings are in conformity with the findings of Singh *et al*. (2011) and Parthasarathi *et al*. (2003), who also reported a gradual increase in the yield of different crops with the application of organic manures continuously for 3 years.

Effect on growth of fungi

The microbial growth of fungi was found significantly superior due to application of different nutrient management and cropping systems. Application of 100% organic nutrient management increased the population of fungi to a greater extent (41.12 and 40.78) × 10^3 cfu g^{-1} soil as compared to integrated nutrient management (39.12 and 38.28) × 10^3 cfu g^{-1} soil. The lowest population was obtained from application of 100% inorganic nutrient management (37.92 and 37.38) × 10^3 cfu g^{-1} soil. The rice-berseem (fodder + seed) cropping system recorded the maximum growth of fungi (42.47 and 42.06) × 10^3 cfu g^{-1} soil significantly superior over all other cropping systems. Whereas, it growth was restricted in rice-vegetable pea-sorghum (fodder) cropping system (38.67 and 38.52) × 10^3 cfu g^{-1} soil and rice-chickpea-sesame cropping system (38.34 and 38.17) × 10^3 cfu g^{-1} soil during both the years. This reduction in growth is due to wide spacing in crops as well as higher nutrient needs of these crops. The fungi growth was comparatively more 39.39 × 10^3 cfu g^{-1} soil during first year as compared to 38.81 × 10^3 cfu g^{-1} soil during second year in case of different nutrient management practices. While in case of cropping system similar effect was observed the fungi growth was more during first year 40.14 × 10^3 cfu g^{-1} soil as compared to second year 39.92 × 10^3 cfu g^{-1} soil. This reduction in growth of fungi is due to aberrant weather conditions which effected the growth of all crops during second year.

Effect on growth of azatobacter

The microbial growth of azatobacter was significantly influenced by different nutrient management and cropping systems. It was obtained that application of 100% organic nutrient management reported maximum population of azatobacter (25.50 and 25.57) × 10^3 cfu g^{-1} soil, which is superior over integrated nutrient management (24.25 and 24.15) × 10^3 cfu g^{-1} soil. The population was reduced under 100% inorganic nutrient management (23.32 and 23.40) × 10^3 cfu g^{-1} soil. The organic manures increased the population of azatobacter in soil. The addition of

Table 1 : Effect of nutrient management and cropping systems on growth of different microbial population (cfu g^{-1} soil) in soil.

Treatments	Total bacterial count (10^5 × cfu g^{-1} soil)		Fungi (10^3 × cfu g^{-1} soil)		Azatobacter (10^3 x cfu g^{-1} soil)	
	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13
Nutrient Management						
100% organic (1/3 N through each of FYM, Vermicompost and Neem oil cake)	45.50	45.82	41.12	40.78	25.50	25.57
100% Inorganic (100% NPK through fertilizers)	41.50	42.82	37.92	37.38	23.32	23.40
Integrated Nutrient Management (50% NPK through fertilizer + 50% N through organic sources)	43.00	44.02	39.12	38.28	24.25	24.45
SEm±	1.62	1.58	1.62	1.58	0.82	0.77
CD(P=0.05)	NS	NS	NS	NS	NS	NS
Mean	43.33	44.22	39.39	38.81	24.36	24.47
Cropping System						
Green manuring (sunhemp)- rice (Pusa Sugandha 5)-wheat (MPO 1106)	45.52	45.60	41.10	40.94	25.20	25.22
Rice (Pusa Sugandha 5)- chickpea (JG 322)-sesame (TKG 55)	42.18	42.22	38.34	38.17	23.79	23.86
Rice (Pusa Sugandha 5)-berseem (JB 5) (fodder+seed)	46.88	46.90	42.47	42.06	25.32	25.50
Rice (Pusa Sugandha 5)-vegetable pea (Arkel)-sorghum (MP Chari) (fodder)	42.50	42.64	38.67	38.52	23.54	23.66
SEm±	1.68	1.62	1.64	1.56	0.63	0.66
CD(P=0.05)	NS	NS	NS	NS	NS	NS
Mean	44.27	44.34	40.14	39.92	24.46	24.56
Initial value	40.15		36.25		23.10	

Table 2 : Effect of different nutrient management and cropping systems on mean gross monetary return (Rs ha^{-1} $year^{-1}$).

Treatments	CS_1-Green manuring-rice-wheat	CS_2-Rice -chickpea-sesame	CS_3-Rice-berseem (fodder+seed)	CS_4-Rice-veg. pea-sorghum (fodder)	Mean
NM_1- 100% Organic (1/3 N through each of FYM, Vermicompost and Neem oil cake)	172238	129366	184870	152834	**159827**
NM_2- 100% Inorganic (100% NPK through fertilizers)	164434	123293	181758	148337	**154455**
NM_3- Integrated Nutrient Management (50% NPK through fertilizer + 50% N through organic sources)	151693	115287	177155	139463	**145899**
Mean	**162788**	**122648**	**181261**	**146878**	

organic manures increased the concentration of humic acid in soil. This enhanced the growth of azotobacter. Similarly, the rice-berseem (fodder + seed) cropping system noted maximum growth of azatobacter (25.32 and 25.50) × 10^3 cfu g^{-1} soil .Whereas, it was lower in rice-chickpea-sesame cropping system (23.79 and 23.86) × 10^3 cfu g^{-1} soil and rice-vegetable pea-sorghum (fodder) cropping system (23.54 and 23.66) × 10^3 cfu g^{-1} soil during both the years. Berseem plant helped in increasing the population of these microbes in soil. The vigorous nature of berseem adds a lot of organic matter to the soil due to shedding of leaves. This increases the pH of soil after harvest which will favor the growth of azatobacter in soil. On an average it was observed that the population of azatobacter was more (24.47) × 10^3 cfu g^{-1} soil during second year as compared to (24.36) × 10^3 cfu g^{-1} soil during first year in case of different nutrient management practices while in case of different cropping systems. Similar trend was observed (24.56) during second year and (24.46) during first year.

Effect on gross monetary return

Out of 3 nutrient management practices 100% organic nutrient management fetched the highest gross monetary return of 159827 Rs ha^{-1} $year^{-1}$, which declined as 154455 and 145899 Rs ha^{-1} $year^{-1}$ due to 100% inorganic nutrient management and integrated nutrient management as on required as given in table 2. Among the 4 cropping system tested, rice-chickpea-sesame cropping system led to record the lowest gross monetary return (122648 Rs ha^{-1} $year^{-1}$), which increased as 146878, 162788 and 181261 Rs ha^{-1} $year^{-1}$ with rice-vegetable pea-sorghum (fodder) cropping system, green manuring-rice-wheat cropping system and rice-berseem (fodder+seed) cropping system, respectively. While considering the effect of treatment combinations rice-berseem (fodder+seed) cropping system with 100% organic nutrient management led to record maximum gross monetary return of 184870 Rs ha^{1} $year^{-1}$, but it was minimum (115287 Rs ha^{-1} $year^{-1}$) under rice-chickpea-sesame cropping system with integrated nutrient management. 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 application of 100% organic nutrient management in rice-berseem (fodder+seed) cropping system was superior over all other treatments. It also resulted in better growth of microbes in soil.

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