Improving Upland Rice Production through Conservation Agriculture

保全農法による陸稲生産の改善

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Abstract

Upland rice cultivation often faces limitations due to poor soil fertility, moisture stress, and unsustainable land management, leading to sub-optimal yields. Conservation agricultural practices, such as reduced tillage, organic amendments, and integrated nutrient management, have the potential to enhance soil health and crop productivity. This study evaluated the combined effects of tillage systems and soil amendments on soil quality and plant performance during upland rice production.

A field experiment was conducted using a 2 × 4 factorial design with eight treatments: Reduced Tillage (RT) and Conventional Tillage (CT), each combined with either organic Mulch (M), Biofertilizer (B), Chemical Fertilizer (C), or a combination of organic Mulch and Biofertilizer (MB). Soil parameters, including pH, Soil Organic Carbon (SOC), total nitrogen (N), Soil Water Content (SWC), and Electrical Conductivity (EC), as well as Norin24 upland rice cultivar metrics (SPAD value and Plant Height), were measured during the vegetative growth stage. We used two-way ANOVA to assess the treatment effects, and multiple regression to identify key soil-plant relationships.

The results showed that organic mulch treatments (RT+MB, RT+M, CT+MB, and CT+M) improved soil moisture retention and led to higher SPAD values, whereas plant height did not differ among treatments 35 days after transplanting. A strong positive correlation (R^2 = 0.89) was observed between the soil water content and SPAD, highlighting the critical role of moisture in the physiological performance of early rice. Notably, chemical fertilizer treatments exhibited lower SPAD values despite the addition of nitrogen. This was attributed to erratic rainfall and water stress, which limited plant nutrient uptake during the season. In contrast, greater water availability in mulch-amended plots promoted both plant vigor and microbial activity, especially when Pseudomonas sp. biofertilizer was applied. Furthermore, chipped rice straw mulch was more effective in conserving soil moisture and enhancing physiological status under reduced tillage than under conventional tillage.

These findings underscore the importance of integrating bacterial inoculation with mulching in reduced tillage systems to mitigate water stress and enhance nutrient-use efficiency in upland rice systems, especially under erratic rainfall conditions.

Keywords: Upland Rice, Conservation Agriculture, Organic Mulch, Biofertilizer, Soil Fertility, Sustainable Agriculture

キーワード：陸稲、保全農業、有機マルチ、バイオ肥料、土壌肥沃度、持続可能な農業

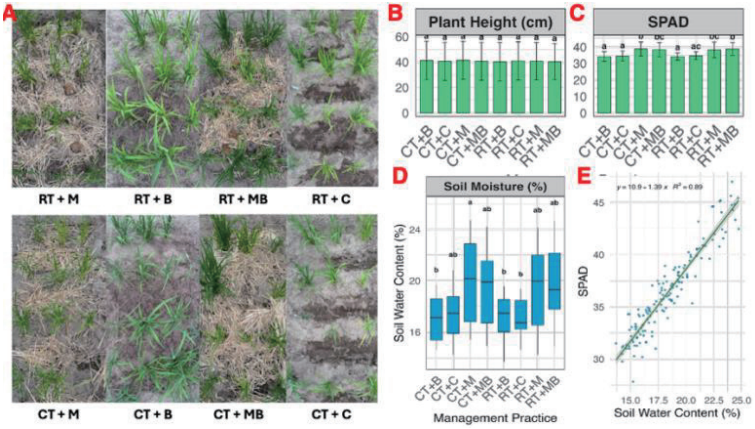

Fig 1. Effects of Different Land Management Practices on Upland Rice Growth.
(A) Representative field photos of upland rice plots at DAT 35.
(B) Plant height.
(C) SPAD (chlorophyll content index).
(D) Distribution of soil water content (%).
(E) Correlation (R^2 = 0.89) between soil water content (%) and SPAD values across all plots and treatments.