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Nutrient Release Rate of *Crotolaria juncea* Degradation with Incorporation of Ligno-cellulolytic Bioinoculant under Dry and Flooded Conditions

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***Abstract*:** The application of green manure in the field needs fallow period of 20-30 days so as to allow decomposition, the application of bacterial culture that can enhance the degradation rate can decrease the fallow period and allow early sowing of next crop thereby saving time. The present study was conducted to evaluate the nutrient release during decomposition of *Crotolaria juncea* with application of efficient lignin-cellulose degrading bacterial consortium in laboratory under dry and flooded conditions. The study reported 15 times higher decomposition during first eight days of incubation under aerobic conditions with application of bacterial consortium. Application of consortium culture was more effective in degradation as compared to control and single culture application. Significant increase in NO_3^--N content was observed during incubation period whereas, NH_4^+-N content showed peak increase at 45 days of incubation. Aerobic conditions supported rapid release of both NH_4^+-N and NO_3^--N content during initial days of incubation. In flooded water regimes nitrogen release (NH_4^+-N + NO_3^--N) was low owing to more denitrification activity in water logged conditions. The phosphorus (P) and potassium (K) content showed positive relation with decomposition of green manure. The application of bacterial consortium has further enhanced the release of P and K as compared to control treatment. This might be due to enhanced degradation that led to release of these nutrients. There was significant impact of water regimes on phosphorous release, as remarkable increase was in P value under flooded conditions. The study showed that application of ligno-cellulolytic consortium bioinoculant enhanced the decomposition as well as nutrient release form *Crotolaria juncea*.

***Keywords*:** Bacterial consortium, Decomposition, Nutrient release, NH_4^+-N, Phosphorous

Environmental contamination has the potential to be a major threat to the survival of living organisms. The misuse of chemical fertilizers and pesticides can contribute to the deterioration of the environment. This can affect soil fertility resulting in a loss of productivity, and this realization has led to the adoption of sustainable farming practices (Vogel et al 2019). Green manure crops have an increasingly important role in sustainable crop production. The incorporation of green manure in soil plays a key role in the nutrient cycling in the soil ecosystems. Their incorporation in soil causes recycling of nutrients bound in plant biomass through microbial decomposition (Kalita et al 2022), thus making them available for crop uptake (Lei et al 2022). The overall nutritional impact of green manure on crop primarily depend on its efficient decomposition and nutrient release. Organic material decomposition is a complex process determined by three main interacting groups of factors: biotic (microorganisms and invertebrates that take part in litter decomposition), chemical (composition of the litter) and physical such as climate and environment surrounding the litter (Berg and Laskowski 2006). There are several naturally occurring microorganisms that are able to decompose organic waste leading to nutrient mineralisation. These microorganisms are also important to maintain nutrient flows from one system to another and to minimize ecological imbalance (Umsakul et al 2010). Microbes utilize organic waste for their growth and nutrition, when their requirements are met or microbial cells are lysed, excess ions got released into the soil pore water, which is accessible to plant roots. Thus, playing vital role in organic matter decomposition and nutrient mineralization (Duan et al 2021).

Decomposition of organic inputs is depended on survival, colonization and growth of microorganisms associated with it. Although, number of soil microorganisms are able to degrade organic inputs, but; scarce number or limited biodegradation capacity of the autochthonous microbes may result in inefficient and delayed decomposition rates (Xu et al 2019). Therefore, the *in-situ* degradation of organic amendments can be enhanced by augmentation of potential ligno-cellulolytic microorganisms into the system (Bhattacharjya et al 2021). The discovery of novel bacterial cultures for biodegradation of lignocellulosic materials is gaining much attention because of their inherent metabolic diversity, higher growth rate, genome variability, biotechnological significance and immense environment stability (Zhao et al 2019). This paper will focus on studying the role of bacterial inoculants in boosting the decomposition and nutrient mineralization from *Crotolaria juncea* in lab conditions.

MATERIAL AND METHODS

The experiments were carried out in the Department of Microbiology, Punjab Agricultural University, Punjab, India. The soil used in the experiment had a pH of 8.46, 5.29 mg/kg available N, 1.32 mg kg^{-1} Olsen P, 1.60 mg/kg exchangeable potassium and an electrical conductivity of 0.20dS/m. The bulk soil sample was collected fresh from the experimental field and was air-dried to sieve through 2 mm pore size. The experiment was conducted in two types of soil *i.e.,* sterilized and unsterilized soil. The fresh soil was autoclaved at 15psi (121°C) for 30 minutes, cooled and again autoclaved for three consecutive days. The experiments was carried out in polypropylene bags (18”×12”) in triplicate.

Organic amendments: The green manure crop (*Crotolaria juncea)* was grown to the age of 45 days in the experimental field of School of Organic Farming, PAU, Ludhiana. The freshly collected green-manure plants were chopped into pieces (3.5-5.5 cm long) for use in this study. Green manure and soil were mixed in 1:2 ratio and contents were thoroughly hand-mixed into the soil.

Bacterial cultures: Three bacterial culture were isolated from different soil samples, screened and selected for their cellulose degrading ability namely BC1, BC2 and BC3 which were applied singly and in mixture of three known as consortium bioinoculants. The control treatment devoid of any bacterial culture was also kept during the study. The bacterial culture was identified molecularly as BC1-*Lysinibacilllus sp.* VKM B-751 (MT539731.1); BC-2-*Glutamicibacter mishrai* strain S5 (CP032549.1); and BC3-*Paenibacillus sp.* A3 (HG003584.2).

Moisture regime: The nutrient transformations in the amended soil were studied at 37±5°C (room temperature) at two moisture regimes using a completely randomized design with two replications. The two moisture regimes were: (i) Aerobic condition (field capacity): The soil was maintained at around 14.0% moisture (w/w). The soil moisture was maintained by adding water after every week. (ii) Flooding conditions: A 1.0 cm layer of water was maintained at the surface of the soil throughout the study period by adding water every 2 days. Total of ten treatments were designed to determine decomposition and nutrient mineralization pattern of *Crotolaria juncea* in two different water regimes (aerobic and flooding) as follows-

Soil sampling and analysis: Decomposition of green manure was monitored by the loss of green manure weight at 2 days interval upto 14^{th} day. Soil samples (10 g) were taken at 2, 4, 6, 8, 10, 12, 14 day and analysed for available phosphorous and exchangeable potassium whereas mineral N (NH^{+}-N + NO_3^{-}-N) was recorded at 16, 30, 45 and 60^{th} day from each treatment (Table 1). The soil phosphorous, potassium content and Mineral nitrogen were determined using methods given by Olsen et al. (1954), Jackson (1967) and Page et al. (1982), respectively.

Statistical analysis: The mean values recorded for different observation and results were subjected to analysis of variance and difference between treatments were analysed by Tukey' b test using SPSS 16.0 software.

RESULTS AND DISCUSSION

Green manure decomposition: Decomposition was recorded in terms of green manure weight loss during the studies. Weight of green manure was significantly affected by the application of bacterial culture in the aerobic conditions than flooding conditions. However, the significant amount of weight loss occurred during the first eight day of green manure incubation with unsterilized soil + consortium culture (Fig. 1a). In sterilized soil, green manure weight loss rate was 4.49 % day^{-1} with the application of the consortium culture which was significantly higher over its uninoculated control i.e., 3.56% day^{-1}. Irrespective of the inoculation, there was a higher weight-loss rate in unsterilized soil treatments as compared to sterilized soil. The application of consortium in unsterilized soil increased weight loss rate by 12 times than that of sterilized conditions. Application of consortium culture increased the green manure weight loss during first week by 5.7 % day^{-1}which was significantly higher than its uninoculated control (4.14% day^{-1}) in sterilized soil. In unsterilized soil this value further increased to 6.38% $day^{-1}$with consortium as compared to 5.37% day^{-1} in its uninoculated control. The present study revealed that application of consortium to green manure accelerated the decomposition in terms of weight loss rate during first week of incubation. Silva et al (2008) observed the decomposition process associates with the compounds that are degraded in each phase, as a result decomposition occurs faster in the early stages when easily assimilable substrates are available to microbes and slows down when only complex material was available to microbes.

Decomposition of green manure significantly affected by the moisture regimes. Weight loss in flooding conditions

Table 1. Details of experimental treatments

Treatment	Details	Treatment	Details
T1	SS+ GM	T6	US+ GM
T2	SS+ GM+BC1	T7	US+ GM+BC1
T3	SS+ GM+BC2	T8	US+ GM+BC2
T4	SS+GM+BC3	T9	US+GM+BC3
T5	SS+GM+C	T10	US+GM+C

*SS-Sterilized soil; GM-Green manure; US-Unsterilized soil; BC-Bacterial culture; C- Consortium indicated that the application of bacterial culture (single /consortium) positively affected the decomposition but not to the extent in aerobic condition (Fig. 1b). Application of single culture in sterilized soil enhanced the weight loss by 1.40-1.46 % day^{-1}, whereas application of consortium enhanced the weight loss by 2.22% day^{-1}. Use of unsterilized soil significantly enhanced the weight loss of organic matter in each case, like in its uninoculated control treatment weight loss enhanced by 0.08% day^{-1}as compared to uninoculated control in sterilized soil. Application of consortium culture significantly enhanced the percent weight loss day^{-1} (2.71) as compared to the control treatment (2.31) during first eight days of incubation. Awasthi et al (2018) reported that bacterial assisted composting of food waste has attained early maturation as compared to uninoculated control; thereby improving C/N ratio, extractable nitrogen (ammonium) content, pH and EC. Manu et al (2019) concluded that microbial inoculation caused early waste stabilization and statistically impacted the degradation rate. Similarly, Greff et al (2022) also mentioned an improved biodegradation of organic inputs using ligninolytic or cellulolytic microbial inoculants. The inoculation with efficient microbes may help in promoting decomposition by reducing the initial lag phase, increasing the concentration of degrading enzymes, promoting the degree of humification and various nutrient transformations (Xu et al 2019, Chi et al 2020).

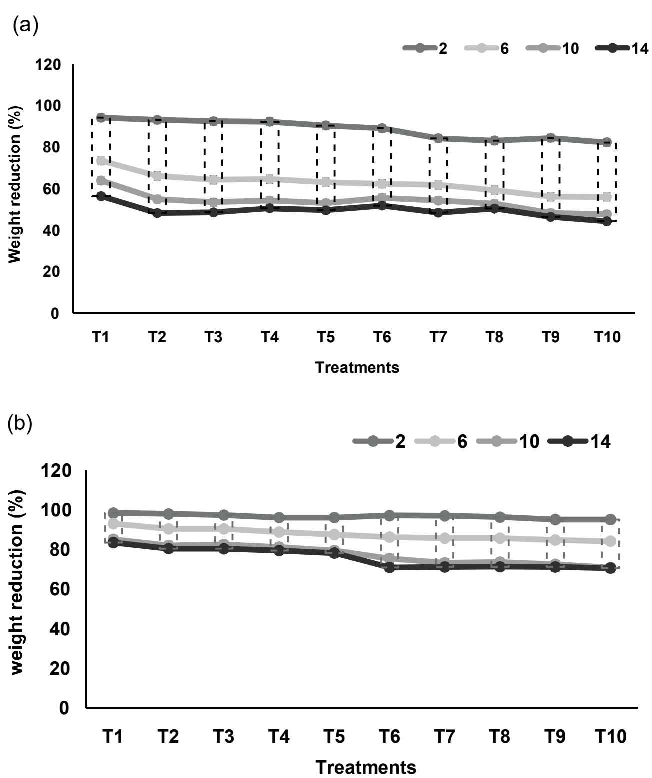

Fig. 1. Weight reduction of green manure using cellulose degrading bacteria in sterilized and unsterilized soil at different time intervals in a) aerobic conditions and b) in flooding conditions

Effect of bacterial inoculants on mineral nitrogen content of soil: In present investigations, an increase in the concentration of mineral nitrogen was brought by decomposition of organic matter bound nitrogen which was mediated by inoculated and indigenous microorganisms present under different soil and moisture regimes.

Nitrogen release under aerobic conditions: The NH_4^+-N content was significantly increased after the incorporation of green manure as compared to the 0 day content (5.29 mg/kg. In all treatments, during the first two weeks, NH_4^+-N content increased significantly over the control afterwards it increased slowly in all treatment. The rapid rise in NH_4^+-N during early period might be due to decomposition of the easily decomposable nitrogenous substances present in *Crotolaria juncea*. In sterilized soil, the highest mineralization rate of NH_4^+-N was observed with the inoculation of BC1 as compared to sole application of other bacterial culture, this might be attributed to the inherent capacity of ammonia released by bacteria (Table 2). However, application of culture as consortium showed further increase in the rate of NH_4^+-N release which indicated the combined efficiency of culture in decomposition of *Crotolaria juncea*. The release of NH_4^+-N was higher in unsterilized soil as compared to sterilized soil in all treatments showing that the inoculated bacterial culture had worked coordinatively with the natural microflora of soil and positively affected the release of nitrogen. As compared to ammoniacal nitrogen, the NO_3^--N content of the soil increased gradually throughout the incubation period (Table 2). The maximum increase in the nitrification was recorded during the 8th to 12th day of incubation in all treatments. The rapid increase in soil NO_3-N content was observed after the 30th day indicating that nitrification dominated over the process of ammonification and may be due to stimulation of nitrifying bacteria in response to higher availability of ammoniacal substrate and aerobic soil condition during decomposition of *Crotolaria* in soils.

The uninoculated control soil also showed a considerable increase in the mineral N content during incubation. This might be due to decomposition of added organic materials that had a positive priming action in increasing mineral N. Present results corroborated with Trinsoutrot et al (2000) that residues having C/N ratio ≤24 induced a surplus of mineral N following addition to soil. Mohanty et al (2011) also reported an immediate nitrogen mineralization on application of

Gliricidia (green manure crop) to soil as rate of nutrient mineralization also dependent on chemical composition of the residue and green manures having low C/N ratio and polyphenols were expected to be easily degraded by soil microbes; releasing nutrients (N) into the soil. In present study an increased N mineralization was recorded under consortium inoculation than uninoculated controls. This could be related to the inherent ability of the inoculated bacterial strains to produce and excrete ammonia or their synergistic effect on the improved degradation of nitrogenous substrates. Resende et al (2000) observed that N contained in stems and leaves of *Crotalaria juncea* was linked to more easily decomposable compounds. Awasthi et al (2020) reported enhanced the extractable ammonium content from food waste with bacterial inoculation as compared to uninoculated control, by supporting degradative and maturation processes. Wu et al (2019) reported that mixed culture of *Trichoderma viride* and *T. harzianum* improved total N, P and K content of corn straw – pig manure and rice straw – pig manure compost over the uninoculated control.

Nitrogen release under flooding condition: Ammoniacal nitrogen content of soil-organic matter mixtures increased during incubation under flooding conditions but, to a lesser extent as compared to the aerobic conditions and can be due to decomposition of organic materials takes place under flooding conditions at slower rate as compared to aerobic conditions. The application of consortium bioinoculant significantly increased NH_4^+-N content at all-time intervals as compared to uninoculated control treatment. Highest NH_4^+-N was observed at 45th day of incubation and then declined progressively. The NO_3-N content too has risen slightly only during the 1st week under flooded conditions. After the 8th day of inoculation, an immediate decrease was observed in NO_3-N content in all treatments (Table 2). The results could be supported in terms that nitrification is an oxidation process occurring under aerobic conditions whereas, slight increase could possibly due to the aerobic conditions prevailed at some void areas making the process feasible for a short period. Additionally, increase in NH_4^+-N up to 45 days of incubation might have favour denitrification under flooding conditions. Higher availability of nitrate N was for BC1 culture and might be due to higher NH_4^+-N produced with application of this culture that acted as precursor for the nitrate production. Degradation of green manure in the presence of microbial inoculants could significantly improve mineral nitrogen content. The flooded soil is a dynamic heterogeneous soil-water system that has three distinct soil layers established mainly by the prevailing oxidation-reduction or redox potential (Eh or pE) of the system. soil NO_3–N concentrations decreased and soil NH_4–N concentrations increased with flooding as expected under the anaerobic soil conditions reached under flooding. Under anaerobic conditions, three main N transformations occur: (i) ammonification (the conversion of organic N into NH_4–N), (ii) nitrate reduction (conversion of NO_3–N into NH_4–N), or (iii) denitrification (conversion of NO_3–N into N_2). Therefore, under flooded conditions, NH_4–N is being produced (ammonification and nitrate reduction) while NO_3–N is being lost (nitrate reduction and denitrification). Nitrate is a mobile form of N and thus it can also be leached from the system under flooded conditions. Unger et al. (2009) also observed that decrease in NO_3–N and an increase in NH_4–N was observed in the 5-week flood treatments, however no differences were observed between the flowing and stagnant treatments. Hefting et al. (2004) demonstrated that the height of the water table can affect the outcome of N mineralization. In their study, when the water table was within 10 cm of the soil surface, ammonification was the primary N mineralization reaction taking place while net nitrification was insignificant.

Effect of bacterial inoculants on soil phosphorus availability

under aerobic conditions: Application of green manure significantly increased the phosphorous content in soil as

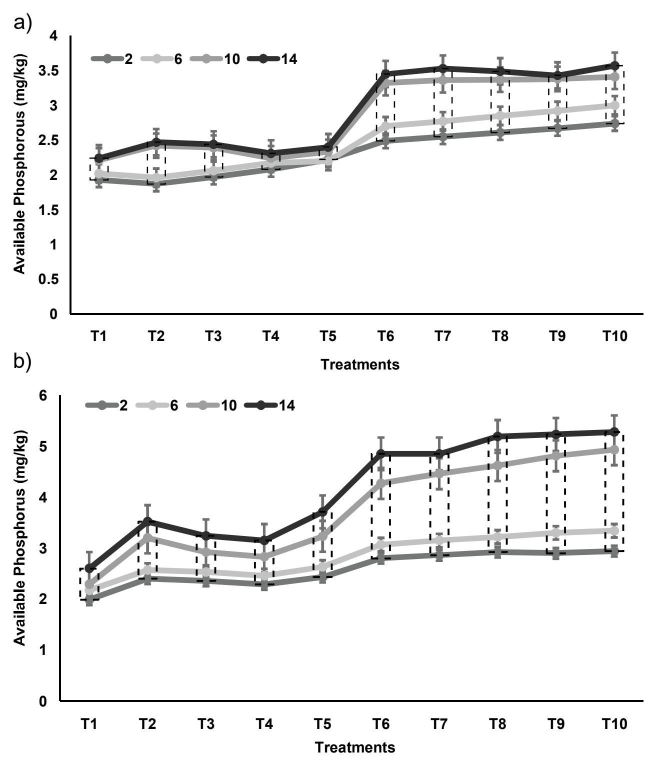

Fig. 2. Effect of different bacterial cultures on phosphorous mineralization from green manure in a) in aerobic conditions, b) in flooding conditions

compared to the 0 day (1.60 mg/kg). The phosphorous content was increased up to the 14[th] days of incubation however, application of bacterial culture positively influenced phosphorous levels in soil. Among the sole inoculants, BC3 culture significantly enhanced the phosphorous level as compared to uninoculated control treatments. The highest phosphorous content was in treatment having application of consortium culture. In sterilized soil conditions, there was about 6.0% increase in the phosphorous level with consortium inoculation over its uninoculated control (Fig. 2). This could be directly related to the enhanced decomposition of green manure due to combined activity of cultures present in consortium in sterile soil. However, the phosphorous content in treatments with unsterilized soil was found to be higher than sterilized soil, which indicated the cooperation derived from indigenous microbial flora in degradation biomass and phosphorous mineralization. Decomposition of green manure causes release of high chelation capacity products which lowers the activity of polyvalent that form insoluble salt with phosphorous thus liberates P from the basic phosphates of these elements. In present study, the phosphorous availability positively correlated with the nitrogen content. This might be due to the fact that soils with high ammonification activities usually favour the processes resulting in rapid release of phosphorous in soil.

Soil phosphorous availability under flooding conditions: The different water regimes significantly affected the soil available phosphorous content during green manure decomposition. The available phosphorous increased markedly in the soil maintained under flooding conditions as compared with aerobic conditions. However, in accordance to aerobic conditions, the highest available phosphorous was in treatment having bacterial consortium. The bacterial inoculation was more effective in improving phosphorous availability from green manure decomposition, indicating that bacterial inoculant effectively coordinated with the indigenous microbial flora (Fig. 2).

Chimouriya et al. (2018 and) Kumar et al (2020) also documented that green manures can affect soil P availability through several mechanisms, such as (i) mineralization of biomass P; (ii) increased soil microbial activity due to release of phytases or phosphatases may transform the unavailable P to available P; (ii) Decomposition released CO_2 that react with water to form carbonic acid in soil solution thereby facilitating dissolution of P (iv) Released organic compounds may mask various P adsorption sites in soil or may release P from these sites by anion exchange method. Zhou et al (2021) observed rapid P release from green manure (milk vetch) during first five days, followed by a gradual increase up to 125 days. This rapid release of unstructured P (40-60 % of the total plant P) may be attributed to nucleic acid or other ionic forms of P in plant residues (Mubarak et al 2002). Sun et al (2021) reported that the P release rate from animal manure-maize straw mixture increased gradually; showing a rapid release initially and slow in the latter stages of decomposition. Moreover, the increasing soil P availability with increase in incubation indicated that supply of P from residues remained higher than microbial demand throughout 60 days (Chimouriya et al 2018).

Effect of bacterial inoculants on exchangeable potassium content: The exchangeable potassium content of soil showed positive correlation with the weight loss of green manure. Potassium content increased up to the 14[th] day after inoculation (Fig. 3). Application of consortium culture significantly increased the potassium as compared to the control treatment. Potassium contained in green manure was also thought be the nutrient that evenly releases as the decomposition process proceeds and become available to plants. The extent and rate of K release from crop residues was usually considered greater than residue dry matter decomposition and N or P release (Lupwayi et al 2006). Talgre (2014) observed negative relation of potassium with the C/N ratio of organic matter, i.e., lower the C/N ratio higher release of potassium. Potassium being not a structural constituent of cell , so got easily solubilized by water in early stages of decomposition of organic residues, thus have

a)

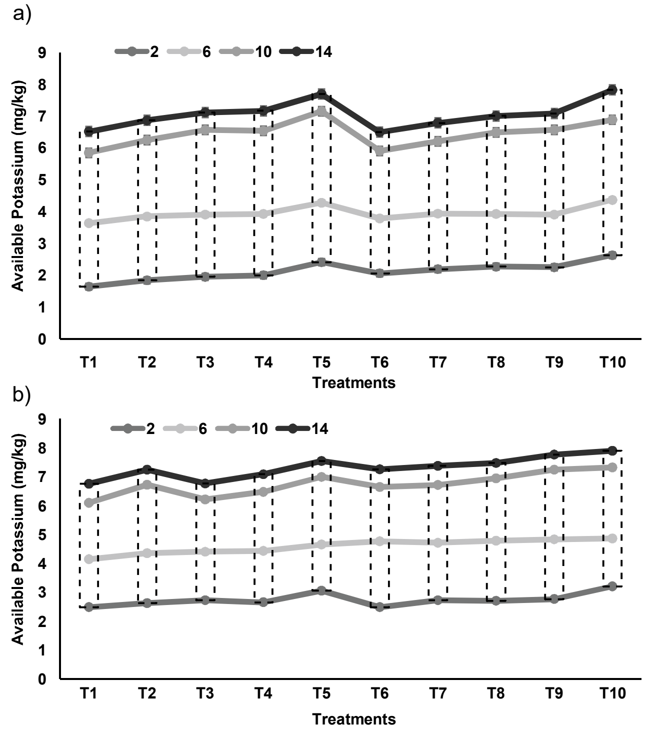

Fig. 3. Effect of different bacterial cultures on exchangeable potassium mineralization from green manure in a) in aerobic conditions, b) in flooding conditions

highest release rate among major nutrients (Mubarak et al 2002). Green manure (such as milk vetch) had been suggested as quick acting K fertilizer as it released 70-84 % of K within first 5 days of application (Zhou et al 2021). Kaur (2018) reported that increase in soil K content following green manuring might be due to the release of Fe^{2+} and Mn^{2+} under highly reduced conditions created during decomposition. Present results of higher soil available K in consortium inoculated treatments indicated that addition of effective microorganism can influence soil macronutrient content by improving the processes of nutrient mineralization (Wu et al. 2019).

In flooding conditions, the potassium content was low as compared to the aerobic conditions indicating the greater contribution to oxidative degradation reaction towards potassium release and availability. The maximum potassium content was with consortium application in unsterilized soil. Increase in soil solution K concentration might be due to release of Fe^{2+} and Mn^{2+} under highly reduced conditions created by green manure (Fig. 3). K release rate could also be highly conditioned by the precipitation during the decomposition period (Rodrı´guez-Lizana et al 2010). Lupwayi et al (2004) observed that intensive root decomposition and K release occurred from June to August with much rain received during these months and this effect was less prominent in above ground mass decomposition. Periera et al (2016) also observed that the rate of release of K could be correlated with the rate of decomposition of dry matter. Likewise, Gao et al (2015) used complex biological agent (fungi + bacteria) capable of increasing the total K content of the final corn stalk-swine waste compost compared to control. Wan et al (2020) reported that inoculation of 25

Table 2. Effect of cellulose degrading bacteria on nitrate and ammoniacal nitrogen in sterilized and unsterilized soil at different time intervals during green manure decomposition

	Nitrate nitrogen (mg/kg) at different days											
	Under aerobic conditions						Under flooding conditions					
	2	8	16	30	45	60	2	8	16	30	45	60
T1	0.01^{I}	0.38^{J}	6.52^{J}	9.57^{J}	11.43^{J}	16.88^{J}	0.01^{H}	0.98^{I}	0.90^{H}	0.89^{G}	0.91^{H}	0.93^{H}
T2	0.22^{F}	4.44^{E}	10.86^{F}	15.29^{F}	17.98^{H}	22.73^{G}	0.12^{E}	1.12^{E}	1.08^{E}	1.07^{E}	1.11^{E}	1.13^{I}
T3	0.03^{H}	2.12^{G}	10.60^{H}	14.66^{H}	17.76^{I}	21.18^{I}	0.07^{G}	1.01^{H}	0.95^{G}	1.00^{F}	1.02^{G}	1.08^{F}
T4	0.04^{G}	1.54^{I}	10.62^{G}	15.19^{G}	18.00^{G}	22.60^{H}	0.09^{F}	1.07^{G}	1.02^{F}	1.01^{F}	1.06^{F}	1.09^{F}
T5	0.34^{C}	3.31^{F}	11.33^{E}	15.51^{E}	19.22^{F}	22.81^{F}	0.22^{C}	1.16^{D}	1.10^{D}	1.09^{D}	1.13^{D}	1.15^{D}
T6	0.22^{F}	1.54^{H}	9.33^{I}	14.02^{I}	19.35^{E}	24.62^{E}	0.13^{E}	1.10^{F}	1.02^{F}	1.01^{F}	1.03^{G}	1.05^{G}
T7	0.38^{B}	6.42^{B}	14.71^{B}	19.45^{B}	25.28^{B}	28.69^{B}	0.24^{B}	1.24^{B}	1.20^{B}	1.19^{B}	1.23^{B}	1.25^{B}
T8	0.27^{E}	5.38^{D}	13.80^{C}	18.70^{C}	23.63^{C}	26.51^{D}	0.19^{D}	1.13^{E}	1.07^{B}	1.12^{C}	1.14^{D}	1.22^{C}
T9	0.29^{D}	5.82^{C}	13.15^{D}	18.54^{D}	23.28^{D}	26.53^{C}	0.21^{C}	1.19^{C}	1.14^{C}	1.13^{C}	1.18^{C}	1.21^{C}
T10	1.54^{A}	6.93^{A}	15.52^{A}	19.88^{A}	26.53^{A}	29.00^{A}	0.34^{A}	1.28^{A}	1.22^{A}	1.21^{A}	1.25^{A}	1.27^{A}
	Ammoniacal nitrogen (mg/kg) at different days											
	Under aerobic conditions						Under flooding conditions					
	2	8	16	30	45	60	2	8	16	30	45	60
T1	5.8^{I}	7.4^{H}	11.4^{J}	16.4^{J}	13.5^{J}	13.2^{J}	5.3^{F}	6.9^{F}	9.8^{I}	11.7^{H}	11.1^{H}	10.9^{G}
T2	6.5^{F}	8.8^{F}	13.6^{F}	18.4^{I}	16.3^{I}	16.1^{I}	5.6^{EF}	7.3^{BCD}	11.7^{E}	14.0^{F}	13.1^{E}	12.8^{E}
T3	6.1^{H}	8.0^{G}	12.8^{G}	19.2^{F}	16.8^{G}	16.5^{G}	5.3^{F}	7.2^{CDF}	11.4^{EF}	14.5^{F}	12.5^{F}	12.5^{E}
T4	6.1^{H}	7.8^{G}	12.3^{I}	18.8^{H}	16.5^{H}	16.1^{H}	5.4^{F}	7.0^{DF}	11.1^{FG}	13.4^{G}	12.1^{G}	11.7^{F}
T5	6.7^{E}	9.1^{E}	14.1^{E}	21.2^{D}	17.6^{E}	16.9^{F}	5.8^{DE}	7.5^{BC}	12.6^{D}	17.5^{C}	14.0^{D}	13.8^{D}
T6	6.4^{G}	7.8^{H}	12.7^{H}	18.9^{G}	17.4^{F}	17.4^{E}	6.0^{CD}	7.5^{BC}	11.0^{G}	17.1^{D}	15.4^{C}	15.8^{C}
T7	7.4^{B}	10.0^{D}	18.7^{D}	21.0^{E}	19.6^{D}	19.2^{D}	6.5^{AB}	9.1^{A}	13.8^{B}	18.6^{AB}	17.3^{AB}	17.8^{A}
T8	7.0^{D}	10.4^{C}	20.7^{C}	23.0^{C}	20.6^{C}	20.3^{C}	6.2^{BC}	8.6^{B}	13.1^{C}	18.3^{B}	17.1^{B}	16.8^{B}
T9	7.3^{C}	11.0^{B}	21.3^{B}	23.2^{B}	21.0^{B}	21.1^{B}	6.3^{BC}	9.1^{A}	13.6^{B}	18.8^{A}	17.4^{AB}	17.7^{A}
T10	7.8^{B}	11.2^{A}	23.7^{A}	24.6^{A}	22.4^{A}	22.0^{A}	6.7^{A}	8.8^{A}	15.3^{A}	20.8^{A}	17.6^{A}	18.0^{A}

**Different letter shows significant differences at p=0.05 using post hoc text Tukey's B within treatments different cellulosic isolates improved co-decomposition of maize straw and chicken manure, resulting in higher nutrient content (NPK) and GI index compared to control.

CONCLUSION

Decomposition and nutrient mineralization from green manure can be improved with the application of microbial inoculants. The application of consortium significantly improved the decomposition and nutrient release in aerobic condition. Decomposed the green manure 7 days earlier than uninoculated control, thus have potential to decrease the fallow period between green manure incorporation and crop sowing (particularly maize). In this aspect, microbial consortium is more effective than individual culture and can be integrated with green manure practices to enhance soil nutrient availability as well as it can minimize ecological imbalance by maintaining nutrient flows from one system to another.

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