Short Communication

Differences in Seedling Emergence and Growth among Rice (Oryza sativa L.) Ecospecies under Reduced Soil Conditions

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To analyze the differences in the rate of seedling emergence and seedling height among rice ecospecies at different soil reduction levels, five blocks were prepared containing soils with different amounts of starch, i.e. 10, 20, 30, 83 and 167 g per block, and no starch addition block (control) was also prepared. The mean rate of seedling emergence and seedling height were increased by the addition of a maximum amount of 20 g starch per block in the three ecospecies. However, the mean rate of seedling emergence markedly decreased with the increase of the amount of starch added over 20 g per block. The mean rate of seedling emergence in the japonica cultivar group was higher than that in the indica cultivar group at all the redox potential levels, whereas that in the javanica cultivar group was intermediate. However, the rate of increase and/or decrease of the mean seedling height with changes in starch amount added was almost similar in the three ecospecies.

KEY WORDS: Oryza sativa L., ecospecies, seedling emergence, seedling growth, soil reduction.

Introduction

Rice plants are able to adapt to a lower oxygen partial pressure for germination and subsequent growth than upland crops (Taylor, 1942; Vlamis and Davis, 1943). However, oxygen deficiency in flooded soil may decrease the effectiveness of respiration in germinating seeds. The rapidity of germination depends on the rate of oxygen absorption and glycolysis (Kanda and Takahashi, 1951). Among the seedling organs, the development of the radicle is more depressed than that of the plumule by oxygen deficiency (Sasaki, 1926; Kanda and Takahashi, 1951). Therefore, the coating of rice seeds with calcium peroxide improves seedling emergence in direct sowing under flooded conditions (Ota and Nakayama, 1970; Baker and Hatton, 1981). However, seedling emergence even in seeds coated with calcium peroxide shows considerable fluctuations year by year especially in the north-east area of Japan (Fujoka, 1987). In the current experiments, the variations in the rate of seedling emergence and subsequent growth among rice ecospecies (Morinaga, 1968) were analyzed at different soil reduction levels in a greenhouse.

Materials and Methods

Forty six japonica cultivars, 18 indica cultivars including two japonica-indica hybrid offsprings from Korea and 15 javanica cultivars were used. These three ecospecies correspond to the a, c and b type classified by Matsuo (1952), respectively. Seeds were harvested at the University Farm of Yamagata (Lat. 38°60' N. and Long. 139°50' E.) in 1984, and were used in the experiments conducted in 1985. After pretreatment of the seeds in an incubator for

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two days at 30°C, the germinated seeds with a plumule length of about 2mm were sown at a depth of about 5mm in puddled paddy soil on July 25, and covered with sieved paddy soil. The air-dried and sieved paddy soil placed in a poly-vinyl box (36×60cm and 7.5cm deep) contained 7g of the commercial compound fertilizer with 13% each of nitrogen, P₂O₅ and K₂O. The depth of the surface water on the seed bed was 2cm. Different levels of soil reduction were prepared by the addition of 0 (control), 10, 20, 30, 83, 167g of potato starch powder per box before puddling. Three replicates in which one plot consisted of 20 seeds (one row) for each cultivar were provided for each level of soil reduction and randomized. Plants were grown in a green-house to avoid low temperature, and the survival and height of the plants were recorded 14 days after sowing. The degree of soil reduction was estimated by determining the amount of Fe²⁺ ion by applying the orthophenanthroline spectrophotometric method after extraction of Fe²⁺ ion with 1N sodium acetate.

**Results and Discussion**

Changes in the mean rate of seedling emergence and seedling height associated with starch addition are shown in Fig. 1 along with the amount of Fe²⁺ produced in the blocks with different quantities of starch added 14 days after sowing.

The growth of rice shoots is maximum at an oxygen pressure ranging from 2.7 to 5.2%, and that of the roots at an oxygen pressure of 5.2%. The growth is markedly depressed at lower levels and slightly depressed at levels exceeding 5.2% (VLAMIS and DAVIS, 1943). Furthermore, the time required for the plumule appearance is shorter at the oxygen pressure of 2% and the appearance is delayed at higher and lower oxygen pressures than 2%. The time required for root appearance is considerably shorter at an oxygen pressure up to 2%.

![Graph](image-url)  
*Fig. 1. Changes in the rate of seedling emergence and seedling height by the addition of starch in soil.*
and slightly shorter at higher levels (Noguchi, 1937). In the current experiments, the mean rate of seedling emergence and seedling height in the block to which 20g starch had been added were higher than those in the block without starch addition and in the block to which 10g starch had been added. The corresponding values decreased significantly with the increase of the amount of starch added over 30g per block in the three ecospecies. Thus, the high rate of seedling emergence and growth at an optimum soil reduction level (block to which 20g starch had been added) and the decrease with the increase of soil reduction in the current experiments may be attributed to the changes in the oxygen partial pressure levels in the soil and the genetic characteristics of the germinating seeds (Noguchi, 1937).

The mean rate of seedling emergence in the japonica cultivar group was high as compared with that in the indica cultivar group at all the redox potential levels, whereas that in the javanica cultivar group was intermediate. The high rate of seedling emergence of the japonica cultivar group may be ascribed to the fact that the plants were sown on a permanent nursery bed provided with a large amount of organic matter for a long period of time. Furthermore, it is considered that the japonica cultivar group may have accumulated genes tolerant to the soil reduction. However, the rate of increase and/or decrease of the mean seedling height with changes in starch amount added was almost similar in the three ecospecies, indicating a similar response of the top part of plants to changes in the soil reduction among ecospecies.

**Literature Cited**


選元土壌条件でのイネの出芽と生長の生態種間差異

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硫化物無添加区および硫化物を10, 20, 30, 83, 167 gを加えた6区の選元状態の異なる土壌におけるイネの3生態種の平均出芽率および初期生長の変異を検討した。3生態種の平均出芽率および初期生長とも土壌がある程度選元状態になった状態（20 g硫化物添加区）で最大値を示し、選元がさらに進行するように硫化物を加えた区で減少した。20 g硫化物添加区で、どの生態種の平均出芽率および初期生長も高い値を示したのは、2-5%の酸素分圧でイネの出芽率が高まること（野口, 1937; Vlaminis and Davis, 1943）と関係していると推察される。どの硫化物添加区でも、日本型品種はインド型およびジャワ型品種よりも高い平均出芽率を示した。なお、ジャワ型品種は日本型品種およびインド型品種の中間の平均出芽率を示し、ジャワ型品種およびインド型品種より日本型品種の還元抵抗性が高いのは、日本型品種が長期にわたって水稲代の選元土壌へ播種されてきたことに対する適応によると推察した。異なる選元土壌での草丈の変動は、生態種間で差異がみられなかった。