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Yield and microbial population of *kharif* maize as affected by *in-situ* incorporation green manures

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Abstract
A field experiment was conducted at the Agricultural College Farm, Bapatla, to study the effect of *in-situ* incorporation of dhaincha, sunnhemp and pillipesara green manure at 60, 45 and 30 DAS. Highest biomass production was recorded from 60 days aged dhaincha. There was a significant increase in microbial population when different green manures were incorporated and age of incorporation of green manures also had significant effect on microbial population per gram of soil as well as their interaction. Age of incorporation of green manure only had exerted significant differences in grain yield. Maximum grain yield was recorded when incorporated at 60 days (7871 kg/ha) which was significantly superior to 45 days (7030 kg/ha) and 30 day (6611 kg/ha) incorporation of green manures. The percentage increase in grain and stover yields due to 60, 45 and 30 days age of incorporation over control was 36.6%, 22.0%, 14.8 % and 22.7%, 15.5%, 10.8% respectively. Similarly a significant increase in organic carbon content was observed due to age of incorporation of green manures.

Keywords: yield and microbial population, incorporation green manures

Introduction

Green manuring means using a crop primarily as a soil amendment and a nutrient source for subsequent crops. Since they represent a local source of nitrogen (N) and carbon (C), leguminous green manures have the potential to reduce the dependency on external N sources and to increase soil organic matter content. The amount of N fixed and the availability of this N for subsequent crops is difficult to predict. The N-fixing capacity of the associated *Rhizobium* varies between crop species, but also as a response to soil properties such as soil texture and nutrient concentration, climatic factors and management practices. The amount and timing of N release from a green manure crop varies with the quality of the green manure, which is influenced by crop species and plant age, soil properties, climatic factors and management. The decomposition and release of nutrients bound in the green manure is mediated by soil microorganisms and fauna. Due to their key role in decomposition of organic amendments and plant nutrient cycling, it is important to understand how resource inputs regulate the biomass, activity and community composition of soil organisms. The amount and quality of resources entering the soil regulate the response of soil organisms and ultimately decomposition rate and nutrient turnover.

Materials and Methods

The field experiment was conducted during the *kharif* season of 2012-2013 at the Agricultural College Farm, Bapatla. The soil was clay loam in texture, alkaline in reaction with p^H 8.1, low-in organic carbon (0.40 %) and available nitrogen (212 kg ha^{-1}), medium in available phosphorus (31 kg ha^{-1}) and potassium (301 kg ha^{-1}). Three different green manure (Dhaincha, sunnhemp and pillipesara) and their three different ages of incorporation (60 days, 45 days and 30 days) were tested in factorial RBD with single control (no green manure) and replicated thrice. 1^{st} sowing of green manure was done on 15^{th} May followed by 2^{nd} and 3^{rd} sowing at 15 days interval. Maize was planted at an inter- and intra-row spacing of 75 cm x 20 cm on 11^{th} of August and harvested 24^{th} of November. Seeds of green manure crops were broadcasted @ *Dhaincha* (50 Kg/ha), *Sunnhemp* (30 Kg/ha) and *Pillipesaera* (15 Kg/ha). An area of $1m^2$ was selected with a quadrant at random in every plot of green manure crop and was cut to ground level so as to record fresh biomass production before the incorporation. The fresh weight of biomass was expressed in t /ha.

Soil microbial population was analyzed by collecting samples from depth of 15cm. Initial soil sample was collected before sowing of green manure crops for estimating initial soil microbial population of bacteria, fungi, azotobacter and rhizobium. Final soil samples were collected at two stages i.e., 30 days after incorporation of green manures and after harvesting of maize. Initial microbial counts observed in the soil were as follows

Total Bacterial count	=	38×10^5
Total Fungal count	=	6.5×10^3
Total Azotobacter count	=	5×10^2
Total Rhizobium count	=	5.5×10^2

Enumeration of microbial populations

The enumeration of total bacteria, fungi, azotobacter and rhizobium in the soil samples collected from rhizosphere of the experimental plots was carried out by following the standard dilution plate count technique by preparing standard dilutions of the soil samples. Nutrient agar for bacteria, Martin's rose bengal with streptomycin sulphate agar for fungi, Ashby's agar for azotobacter, Yeast Extract Manitol agar with congo red for rhizobium were used for enumeration. The Petri plates after spread plate method were incubated at 30^0C for two days for bacteria and fungi, four days for azotobacter and rhizobium and population was counted and expressed as number of cells per gram on dry weight basis.

Results and Discussion

The data (Table 1) revealed that among different green manure crops, dhaincha (13.8 t/ha) recorded maximum biomass production which is significantly superior to sunnhemp (12.6 t/ha) and pillipesara (9.1 t/ha). A similar significant difference was observed between sunnhemp and pillipesara. Similarly, age of green manures also had a significant effect on biomass production. The 60 day aged green manure recorded maximum (18.1 t/ha) biomass which was found significantly superior to 45 day (10.4 t/ha) and 30 day (7.0 t/ha) aged green manures. Highest biomass was produced in 60 day dhaincha (20.6 t/ha) followed by 60 day sunnhemp (18.8 t/ha) which in turn is followed by dhaincha 45 day (12.7 t/ha). Least biomass was produced in 30 day pillipesara (5.3 t/ha).

Climatic condition might have favoured the better performance of dhaincha as it can grow in wet as well as dry conditions. Growth rate of the plant is slow in the initial stage as plants are in lag phase. Maximum growth and biomass production occurs in grand growth phase. Growth of the plant continues from grand growth phase to senescence phase but the growth is slow. Since dhaincha comes to flowering at 45 to 47 days there is rapid biomass accumulation upto that stage, biomass accumulation continues even after flowering but, the biomass accumulation slows down. Whereas, sunnhemp comes to flowering by 72 to 74 days that may be the reason for lesser biomass accumulation by sunnhemp at 60 day than dhaincha at 60 days age. Pillipesara recorded least biomass among all green manures at 60 days age might be because of the genetic potential of the plant as well as the prevailing climatic conditions. Earlier Bharadwaj *et al.* (1981) [1], Ghai *et al.* (1985) [8] and Salam *et al.* (1989) [14] also reported similar results which are in tune with the present findings.

Data presented in Table 3 reveals that there was a significant increase in population of bacteria when different green manures were incorporated and age of incorporation of green manures also had significant effect on total number of bacteria per gram of soil as well as their interaction. Total bacterial count was maximum (111.7×10^7) in pillipesara incorporated plot which was closely followed by dhaincha (98.3×10^7) and sunnhemp (53.3×10^7). Similarly maximum bacterial count was observed when green manure was incorporated at 30 days (95.0×10^7) which was on par with 45 days (95.0×10^7) incorporation but was found to be significantly superior to 60 days (73.3×10^7) incorporation but the latter two differed significantly. Among the treatments, highest total bacterial count was observed when dhaincha was incorporated at 30 days (140.0×10^7) followed by pillipesara incorporated at 45 days (125.0×10^7) which was followed by pillipesara incorporated at 30 (105.0×10^7) and 60 (105.0×10^7) days. The lowest number of bacteria was observed where sunnhemp was incorporated at 30 days (40.0×10^7) whereas in control, bacterial count was 38.3×10^7.

Significant increase in total bacterial population at 30 days age of incorporation might be because of the crop is tender, succulent and C : N ratio is low whereas at later stage, synthesis of lignins and tannins may take place which does not favour the multiplication of bacteria as it is resistant to bacterial decomposition. Similarly, the variability in bacterial population due to incorporation of different green manures may be because of its ability to decompose easily. The observed interaction between different green manures and age of incorporation might be due to the fact that as the age increases the tenderness of the green manure decreases and synthesis of some complex carbohydrates may take place which slows down the process of decomposition. The present finding is in agreement with Schenck (2003) [16]; Tilak (2004) [19]; Krishna (2010) [11] and Mazinani *et al.* (2012) [12].

Population of bacteria in soil after harvest of maize is presented in Table 4. It reveals that there existed significant differences in bacterial population after harvest of maize due to incorporation of different green manures and age of incorporation of green manures and their interactions on total number of bacteria present per gram of soil. Total bacterial count per gram of soil was found maximum (10.3×10^7) where dhaincha was incorporated closely followed by sunnhemp (6.0×10^7) which differed and both were significant between themselves and found to be significantly superior to pillipesara (4.6×10^7). Maximum number of bacterial colonies was observed when green manures were incorporated at 60 days (10.1×10^7) followed by 45 days incorporation (6.2×10^7) which was followed by 30 days (4.6×10^7) of incorporation. Among all the treatments, highest number of bacterial count was observed where dhaincha was incorporated at 60 days (13.3×10^7) followed by sunnhemp incorporated at 60 days (10.0×10^7) which is followed by dhaincha incorporated at 45 days (9.3×10^7). The minimum number of bacteria (2.3×10^7) was observed when pillipesara was incorporated at 30 days which was also significantly superior to bacterial population in control plot (2.0×10^7).

Quantity of organic matter left after decomposition might have affected the bacterial population in soil. It is axiomatic that soil organic matter is the food for microbes so the decrease in organic matter content after the harvest of maize may be one reason for the decreased bacterial population. Moisture content in the soil also one of the very important criteria for the survival of microbes which decreased at the time of maize harvesting as no irrigation was given and there was no rain further.

Data pertaining to total fungal count in soil are presented in Table 5 shows that there is a significant increase in fungal population due to incorporation of green manures and age of incorporation and their interactions in increasing the population of fungi. Maximum total fungal population (22.1×10^3) was observed where dhaincha was incorporated and found significantly superior to sunnhemp incorporated plot (18.9×10^3) but both were significantly superior to pillipesara incorporated plot (16.7×10^3). The maximum fungal population was observed at 60 days incorporation (33.3×10^3) which was significantly superior to 45 days of incorporation (14.4×10^3) and 30 days incorporation (9.9×10^3). Similarly, a significant difference was observed between 45 days and 30 days stage of incorporation. Among all treatments, highest fungal population was observed when dhaincha was incorporated at 60 days(40.0×10^3) followed by sunnhemp incorporated at 60 days(33.3×10^3) which is followed by pillipesara incorporated at 60 days(26.7×10^3). The lowest fungal count was observed where dhaincha was incorporated at 30 days (9.7×10^3) which was on a par with the control plot (9×10^3).

An increase in fungal population at 60 days aged green manure was observed may be because more aged green manures might have synthesized lignins, tannins and other complex carbohydrates which cannot be degraded by bacteria but fungi can degrade that's why fungal population increased. Some scientists have also stated that increase in fungal and bacterial population has an inverse relation. The present finding is in agreement with Schenck (2003) [16].

Data pertaining to total fungal count in soil after harvest of maize are presented in Table 6 which shows similar trends that were observed with 30 DAS of maize except the number decreased at time of harvest. This may be due to soil moisture content was very less at the time of harvest and undecomposed green manure portion left in soil had also decreased. The results are akin to those reported by Schenck (2003) [16].

Total rhizobium count per gram of soil 30 DAI of green manures is presented in the Table 7. Significant differences were observed in rhizobium population due to incorporation of different green manures and their age of incorporation. Among different green manures, maximum rhizobium population was observed in dhaincha (18×10^4) followed by pillipesara (15×10^4) and sunnhemp (13×10^4) which were found to significantly superior to each other. Maximum rhizobium population was recorded at 60 days ($19 \text{ x } 10^4$) which was followed by 45 days (16×10^4) and 30 days (11×10^4) and both of them were found to be significantly superior to each other. Among all the treatments, highest rhizobium population was observed where dhaincha was incorporated at 60 days (22×10^4) followed by dhaincha incorporated at 45 days (19×10^4) which was followed by sunnhemp incorporated at 60 days (18×10^4).

Rhizobium strain which is compatible with the specific legume leads to the formation of nodules which help in fixation of nitrogen. Majority of the multiplication of rhizobium takes place inside the nodules and when these nodules are incorporated or shed off from the root during the growth of host plant legumes they release all the rhizobium into the soil. This might be the reason for increased rhizobium population in the soil after incorporation of green manures. This result is in agreement with Denison and Kiers (2004) [4].

Data pertaining to the rhizobium population in soil after harvest of maize are presented in Table 8 shows that rhizobium population in the soil after harvest of maize differed significantly due to incorporation of green manures and their age of incorporation as well as their interaction. Maximum rhizobium population after harvest of maize was observed in pillipesara (0.7×10^4) followed by dhaincha (0.5×10^4) and pillipesara (0.4×10^4). All these were found to be significantly superior to each other. Among age of incorporation of green manures, maximum rhizobium (0.8×10^4) population was observed at 60 days followed by 45 days and 30 days which were found to be significantly superior to each other. Among all treatments, highest rhizobium population (1.0×10^4) was observed where pillipesara was incorporated at 60 days.

Besides vegetation and cropping history, the population of rhizobia in the soil is influenced by the environment particularly rainfall. Areas with adequate rainfall often have large numbers of native rhizobia (when rhizobia live in the soil without legume partner). Since, there was no rain, the moisture content in the soil was less due to which the population of rhizobium surviving in the soil might have decreased. But, it had increased due to growing and incorporation of green manures. This present finding is in agreement with Denison and Kiers (2004) [4].

Data pertaining to total azotobacter population 30 DAI of green manures are presented in the Table 9. Total azotobacter population per gram of soil was found to be significant due to incorporation of different green manures and age of incorporation of green manures as well as their interaction. Due to incorporation of different green manures maximum azotobacter population was observed in pillipesara (145.6×10^3) which was significantly superior to sunnhemp (134.4×10^3) and dhaincha (133.3×10^3). However, azotobacter population in sunnhemp and dhaincha incorporated plot was on a par with each other. Among age of incorporation of green manures, maximum azotobacter population was observed at 60 days (203.3×10^3) age of incorporation followed by 45 days (131.1×10^3) which was followed by 30 days (78.9×10^3) and all these were found to be significantly superior to one and another. Among all the treatments, highest azotobacter population was recorded where pillipesara (260.0×10^3) was incorporated at 60 days followed by sunnhemp (186.7×10^3) incorporated at 60 days and dhaincha (163.3×10^3) incorporated at 60 days.

Increase in azotobacter population in the soil may be because of the increase in organic matter content in the soil. Pillipesara incorporated plot recorded the highest azotobacter population which might be due to easy and quick decomposition and the decomposition products released from these green manures might be having some triggering effect for the increase in the azotobacter population. Green manure incorporation might have provided the optimum pH for the growth and multiplication of azotobacter. Earlier researchers have also similar opinion that legume grown plot recorded higher azotobacter number (Islam *et al.*, 2008 and Patel and Kumhar, 2010) [9, 13].

Data (Table 10) on total azotobacter count after harvest of maize are presented which reveals that total azotobacter count significantly differed due to incorporation of different green manures, age of incorporation of green manures and their interaction. Among different green manures, maximum azotobacter population was observed in dhaincha (15.0×10^3) after harvest of maize followed by sunnhemp (9.8×10^3) which was followed by pillipesara (4.7×10^3) and all these differed significantly with each other. Among the age of incorporation of green manures, maximum at 60 days (17.1×10^3) followed by 45 days (8.1×10^3) and by 30 days (4.2×10^3). Among all the treatments, highest number of azotobacter was noticed where dhaincha was incorporated at 60 days (23.7×10^3) followed by sunnhemp incorporated at 60 days

(19.3×10^3) and dhaincha incorporated at 45 days (13.7×10^3).

Reduction in the azotobacter number was observed after harvest of maize may be because the moisture content in the soil was very low during this period and the organic carbon content had also decreased. However, the azotobacter number recorded after harvest of maize was more where green manures were incorporated compared to control where no green manure was incorporated. So, increased organic carbon content might be the reason for the increased azotobacter number in the soil. Some scientist have also reported that highest population was observed in soil samples with the range of pH=7–7.4 and the lower population was found in pH>8 (Mazinani *et al.*, 2012) [12].

Organic carbon content (%) of the soil 30 DAS of maize and at harvest is presented in the Table 2 reveals that organic carbon content of the soil varied significantly due to incorporation of different green manures as well as due to age of incorporation of green manures but not their interaction. Maximum organic carbon content (0.73%) in soil was recorded where dhaincha was incorporated followed by sunnhemp (0.71%) and pillipesara (0.64%). Organic carbon contents in dhaincha and pillipesara incorporated plots were found to be significantly different with each other. However, organic carbon content when compared between dhaincha and sunnhemp as well as sunnhemp and pillipesara incorporated plot was remained on a par with each other. Due to age of incorporation of green manures, maximum organic carbon content in soil was recorded where green manures were incorporated at 60 days (0.75%) followed by 45 days (0.68%) and 30 days (0.65%). Organic carbon content in 60 days incorporated green manures was found to be significantly superior to 45 days and 30 days incorporated green manures. However, organic carbon content in 45 days and 30 days incorporated green manure did not differ significantly with each other. The entire green manure treated plots recorded a higher organic carbon content which were found to be significantly superior to control where no green manure was incorporated. A similar trend was observed in organic carbon content after harvest of maize though there was a decrease in organic carbon content in the soil.

Increase in organic carbon content in the soil depends on the quantity of organic matter added to the soil. As it is already discussed earlier that dhaincha accumulated maximum green biomasses which were incorporated into the soil. Increased age of green manures helps in accumulation of higher biomass which might be the reason for increase in organic carbon content due to incorporation of aged green manures. These results are in complete agreement with the findings of Singh and Brar (1985) [17], Yan and Li (1985) [20] and Datt and Bharadwaj (1995) [3].

Data on grain yield are presented in Table 2 which shows higher grain yield at 60 day age of incorporation. Increase in yield in this treatment may be due to higher cob weight and test weight. The cob weight at 60 day age of incorporation was significantly superior to any other treatment combination. Similarly, test weight recorded in maize at 60 day age of incorporation was superior to other treatments. Green manures added large quantity of organic biomass. The percentage increase in grain yield due to 60 day, 45 day and 30 day age of incorporation over control was 36.6 %, 22.0 % and 14.8 % respectively. Incorporation and decomposition of green manure has a solubilising effect of N, P, K, and micronutrients (Zn, Fe, Mn, and Cu) in the soil (Saraf and Patil, 1995) [15] and deficiency of different nutrient elements can be mitigated by way of recycling of nutrients through green manuring. Further, it also reduces the leaching and gaseous losses of N, thus increasing the efficiency of applied plant nutrients. When green manures are turned under at the time of flowering, the decomposition starts immediately in the soil. The green leaves, flowers, immature pods, and vegetative buds decompose very rapidly as they contain simple sugars, starches, hemicelluloses, amino acids, amides, and aldehydes which are hydrolyzed readily by heterotrophic bacteria (Tandon, 1992) [18]. Ammonification starts within two days. These are called “Rapid-N” liberators. The aged shoots, roots, and other woody parts are resistant to decomposition as they contain complex lignin compounds. Biological processes are very slow on these parts and termed as “Slow-N” liberators. The initial fraction (Rapid-N) supplies N at the time of crop establishment and early tillering. The second and third fractions (Slow-N), which are 20-50% of total N, contribute to nutrition at the reproductive phase of crop. About 40% of carbon and 80% of total N present in Sesbania were released in about two weeks. Since, 60 day aged green manure has both the rapid N liberator and slow N liberator so it might have provided the nutrients to maize crop according to their demand from initial stage to reproductive stage. Green manure incorporation preceding the maize might have helped in maintaining the buildup of soil organic matter, which in turn, helped in improving the soil's structure, pore size and water-holding capacity, increase in microbial population in rhizosphere of maize which might be able to have better availability of nutrients including micronutrients by reducing the loss of nutrients and improving the fertilizer use efficiency. Such observations were also reported by Cook *et al.* (2010) [2], Patel and Kumar (2010) [13] and Fabunmi *et al.* (2012) [6].

The data on stover yield (Table 2) indicates significant differences in stover yield due to age of incorporation of green manures only but no significant difference was observed due to either different green manures or their interaction. With the increased age of incorporation of green manures the stover yield was found to increase. Maximum stover yield (9182 kg ha^{-1}) was obtained when they were incorporated at 60 days which was significantly superior to 30 days incorporated green manure where stover yield obtained was (8290 kg ha^{-1}), whereas stover yield was on a par with each other in case of 60 days and 45 days incorporated green manure as well as 45 days and 30 days incorporated green manure. The lowest stover yield (7478 kg ha^{-1}) was observed with control (7864.7 kg ha^{-1}) where no green manure was incorporated. All green manure treated plots recorded significantly higher grain yield over control. The percentage increase in grain yield due to 60 days, 45 days and 30 days age of incorporation over control was 22.7 %, 15.5 % and 10.8 % respectively.

More quantity of green manure biomass addition might have added macro and micro nutrients which may contribute for better availability of nutrients for longer duration. Increased organic carbon content during crop period might have increased fertilizer use efficiency as it withholds the nutrients and prevent them from getting lost due to leaching. Besides, increased organic carbon might have contributed for increase in microbial population which is the food for microorganism which, in turn, would have contributed for the nutrient transformations occurring in the soil and their better availability to the plants. Gangawar and Kalra (1981) and Itnal and Palled (2001) [10] have also reported that yield and yield attributing characters increases due to incorporation of green manures.

Table 1: Green manure crops biomass production (t ha^{-1}) before incorporation as influenced by *in-situ* incorporation of green manures and age of their incorporation

Green Manures	Age of Green Manure Incorporation			
	60 DAS	45 DAS	30 DAS	MEAN
Dhaincha	20.6	12.7	8.1	13.8
Sunnhemp	18.8	11.4	7.5	12.6
Pillipesara	12.0	7.1	5.3	9.1
MEAN	18.1	10.4	7.0	
Control	0			
	Sem ±	C D (P=0.05)	C V (%)	
Green Manures	0.51	1.0	10.6	
Age of Incorporation	0.51	1.0		
Interaction (G x A)	0.89	1.8		
Control Vs treated	0.94	1.9		

Table 2: Organic carbon content, grain and stover yield as influenced by *in-situ* incorporation of green manures and age of their incorporation

Treatments	Organic carbon content (%)		Grain yield (kg ha^{-1})	Stover yield (kg ha^{-1})
	30 DAS	At Harvest		
Green Manures				
Dhaincha	0.73	0.51	7475	8986
Sunnhemp	0.71	0.49	7274	8812
Pillipesara	0.64	0.44	6763	8319
S Em ±	0.01	0.01	366.1	301.6
C D (P=0.05)	0.03	0.03	NS	NS
Age of GM incorporation				
60 DAS	0.75	0.54	7871	9182
45 DAS	0.68	0.46	7030	8644
30 DAS	0.65	0.43	6611	8290
S Em ±	0.01	0.01	366.1	301.6
C D (P=0.05)	0.03	0.03	769	634
Control	0.40	0.40	5761	7478
Control Vs treated	0.69	0.48	7170	8705
S Em ±	0.02	0.03	668.5	550.6
C D (P=0.05)	0.05	0.05	1404	1157
Interaction (G x A)				
S Em ±	0.02	0.02	634.2	522.3
C D (P=0.05)	NS	NS	NS	NS
C V (%)	3.8	6.3	11.2	7.5

Table 3: Total bacterial count (x 10^7) per gram of soil at 30 day after incorporation of green manures in maize as influenced by *in-situ* incorporation of green manures and age of their incorporation

Green Manures	Age of Green Manure Incorporation			
	60 DAS	45 DAS	30 DAS	MEAN
Dhaincha	60.0	95.0	140.0	98.3
Sunnhemp	55.0	65.0	40.0	53.3
Pillipesara	105.0	125.0	105.0	111.7
MEAN	73.3	95.0	95.0	
Control	38.3			
	Sem ±	C D (P=0.05)	C V (%)	
Green Manures (G)	2.93	6.2	7.5	
Age of Incorporation (A)	2.93	6.2		
Interaction (G x A)	5.07	10.7		
Control Vs treated	5.35	11.2		

Table 4: Total bacterial count (x 10^7) per gram of soil after harvest of maize as influenced by *in-situ* incorporation of green manures and age of their incorporation

Green Manures	Age of Green Manure Incorporation			
	60 DAS	45 DAS	30 DAS	MEAN
Dhaincha	13.3	9.3	8.3	10.3
Sunnhemp	10.0	5.0	3.0	6.0
Pillipesara	7.0	4.3	2.3	4.6
MEAN	10.1	6.2	4.6	
Control	2.0			
	Sem ±	C D (P=0.05)	C V (%)	
Green Manures (G)	0.22	0.5	7.4	

Age of Incorporation (A)	0.22	0.5		
Interaction (G x A)	0.39	0.8		
Control Vs treated	0.41	0.9		

Table 5: Total fungal count (x 10^3) per gram of soil at 30 day after incorporation of green manures in maize as influenced by *in-situ* incorporation of green manures and age of their incorporation

Green Manures	Age of Green Manure Incorporation			
	60 DAS	45 DAS	30 DAS	MEAN
Dhaincha	40.0	16.7	9.7	22.1
Sunnhemp	33.3	13.3	10.0	18.9
Pillipesara	26.7	13.3	10.0	16.7
MEAN	33.3	14.4	9.9	
Control	9.0			
	Sem $\pm$	C D (P=0.05)	C V (%)	
Green Manures (G)	0.97	2.0	11.3	
Age of Incorporation (A)	0.97	2.0		
Interaction (G x A)	1.68	3.5		
Control Vs treated	1.77	3.7		

Table 6: Total fungal count (x 10^3) per gram of soil after harvest of maize as influenced by *in-situ* incorporation of green manures and age of their incorporation

Green Manures	Age of Green Manure Incorporation			
	60 DAS	45 DAS	30 DAS	MEAN
Dhaincha	10.0	9.0	6.3	8.4
Sunnhemp	9.3	6.3	5.3	7.0
Pillipesara	8.0	5.3	4.7	6.0
MEAN	9.1	6.9	5.4	
Control	4.3			
	Sem $\pm$	C D (P=0.05)	C V (%)	
Green Manures (G)	0.28	0.6	8.5	
Age of Incorporation (A)	0.28	0.6		
Interaction (G x A)	0.48	1.0		
Control Vs treated	0.51	1.1		

Table 7: Total rhizobium count (x 10^4) per gram of soil at 30 day after incorporation of green manures in maize as influenced by *in-situ* incorporation of green manures and age of their incorporation

Green Manures	Age of Green Manure Incorporation			
	60 DAS	45 DAS	30 DAS	MEAN
Dhaincha	22.0	19.0	13.0	18.0
Sunnhemp	18.0	16.0	7.0	13.7
Pillipesara	17.0	15.0	13.0	15.0
MEAN	19.0	16.7	11.0	
Control	5.0			
	Sem $\pm$	C D (P=0.05)	C V (%)	
Green Manures (G)	0.56	1.2	8.2	
Age of Incorporation (A)	0.56	1.2		
Interaction (G x A)	0.97	2.0		
Control Vs treated	1.02	2.1		

Table 8: Total rhizobium count (x 10^4) per gram of soil after harvest of maize as influenced by *in-situ* incorporation of green manures and age of their incorporation

Green Manures	Age of Green Manure Incorporation			
	60 DAS	45 DAS	30 DAS	MEAN
Dhaincha	0.7	0.6	0.4	0.55
Sunnhemp	0.7	0.4	0.3	0.48
Pillipesara	1.0	0.6	0.5	0.70
MEAN	0.8	0.54	0.39	
Control	0.13			
	Sem $\pm$	C D (P=0.05)	C V (%)	
Green Manures (G)	0.03	0.06	10.58	
Age of Incorporation (A)	0.03	0.06		
Interaction (G x A)	0.05	0.10		
Control Vs treated	0.05	0.10		

Table 9: Total azotobacter count (x 10^3) per gram of soil at 30 day after incorporation of green manures in maize as influenced by *in-situ* incorporation of green manures and age of their incorporation

Green Manures	Age of Green Manure Incorporation			
	60 DAS	**45 DAS**	**30 DAS**	**MEAN**
Dhaincha	163.3	133.3	103.3	133.3
Sunnhemp	186.7	160.0	56.7	134.4
Pillipesara	260.0	100.0	76.7	145.6
MEAN	203.3	131.1	78.9	
Control	10.0			
	Sem ±	C D (P=0.05)	C V (%)	
Green Manures (G)	3.81	8.0	6.5	
Age of Incorporation (A)	3.81	8.0		
Interaction (G x A)	6.60	13.9		
Control Vs treated	6.96	14.6		

Table 10: Total azotobacter count (x 10^3) per gram of soil after harvest of maize as influenced by *in-situ* incorporation of green manures and age of their incorporation

Green Manures	Age of Green Manure Incorporation			
	60 DAS	**45 DAS**	**30 DAS**	**MEAN**
Dhaincha	23.7	13.7	7.7	15.0
Sunnhemp	19.3	7.0	3.0	9.8
Pillipesara	8.3	3.7	2.0	4.7
MEAN	17.1	8.1	4.2	
Control	1.0			
	Sem ±	C D (P=0.05)	C V (%)	
Green Manures (G)	0.33	0.7	7.9	
Age of Incorporation (A)	0.33	0.7		
Interaction (G x A)	0.58	1.2		
Control Vs treated	0.61	1.3		

References

1. Bharadwaj SP, Prasad SN, Singh G. Economizing nitrogen by green manures in rice-wheat rotation. Indian Journal of Agricultural Sciences. 1981; 51:86-90.
2. Cook JC, Gallagher RS, Kaye JP, Lynch J, Bradley B. Optimizing vetch nitrogen production and corn nitrogen accumulation under no-till management. Agronomy Journal. 2010; 102(5):1491-1499.
3. Datt N, Bharadwaj KKR. Nitrogen contribution and soil improvement by legume green manuring in rice-wheat cropping on an acid clay loam soil. Journal of the Indian Society of Soil Science. 1995; 43:603-607.
4. Denison RF, Kiers ET. Life style alternative for rhizobia: mutualism, parasitism and forgoing symbiosis. FEMS Microbiology letters. 2004; 273:187-193. http://doi:10.1016/j.femsle.2004.07.013.
5. Elfstrand S, Bath B, Martensson A. Influence of various forms of green manure amendment on soil microbial community composition, enzyme activity and nutrient levels in leek. Applied Soil Ecology. 2007; 36(1):70-82.
6. Fabunmi TO, Adigbo SO, Odedina JN, Olasunkanmi TO. Effect of planting dates on green manure of cowpea (*Vigna unguiculata* L.), Response of succeeding maize in a derived savanna ecological zone of Nigeria. Journal of Agricultural Science. 2012; 4(7):57-66. http://dx.doi.org/10.5539/jas.v4n7p57.
7. Gangawar B, Kalra GS. Intercropping of rainfed maize with different legumes. Indian Journal of Agricultural Sciences. 1982; 52:113-116.
8. Ghai SK, Rao DLN, Batro L. Comparative study of the potential of Sesbania for green manuring. Tropical Agriculture. 1985; 62:52-56.
9. Islam MZ, Sharif DI, Hossain MA. A Comparative Study of Azotobacter spp. from Different Soil Samples. J Soil. Nature. 2008; 2(3):16-19.
10. Itnal PK, Palled YB. Studies on intercropping of sunnhemp green manuring in hybrid maize. Karnataka Journal of Agricultural Sciences. 2001; 14(3):586-592.
11. Krishna KR. Agroecosystems of South India: Nutrient Dynamics, Ecology and Productivity. Brown Walker Press, Boca Ratan, Florida, USA, 2010, 141-160.
12. Mazinani M, Aminafshar M, Asgharzadeh A, Chamani M. Effect of Azotobacter population on physic-chemi calaracteristics of some soil samples in Iran. Annals of Biological Research. 2012; 3(7):3120-3125.
13. Patel A, Kumhar AK. Effect of green manuring and nitrogen levels on soil health and yield of rice. Green Farming. 2010; 3(1):20-22.
14. Salam MA, Hamed SMS, Shivaprasad P, Tajuddin E, Thomas Y. Performance of *Sesbania rostrata* in acid soils. International Rice Research Institute Newsletter. 1989; 14:33-34.
15. Saraf CS, Patil RR. Fertilizer use in pulse based cropping systems. Fertilizer News. 1995; 40(5):55-65.
16. Schenck S. Soil incorporation of cover crop biomass: Effect on soil microorganisms and nitrogen levels. Diversified Crops Report No, 2003, 23.
17. Singh B, Brar SP. Effect of organic manures and nitrogen on grain yield and soil properties in a maize-wheat rotation. Journal of Research Punjab Agricultural University. 1985; 22:243-252.
18. Tandon HSL. Fertilizers, Organic Manures, Recyclable Wastes and Biofertilizers. FDCO, New Delhi, 1992.
19. Tilak KVBR. Response of green manuring and mungbean residue incorporation on microbial activities for sustainability of a rice-wheat cropping system. Journal of Agriculture and Rural Development in the Tropics and Subtropics. 2004; 105(2):189-196.
20. Yan XC, Li DM. Effect of planting green manure legumes on purple dry land soil. Journal of Soil Science. 1985; 16:112-115.