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THE EFFECT OF WATER MANAGEMENT ON RATOON ABILITY OF RICE PLANTS

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水稲の再生能に及ぼす水管理の影響

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The ratoon ability of rice plants was tested agronomically. Two experiments were conducted with 1/2000 Wagner pots to determine the effect of water management systems on the ratoon ability. Rice plants were cut on the 10th day following heading. Cutting heights in experiment I were at the ground level or 5 cm above the ground, while in experiment II they were 20 cm above the ground. Percentages of ratoon tillers and ratoon heights were noted for 40 days after cutting.

Most of the hills did not produce ratoons when the main crop was cut at ground level and the water depth was maintained at 5 cm above the ground. Water depth did not affect the percentage of ratoon tillers and ratoon heights when the main crop was cut 5 cm above the ground. Also no significant effects of water management on the percentage of ratoon tillers and ratoon heights were observed, when the main crop was cut at 20 cm above the ground. There is therefore no need for paying any special attention to the water management during the period before and after cutting as was revealed by this test of agronomical characters and double-cropping through ratooning.

水稲における農業形質の間接選抜手段としての利用ならびに再生を利用した二期作栽培にとって再生能は重要な特性である。再生能は遺伝的変異を有する特性であるが，株の内的および外的環境条件によって変異するであろう．しかしながら再生能に関する基礎的知見はきわめて少い．そこで地上部刈取り期前後の水管理が再生能に及ぼす影響について検討するため２つの実験を行った．実験Ｉでは，出穂後10日に地上０または５cm で地上部を刈取り，その後の水位を０または５cm に保った．実験 II では，出穂後10日に地上 20cm で地上部を刈取り，刈取り期前後を中心に水管理の異なる10区を設けた．実験Ｉおよび II のいずれにおいても，再生能を評価するため地上部刈取り後の再生茎率ならびに再生草丈を調査した．

刈取り高さが地上０cm で，かつ刈取り後の水位が５cm であった株，すなわち水没した株からはほとんど再生しなかった．刈取り高さが５cm の場合，再生茎率および再生草丈のいずれにおいても水位間の差は認められなかった．地上部刈取り期前後に湛水した区に比べ，同期間に落水した区の再生茎率が高いようであったが，その差は有意でなかった．再生草丈はいずれの区においてもほぼ同様であった．地上部刈取り期前後の水管理によって再生能は大きく変異せず，農業形質の間接検定ならびに再生を利用した二期作栽培にとって地上部刈取り期前後の水管理はあまり重要でないと思われる．

Introduction

There is a wide genetic variation in the so called ratoons which are stems of a second growth origin following harvesting of the main crop of the rice plant. The ability of cut aerial parts of rice plants during grain development to produce ratoons may be deduced by a test of percentage of ripened grains and lodging resistance (Ichii and Kuwada 1981, Ichii and Hada 1983). Eventhough ratoon ability is hereditable the quality of the ratoon varies also according to the internal and external conditions of the stubble and roots of the rice plant. Ratoon ability was largely depended on stem base weight and food reseves (Ichii and Sumi 1983) and was higher for high-temperature

growth conditions (ICHII 1982). Rice ratoon crops respond well to nitrogen fertilizer (YAMAMOTO 1967, IRRI Ann. Rep. 1975, BAHAR and DE DATTA 1977), through the effect of nitrogen fertilizer on ratoon ability have not been determined. Another factor that effects the regrowth and yield of ratoons is the irrigation timing. According to HERNAEZ (1958), irrigation immediately after harvest can cause the stubble to rot. BAHAR and DE DATTA (1977) found that the cutting height of the first crop had no influence when the stubble was reflooded. When the planted crops were cut at ground level, they obtained yield increases by delaying flooding until 12 days after harvest. However, when the planted crop was cut at 15 cm, the timing of the flood during the first 16 days after harvest had no effect on yield. MENGEL and WILSON (1980) reported that early flooding after harvest of the main crop resulted in a more rapid and uniform regrowth than that obtained with the delayed flooding water regime.

The objective of this study was to determine the effect of reflood timing on the ratoon ability of rice cultivars. The study consisted of two experiments.

Materials and Methods

Experiment I.

Rice cultivars, Yaeho and Oseto, were used. Thirty five-days-old seedlings were transplanted on June 17 to 1/2000 Wagner pots with two plants per pot. The transplanted plants were fertilized with 12.0 g of compound synthetic fertilizer (N: 15%, P_2O_5: 12%, K_2O: 15%). Five-sixth of the fertilizer was broadcast before transplanting; the rest of the fertilizer was applied at the stage. Rice plants were cut at ground level and 5 cm above the ground on the 10th day following heading. Immediately after cutting, rice plants received two irrigation treatments: a 5 cm continuous flooding and a non-flooding. Percentage of ratoon tillers and ratoon height were noted on the 5th, 10th, 20th and 40th day after cutting. The percentage of ratoon tillers was taken to be the number of ratoon-plant tillers times 100 divided by the number of mother-plant tillers. Ratoon heights were measured from the cutting level.

Experiment II.

Rice cultivar Koshihikari was used. Thirty five-days-old seedlings were transplanted on June 18 to 1/2000 Wagner pots with two plants per pot. The transplanted plants were fertilized in much the same application as in experiment I. Rice plants were cut at 20 cm above the ground on the 10th day after heading. The plants received ten irrigation treatments as shown in Fig. 1 for a given period before and after cutting. Percentage of ratoon tillers and ratoon height were measured in the same way as in experiment I.

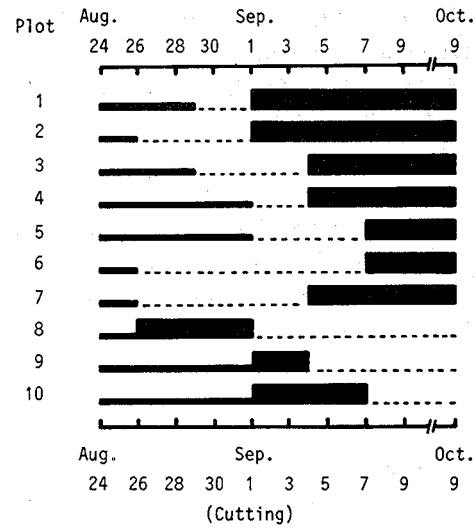

Fig. 1. Water management assigned.
: Under 1 cm of water
: Drained
: At 5 cm of water

Results

Experiment I.

The heading dates of Yaeho and Oseto were August 31 and August 26, respectively. Changes in the percentages of ratoon tillers are shown in Fig. 2. Most of the hills for either cultivar did not produce ratoons when the main crop was cut at ground level and the water depth maintained at 5 cm. Water depth did not affect the percentage of ratoon tillers when the main crop was cut at 5 cm. Reducing the cutting height from 5 cm to ground level caused a significant decrease for Oseto, but not for Yaeho. The percentage of ratoon tillers reached

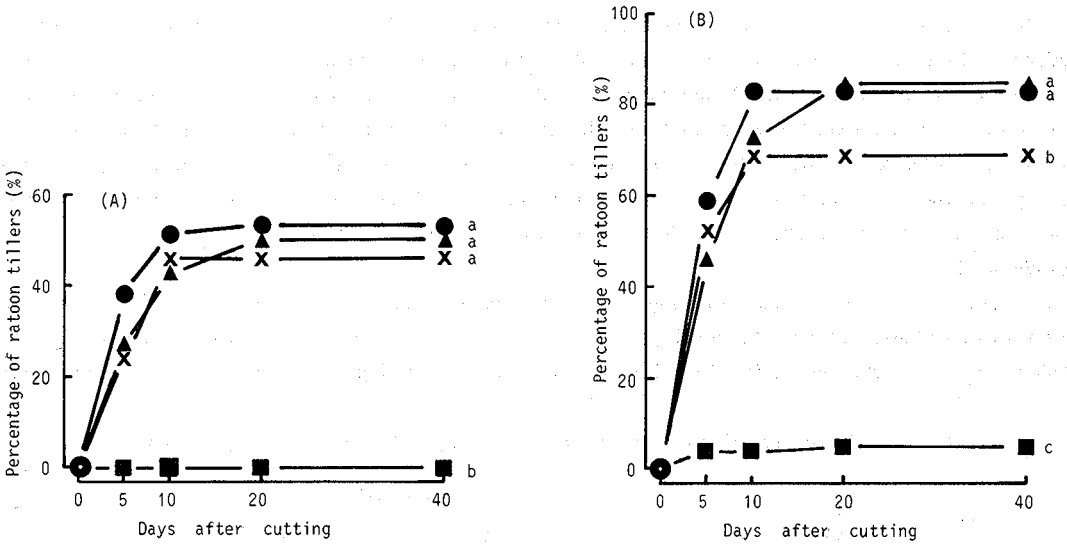

Fig. 2. The effects of cutting height and water management on percentage of ratoon crops (A) Yaeho and (B) Oseto.

Means on the 40th day after cutting followed by the same letter are not significantly different at 5% level according to Dancan's Multiple Range Test

●: Cut at 5 cm above the ground and non-flooded
▲: Cut at 5 cm above the ground and flooded
×: Cut at the ground level and non-flooded
■: Cut at the ground level and flooded

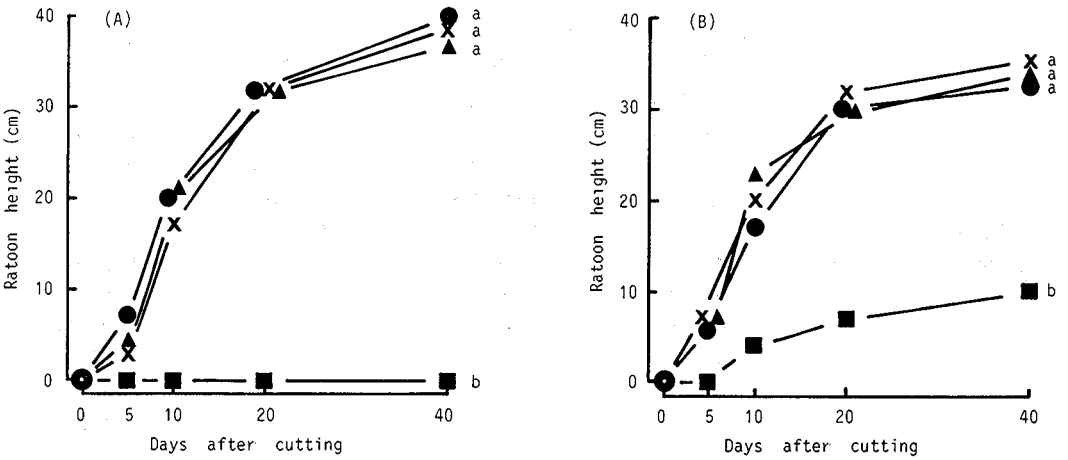

Fig. 3. The effects of cutting height and water management on ratoon height of ratoon crops (A) Yaeho and (B) Oseto.

Means on the 40th day after cutting followed by the same letter are not significantly different at 5% level according to Dancan's Multiple Range Test

●: Cut at 5 cm above the ground and non-flooded
▲: Cut at 5 cm above the ground and flooded
×: Cut at the ground level and non-flooded
■: Cut at the ground level and flooded

its highest value on the 20th day following cutting. Fig. 3 shows changes in ratoon height following cutting. The plant heights in the plot in which the cutting height was at ground level and the water depth was 5 cm were significantly lower in either cultivar, because most of the hills were missing in this plot. In the other plots no significant differences were found. Water depth also did not affect ratoon heights when the main crop was cut at 5 cm above the ground level. The cutting height did not affect the ratoon heights in the non-flooded plots. It is assumed in this figure that the height may be increased on and after the 40th day following cutting. However, heading was observed in most of the plots in a period between the 30th day after cutting and the 35th day. It is estimated that ratoon heights reached the heightest value within 35 days after cutting.

Experiment II.

The heading date of Koshihikari was August 22. Rice plants received ten irrigation treatments for a given period before and after cutting. Missing hills have not been observed in the ratoon crops. Percentages of ratoon tillers and ratoon heights on the 5th, 10th, 20th and 40th day after cutting are shown in Table 1. Percentages of

Table 1. Percentage of ratoon tillers and ratoon height in different water managements

Trait	Plot number	Days after cutting			
		5	10	20	40
Percentage of ratoon tillers	1	20.8±4.5	38.0±6.1	47.0±3.2	47.0±3.2
	2	19.4±1.4	38.6±3.3	48.8±2.6	48.8±2.6
	3	21.0±3.0	37.4±2.9	52.2±3.9	52.2±3.9
	4	21.4±2.9	36.8±2.9	48.0±1.3	48.0±1.3
	5	31.2±3.1	44.8±4.2	57.0±2.6	57.0±2.6
	6	26.6±3.1	41.2±5.1	56.0±5.0	56.0±5.0
	7	20.4±3.5	39.4±3.9	57.4±3.6	57.4±3.6
	8	22.4±4.1	34.8±4.2	46.2±3.5	46.2±3.5
	9	20.4±3.3	41.4±4.0	47.0±4.1	47.0±4.1
	10	23.0±3.6	35.6±2.7	46.4±2.7	46.4±2.7
		NS	NS	NS	NS
Ratoon height	1	9.8±1.8	17.0±1.8	32.5±1.9	42.6±1.9
	2	10.6±0.8	20.4±0.8	36.0±1.2	46.4±0.9
	3	11.4±1.2	22.8±1.1	34.8±1.4	45.8±1.6
	4	9.6±0.9	19.0±0.8	37.2±0.7	44.6±1.5
	5	10.4±1.1	18.4±1.3	35.2±1.6	44.2±1.8
	6	9.0±1.1	19.0±1.1	34.4±1.2	47.2±0.8
	7	9.8±1.3	19.8±1.1	33.8±1.5	44.8±1.7
	8	9.4±0.9	17.0±1.3	30.6±2.1	43.0±2.0
	9	8.8±0.3	18.4±0.2	31.8±1.0	44.4±1.6
	10	8.4±0.5	16.8±0.8	33.0±1.4	40.8±1.2
		NS	NS	NS	NS

NS: Means vertically within column are not significantly different at 5% level according to analysis of variance

ratoon tillers and ratoon heights were, respectively, the heighest on the 20th day and on the 35th day following cutting much the same as the results of experiment I. The percentage of ratoon tillers tended to be lower in the plots that have been flooded immediately after cutting than in the plots which have not been flooded for a week following cutting. Ratoon heights did not differ much among the plots. The conclusions based on an analysis of variance for the percentages of ratoon tillers and ratoon heights are given in Table 1, showing that there were no significant

differences in the variance due to the irrigation treatment. Therefore, water management in a given period before and after cutting did not seem to significantly affect the percentage of ratoon tillers and ratoon height.

Discussion

Vigorous ratoons were observed following a cutting height above 5 cm. Most of the hills, however, did not produce ratoons when the stubble plant was submerged in water for a long period following cutting at ground level. BAHAR and DE DATTA (1977) found that the percentage of missing hills increased as the time between irrigation and harvest was shortened. Missing hills, therefore, may be caused by rotting of the resting lateral buds, as HARNAEZ (1958) reported. MENGEL and WILSON (1981) obtained significant increases due to eariler flooding in the plant heights and the rough rice yields of the ratoon crops. They found also that early flooding after harvest of the main crop resulted in more rapid and uniform regrowth than that obtained with the delayed flooding regime. No significant effects of water management on grain yields of ratoon crops were observed, according to BAHAR and DE DATTA (1977). In our investigation water management did not significantly effect the percentage of ratoon tillers and ratoon height when the main crop was cut at 5 cm above the ground. And a more rapid regrowth did not be observed in the early flooding regimes. The response to water management obtained in our study was seemed to be similar to that reported by BAHAR and DE DATTA (1977). No significant effects of water management on the ratoon ability, the percentage of ratoon tillers and ratoon heights, can be explained by the facts (ICHII 1982, ICHII and SUMI 1983) that this ability depends largely on food reserves contained in the stem base and on the influence of temperature.

More rapid growth in ratoon plants was very important in double-cropping through ratooning and soiling of rice plants. The percentage of ratoon tillers does not increase after the 20th day following cutting, as is evident from the results of this investigation. According to HSIEH and YOUNG (1959), and MAHIUL HAQUE and COFFMAN (1980), a highly significant and positive correlation was found between the percentage of ratoon tillers and ratoon yield. It is of importance for double-cropping through ratooning of plant to reach enough tillers in the early stage of the regrowth. However, water management does not significantly effect the number of tillers, as was stated previously. There is not necessity for paying sepcial attention to water management during the early stage of the regrowth in double-cropping through ratooning, especially in the normal conditions in which the surface of the field is not dry before and after the harvesting of the main crop. However, the effect of water management on the yield component remains to be determined in the future.

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