EVALUATION OF CONSORTIUM CELLULOLYTIC MICROBES IN DEGRADATION OF RICE STRAW TO IMPROVE PLANT GROWTH

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ABSTRACT

A consortium of cellulolytic microbes (CCM) isolated from paddy fields were developed to degrade rice straw in the field. Under green house conditions, paddy plants grown in soil incorporated with the consortium cellulolytic microbes and straw for eight weeks showed significant ($P \leq 0.05$) increases in total dry weight, biomass, stem length and seed weight compared to controls, suggesting the CCM to be effective in degrading the paddy straw and improving paddy growth. Laboratory phytotoxicity study showed a germination index of 116.7% indicating the CCM to be harmless to plants and suggesting it to be phytonutrient-phytostimulant.
Key word: consortium cellulolytic microbe, rice straw, paddy, phytonutrient-phytostimulant

INTRODUCTION

Rice straw is not easily degraded in the field and thus is not generally applied directly into the soil because of its high C:N ratio. It is common practice for farmers to burn rice straw in the field, causing greenhouse gas emissions (Badrinath et al. 2006). An alternative and more environmentally friendly approach to this problem is to incorporate microbes that can assist in the breakdown of rice straw in the field. These cellulolytic microorganisms can convert the organic material (OM) in the rice straw into valuable soil conditioners, improving soil nutrient, increasing soil drainage and aeration (Cox et al. 2001) thus assisting plant growth and generally enhance sustainable agricultural production (Lynch 1987). In this paper we report application of a consortium cellulolytic microbes (CCM), previously isolated from paddy fields, to rice straw and their effect on paddy growth, under greenhouse condition.

METHODS

Consortium cellulolytic microbes (CCM) isolated previously (Linda et al. 2011) was used as inoculums in this experiment. The rice straw variety MR219 was sampled from rice field after harvesting the grains. The straw was cut to a 4-5 cm length (stems and leaves) and oven-dried at 60°C for 48 hour as described by Singh et al. (2004). Air-dried clay soil, sieved through a 2 mm mesh (3.0 kg) was placed into each of in a 16 cm diameter, 18 cm tall pot plastic without hole at the bottom. The CCM culture 10 ml (v/v) with inoculums size of 10^8 cfu ml^{-1} was added to 2.0 g of rice straw. The mixture was then mixed with the soil ; water was added to a 100% field capacity and maintained throughout experiment. One paddy seed (variety MR 219) was then planted into each pot. Each treatment was repeated in triplicates. After 110 days, the agronomic traits of the paddy plant namely the dry weight, biomass, tiller, stem length and seed weight (Chang & Bardenas 1965) were analyzed.

Phytotoxicity of CCM culture was assessed by measuring the germination index (GI) of the paddy seeds obtained Zucconi et al. (1981). Ten seeds were placed on a sterile filter paper (Whatman 6) soaked with 10 ml of CCM culture (10^8 cfu ml^{-1}) for 24 h. Germination of seeds were observed for 10 days**.** Experiments were done in triplicates and seeds germinated is distilled water served as the control. Data were analyzed by a one-way analysis of variance using the CCM as the single factor. Means were compared by Duncan's new multiple range test at the 5% level.

RESULT AND DISCUSSION

Treatment of soil with CCM and rice straw showed significant ($p<0.05$) increases in the dry weights (4.6%), biomass (4.1%), stem lengths (1.7%) and seed weight (3.1%) of the paddy

plants (Figure.1). These results show that CCM enhances breakdown of rice straw in soil resulting in more available nutrients such as amino acids and proteins that resulted in increases in the dry weight, stem length and seed weights. Seed weights increase would correlate to yield of the plant. There was however, no significant increase in the numbers of tiller compared to the control. The results from this study concur with previous report by Han and He (2010) who reported increases in plant biomass, chlorophyll-a, chlorophyll-b and total chlorophyll content when they added commercial cellulase into rice straw.

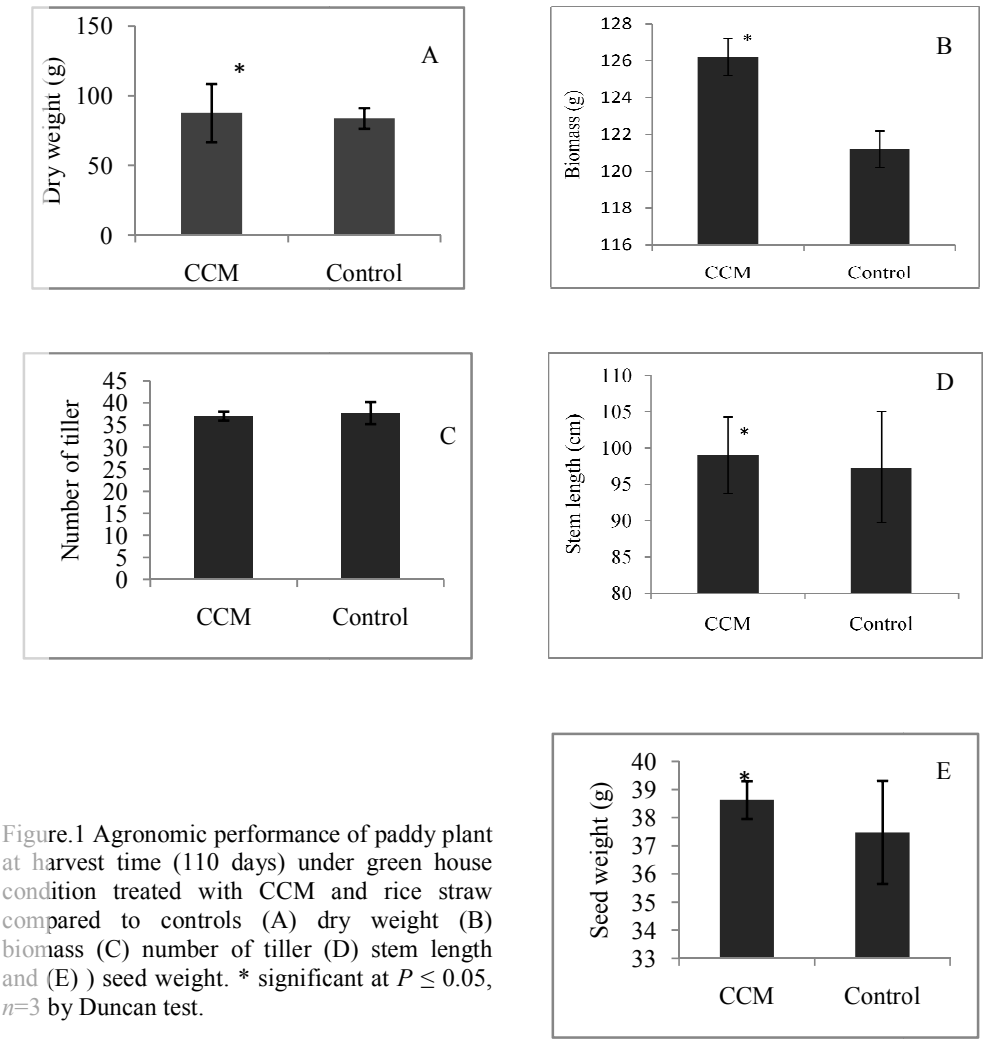

Figure.1 Agronomic performance of paddy plant at harvest time (110 days) under green house condition treated with CCM and rice straw compared to controls (A) dry weight (B) biomass (C) number of tiller (D) stem length and (E)) seed weight. * significant at $P \leq 0.05$, $n=3$ by Duncan test.

Table 1 shows that treatment with CCM caused about 13% more seed germination, compared to controls. Furthermore, the CCM also caused 3% increase in paddy root length. Germination Index (GI) is a factor of relative seed germination to relative root elongation and GI of > 101 shows substrate to be characterized as phytonutrient-phytostimulant, and to be beneficial in agriculture (Aggelis et al. (2002). The germination index (GI) of CCM treated rice straw was 116.7%, thus suggesting its phytonutrient-phytostimulant activity.

Table 1. Effect of CCM culture on germination of paddy seeds

Treatment	Average of germinated seed (%)	Average root length (cm)	Germination index (GI%)
Control (distilled water)	84.92±1.375	6.50±1.608	-
CCM	96.30±6.415*	6.69±1.481	116.7

From the foregoing paragraphs, it can be suggested that the developed CCM is a suitable agent to be added to agricultural soil as it can accelerate degradation of the rice straw to increase the nutrient availability and improve paddy growth. Incorporation of CCM culture to rice straw is a cheap strategy for a sustainable farming as it improves soil fertility and avoid environmental degradation through rice straw burning in the field.

CONCLUSION

The applications of CCM culture to rice straw in soil under green house condition has been shown to improve the paddy growth and yield. CCM is also shown to be harmless to plants and is a phytonutrient-phytostimulant.

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