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Low Energy Rice Stubble Management through in Situ Decomposition

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Abstract

The disposal of rice stubbles after harvest of crop remains a major concern in all rice growing areas. In lowland rice ecosystems, where sole cropping is mostly practiced, low energy in situ composting may contribute tremendously towards recycling of solid waste and long-term sustenance of soil fertility. Spraying of a bacteria, isolated and characterized for its cellulose degrading ability (CDM), was done singly or in consortium with Azospirillum sp or with Bacillus sp or with both to rice stubbles under field condition after harvest of the crop. Spraying with glyphosate, or with glyphosate and sugar significantly reduced stubble dry weight, and carbon content during the three months period. Consortium of CDM, Azospirillum sp and Bacillus sp performed better compared to the others. Further works may complement the findings of the present study into a low energy, simple and easily acceptable in situ rice stubble management technology.

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Keywords: Cellulose degrading bacteria, rice stubble, in situ decomposition, glyphosate;

1.0 Introduction

Huge quantities of rice straw are left for disposal after harvest of the crop (Brouder and Hill, 1995; Sidhu and Beri, 2008; Wannapeera *et al*, 2008; Jusoh *et al*, 2013) and most of this remains unutilized in the field. Removal of rice straw is done for its use as livestock bedding and feed, fuel for cooking, and other off-field purposes

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(Dobermann and Fairhurst, 2002; Bijay-Singh, *et al*, 2008). Their potential as feedstock for bioethanol production (Dominguez-Escriba and Porcar, 2009; Binod et al., 2010), and prospective applications of the separated oligosaccharides in pharmaceutical, food and feed industries (Moniz *et al*, 2014) are also reported. Recent work also suggested baling of the rice straw and selling them as animal feed during the lean season (Kanokkanjana and Garivait, 2013). The most common practice adopted by farmers is burning (Kumar *et al*, 2015), especially in areas where the succeeding crop is grown in a short time thus allowing less time for its incorporation into soil for decomposition (Bijay-Singh *et al*, 2008). Alternative to burning, rice straw management options remain costlier either for its incorporation into the soil (Blank *et al*., 1993; Sidhu and Beri, 2008) or its conversion to compost (Sidhu and Beri, 2008). On the other hand, burning is implicated for causing pollution and affecting soil fertility adversely (Kumar *et al*, 2015). Winter flooding of rice fields had been reported to promote wildlife like waterfowl (Brouder and Hill, 1995), to reduce weed infestation (Fogliatto *et al*, 2010; Koger *et al*, 2013) as additional benefits to rice stubble decomposition. But, one major concern to this anaerobic decomposition had been high levels of methane emission (van Breemen and Feijtel, 1990; Potter *et al*, 2006; Zhang *et al*, 2011; Liou *et al*, 2015). Low net carbon mineralization, despite higher decomposition, especially at low temperature (Devevre and Horwath, 2000) and production of organic acids (Shan *et al*, 2008) toxic to rice roots and their breakdown into harmful gases (Brouder and Hill, 1995), leaching loss of potassium with increasing duration of submergence (Amamsiri and Wickramasinghe, 1973) are reported as undesirable effects under flooded condition. Rainfed lowland rice is grown in about 36 m ha of which 34 m ha are found in Asia, and the fallow periods between two crops range from a few days to 3 months (Dobermann and Fairhurst, 2002). Sole cropping is done due to limited water supply in saline areas (Pandey et al, 2012) or due to other factors (Sarungbam and Prasad, 2011). Lowland rainfed rice ecosystems are managed with low inputs (Dobenmann and White, 1996) and are usually characterized by medium to high clay content. The soil type largely determines the management of physical environment through tillage (Mambani et al, 1990), and nutrient transformation and availability (Fageria *et al*, 2011). There is ample scope for buildup of the soil fertility through *in situ* utilization of the stubbles, which is a good source of sulphur (Dobermann and Fairhurst, 2002), and contains almost all the K and about one-third of the N, P, and S removed from the soil by the rice crop (IRRI, 1984).

Rice stubble is composted *in situ* successfully either through their incorporation into soil or by aerobic decomposition making piles. Rapid *in situ* aerobic method of composting involves periodical spraying of moisture and turning of materials (Anonymous, 2000), and the processes consume considerable energy. Co-composting of rice straw with poultry manure was reported to save carbon loss (Devi *et al*, 2012). Use of microbial consortium through sequential or combined application during co-composting (Zhou *et al*, 2015) and effort to characterize their maturity index (Qian *et al*, 2014) had been reported. But the requirements of additional effort in terms of energy do not suit the preference and need of the resource poor farm units. Thus, a simple method with low energy input would facilitate both the farming community, and in the long run sustenance of soil fertility. Isolation of nitrogen fixing bacteria from stem, root, leaves and their presence in intercellular spaces, senescing root cortical cells, aerenchyma, and xylem vessels of rice had been reported (Gyaneswar *et al*, 2001). However, survival and function of the microorganisms remain to be a question as host defense mechanism was cited as a reason for declining colonies of *Herbaspirillum seropedicae* Z67 in artificially inoculated rice seedlings (James *et al*, 2002). Pre-harvest application of glyphosate, a non-selective herbicide, for weed control in crops (Monsanto International sarl and Monsanto Europe sa, 2010) was reported to cause desiccation of wheat (Jaskulski and Jaskulska, 2014) and offers scope for use in rice stubbles which maintain green stems even after the crop harvest. Combined use of molasses (sugar cane) had been shown to provide the mineral matters to the applied microorganisms (Jusoh *et al*, 2013). Accordingly, the present work was planned to evaluate the effectiveness of bacterial strains singly or in consortium with or without glyphosate, and sugar for *in situ* decomposition of rice stubbles.

2.0 Materials and methods

2.1 Location and climate

A field experiment was conducted during January to April, 2015 at Instructional *cum* Research (ICR) Farm of Assam Agricultural University (26°44´N, 94°l0´E and 91 m above MSL), Jorhat, India. The soil of the experimental site had clay loam texture, pH 5.6, and organic carbon 6.4 g/kg. The daily temperature of Jorhat increases from