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Soil microflora as influenced by different intercropping systems and nitrogen management practices

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Abstract
The soil micro-organisms are catalyst for making soil as live, without microorganism so many processes like transformation of nutrients and decomposition of wastes is inhibited. Their activities are much influenced by management practices. Microbial populations were determined in this study, and results showed that Intercropping of baby corn with clusterbean (M1) recorded significantly higher number of bacterial CFU (13.46 X 10^7). Significantly higher number of fungal colonies (24.22 X 10^3) were observed in sole baby corn and significantly higher actinomycetes population (65.00 X 10^4) in baby corn + okra system (M_2). Among nitrogen management practices application of 50% RDN through goat manure + 50% RDN through poultry manure (S3) recorded significantly higher microbial population.

Keywords: intercropping system, microbial population and nitrogen

Introduction
Soil microorganisms are very important part of soil health is concerned as almost every chemical transformation taking place in soil involves active contributions from soil microorganisms. In particular, they play an active role in soil fertility as a result of their involvement in the cycle of nutrients like carbon and nitrogen, which are required for plant growth. The crop management practices like source of nutrient, selection of crop and growing inter crops will decide the extent of microbial population. Rather than growing cereals as sole crop it's better to include legumes as an intercrop as legumes have beneficial role of adding nitrogen to soil and enhancing microbial load in the soil. The application of chemical fertilizer may assist in obtaining maximum production of baby corn but it may lead to hazardous effect on environmental health and have negative effect on soil microbial population. Judicious use of fertilizers from different sources for a crop or baby corn production will maintain the environmental sustainability for generations, without affecting the environmental health and enhances microbial population. Baby corn is nutrient exhaustive crop and due to high planting density, integrated nutrient management (INM) practices are important to get maximum benefit. The adoption of INM practices on the field will reduce the production cost, thereby increasing the economic returns to the farmers and also increases the supply and availability of soil nutrients to the crop as well as increasing the activity of beneficial soil microorganism due to availability of more organic matter content (Auwal, 2014) [1]. Increasing the sustainability of cropping systems involves the reduction of agrochemical and fertilizer inputs through the reliance in soil ecosystem processes and biological interactions for the provision of plant nutrients. Of particular importance are soil microbial processes as they are crucial for plant nutrient supply given their central role in soil organic matter decomposition and nutrient dynamics. Mineral fertilization can provide readily available nutrients to the plant growth but it does not contribute to the soil physical condition. Management of soil fertility through organic fertilizers has always been a pivotal principle of sustainable agriculture.

Materials and Methods
Field experiment on nitrogen management studies on baby corn based vegetable intercropping systems was carried out to during *kharif* 2015 at IFS farm, University of Agricultural Sciences, Raichur. Soil was clayey in texture, organic carbon (0.7%) and available nitrogen (120.0 kg ha^{-1}), available phosphorous (26.0 kg ha^{-1}) and available potassium (285.0 kg ha^{-1}). The land was ploughed once with mould board plough and then harrowed twice to bring the soil into fine tilth. The experiment was laid out as per the plan. Small bunds were raised around each plot. Experiment was laid down in Split Plot Design with three replications. Main plot treatments includes baby corn + clusterbean (1:1) (M_1), baby corn + okra (1:1) (M_2), baby corn + coriander (1:1) (M_3), baby corn + palak (1:1) (M_4) and sole baby corn (M_5) and sub plot treatments are 100% RDN through chemical fertilizer (S_1), 50% RDN through chemical

fertilizer + 25% RDN through goat manure + 25% RDN through poultry manure (S_2) and 50% RDN through goat manure + 50 % RDN through poultry manure (S_3).The required quantities of poultry manure and goat manure obtained from the livestock components *viz.*, goat, poultry were applied and incorporated in the plots before sowing as per the treatments. Recommended dose of P_2O_5 and K_2O (150: 75: 37.5 kg ha^{-1} respectively) was applied to the soil in the form of single super phosphate and muriate of potash, respectively. And 50 per cent of nitrogen was applied as basal dose at the time of sowing in the form of urea as per the treatments. Remaining 50 per cent of nitrogen was top dressed at 25 DAS through urea as per the treatments. Shallow furrows were opened at 60 cm apart with the help of a marker. The seeds were hand dibbled uniformly on 21-08-2015. Intercrops were sown in between the crop rows of baby corn, and were covered with moist soil immediately after sowing. To control stem borer, phorate (10G granule) was applied in the whorls at 16 DAS and chloropyriphos (2 ml $litre^{-1}$) was sprayed at 30 DAS for control of sucking pest in okra. Hand weeding was done at 15, 35 and 60 days after sowing and no herbicides were used due to different combination. Soil samples collected from different treatment plots were used for enumeration of general soil microorganism's *viz.*, bacteria, fungi and actinomycetes. Fresh soil sample was collected from the field before sowing and at harvest, soil sample was sieved through the 1000 micromesh to remove the bigger particles and debris and was used for enumeration. soil microorganism's are expressed in terms of colony forming units (CFU) per gram of soil on dry weight basis (Srinivas *et al.*, 2011) [4]. For enumeration of Bacteria nutrient agar medium standard plate count method was used. The plates were incubated for 48 h at 28º C. Colonies that appeared on the media were counted and for enumeration of fungi Martin's rose bengal agar medium (MRBA) standard plate count method was used. The plates were incubated for 4 days at 28º C. Colonies that appeared on MRBA media were enumerated and expressed in terms of cfu per gram of soil on dry weight basis. For enumeration of actinomycetes Kuster's agar medium standard plate count method was used. The plates were incubated for 6 days at 28º C. Colonies that appeared on Kuster's agar media were enumerated and expressed in terms of cfu per gram of soil on dry weight basis.

Results and Discussion

In general baby corn + vegetable intercropping systems have recorded higher population of bacteria and actinomycetes (Table 1) compared to sole cropping it might be due to organic acid in root exudates would have increased in intercropping system as compared to sole crop. Among different intercropping system tested baby corn + clusterbean recorded significantly higher bacterial population. Significantly higher actinomycetes population was recorded with baby corn + okra (65×10^4). Significantly lower bacterial and actinomycetes population was recorded with sole baby corn (10.8×10^7 and 43×10^4). This might be attributed to the interaction between different plant roots in intercropping, increased soil C content and root biomass in intercrops as compared to sole crops. Another potential indirect effect in the rhizosphere of intercropped species is enhanced nutrient mineralization due to the priming effect. The priming effect is defined as the change in soil organic matter decomposition rates, resulting from the addition of fresh organic matter. These results are supported by the work of Khan *et al.* (2014) [3].

Fungal biomass in soil at harvest was low as compared to bacterial and actinomycetes population. Significantly lower fungal biomass is typical of intensively cultivated agricultural soils and it has been attributed to different factors such as physical disturbance, and altered amount and complexity of the nutrient inputs and decrease in soil organic matter as compared to undisturbed soils. When compared to sole cropping, lower population (24.2×10^3) was recorded with intercropping system it might be due to fungi being saprophyte lesser rhizosphere activity under sole crop provided favourable environment compared to intercropping system.

Among different nitrogen management practices tested, application of 50% RDN through goat manure + 50% RDN through poultry manure recorded significantly higher bacteria, fungi and actinomycetes population is presumably related to the higher input of labile organic matter and readily available organic compounds via manure compared to 100% RDN through chemical fertilizer. These results are in accordance with Cristina *et al.* (2012) [2].

Table 1: Bacteria, fungi and actinomycetes colony forming units (CFU g^{-1} soil) before sowing and at harvest as influenced intercropping systems and nitrogen management practices

Treatments	Bacteria ($\times10^7$)		Fungi ($\times10^3$)		Actinomycetes ($\times10^4$)	
	Before sowing	At harvest	Before sowing	At harvest	Before sowing	At harvest
Intercropping system						
M_1: Baby corn + Clusterbean (1:1)	10.60	13.46	25.80	20.28	34.30	61.90
M_2: Baby corn + Okra (1:1)	10.60	12.65	25.80	19.06	34.30	65.00
M_3: Baby corn + Coriander (1:1)	10.60	11.72	25.80	21.67	34.30	45.89
M_4: Baby corn + Palak (1:1)	10.60	11.44	25.80	22.67	34.30	45.00
M_5: Sole baby corn		10.80	25.80	24.22	34.30	43.33
S.Em.±	-	0.43	-	0.58	-	1.19
C.D. (P=0.05)	-	1.41	-	1.88	-	3.89
Nitrogen management practices						
S_1: 100% RDN through chemical fertilizer	10.60	10.28	25.80	20.73	34.30	46.73
S_2: 50% RDN through chemical fertilizer + 25% RDN through goat manure + 25% RDN through poultry manure	10.60	11.86	25.80	21.50	34.30	51.89
S_3: 50% RDN through goat manure + 50% RDN through poultry manure	10.60	13.90	25.80	22.50	34.30	58.04
S.Em.±	-	0.25	-	0.35	-	1.25
C.D. (P=0.05)	-	0.73	-	1.02	-	3.69
Interaction						
S.Em.±	-	0.63	-	0.86	-	3.00
C.D. (P=0.05)	-	NS	-	NS	-	NS

RDN: Recommended dose of nitrogen (150 kg ha^{-1}) NS: Non-significant

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