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Rice Varietal Screening for Ratoonability

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Abstract: The field experiment was conducted at Philippine Rice Institute (PhilRice), located at Maligaya Munoz Nueva Ecija, Philippines. Rice ratooning ability under 10, 20 and 30 cm stubble cutting heights was evaluated on the basis of basal and nodal tillers regeneration, missing hills, ratoon vigour and rating and grain yield. Out of 30 varieties/lines tested only PSBRc8, PSBRc6 and BPIRi10 showed ratooning potentiality in terms of ratoon vigour and rating, basal and nodal tillers regeneration and final grain yield at lower stubble cutting height of 10 cm. It is recommended that for higher ratoon grain yield cutting of stubbles at the 10 cm should be performed.
Keywords: Rice, Ratoonability and Screening

Introduction

The ratoon tiller regeneration and growth depends on the buds that remained on the stubbles. The buds exist in various stages of development (Nair and Sahadevan, 1961). Auxiliary buds that develop at those nodes grow into ratoon tillers. In hybrid rice, most of the buds on the second, third and fourth nodes of the stubble are more viable compared to fifth node bud from the base (Sun Xiaohui *et al.*, 1988). The buds grew in different stages of development and no longer at the lowest nodes and were shorter at the upper nodes (Nair and Sahadevan, 1961; Chauhan *et al.*, 1985) observed that IR-44's buds were similar in length irrespective of their position on the stubble. However, the length of buds was affected by nitrogen fertilizer application to the main crop as observed.(Sun Xiaohui *et al.*, 1988) in hybrid rice. Ratoon development began soon after the main crop ripened. In the case of delayed harvesting of the main crop, the culms of the growing tillers became damaged as they elongated under the old leaf sheaths (Szokolay, 1956). In a study on ratoon tiller development of IR-44, the length of the buds at the first, second and third nodes did not vary. Buds grew slowly 40 days after cutting of the main crop. After 5 days, the duds at the first node generally grew faster, followed by those from the second and third nodes. Maximum bud lengths were 235, 159 and 74 mm. The average bud lengths were 144.45 and 17 mm. Eight days after ratooning, the culms began to branch (Chauhan, 1988). Ratoon tillers are characterized by different C:N ratios according to their origin (Iso, 1954). In Kagi Ban2 cultivar, the C: N ratio was 17.0 in tillers from upper nodes, 13.88 in those from the base and 10.80 from those below the soil. Moreover, the tillers from the upper nodes with high C: N reached like old seedlings. They matured faster and were shorter in culm than those tillers emerging from the lower nodes, which behaved like young seedlings (Iso, 1954: Aubin, 1979) observed in the D52-37 rice cultivar that the upper node tillers had fewer leaves than the lower node tillers. However, Volkova and Smetanin (1971) reported that different cultivars produced ratoon tillers differently.

The morphology of the ratoon plant differs significantly from that of the main crop plant. Usually, plant height (Balasubramanian *et al.*, 1970) is lower and effective tillers are fewer in the ratoon crop than in the main crop (Bahar and De Datta, 1977). However, ratoon crop produce more total tillers than the main crop (Quddus, 1981; Samson, 1980). Stem thickness is correlated with higher carbohydrate content in the stubbles. This could have induced more vigorous regeneration of ratoon tillers, resulting in the production of a larger number of tillers and higher grain yield (Palchamy and Purushothaman, 1988). Ratoon growth of rice depends upon the amount of Total Carbohydrate Content (TAC) in the stem base, at least early growth. The large amount of TAC is required to produce many tillers, and it would be achieved by high cutting of main crop stubbles, because the amount of TAC in the stubbles increases with cutting height (Ichii and Ogaya, 1985). Ratoon growth after the early stage was affected not only by the amount of reserves in the stem base but also by photosynthetic products in foliage. However, the dependence of photosynthesis in foliage is far less important in determining tiller number than it is in determining foliage weight, because tiller number became constant far more rapidly than foliage weight after main crop harvest. ratoon plants should have sufficient tillers in the early stage after the main crop harvest to achieve high yields. Cultivars and cultural practice including cutting height, which provides a large quantity of reserves at harvest, may be advantageous for rice ratooning (Ichii, 1984). Tillers that regenerated from higher nodes formed more quickly grew faster and matured earlier (Prashar, 1970).

The prospect of successful ratoon cultivation depends largely on ratooning of a variety. Among the plant characteristics sought for high yield potential, plant type and nitrogen responsiveness have received extensive consideration (Poehlman, 1976). Lack of acceptance of rice ratooning by commercial farmers has been attributed to low yields, lack of good ratooning varieties, uneven maturity, disease and insect problem, lack of location-specific cultural practices, inferior grain quality and lack of assured return from investment (Chauhan *et al.*, 1985). Ratooning ability has been found to be a varietal character (Balasubramanian *et al.*, 1970; Bahar and De Datta, 1977; Haque, 1975; Nadal and Carangal, 1979). Further, Nadal and Carangal (1979) identified three rice selections without standing tillering capacities and high ratoon yields under varying soil moisture regimes. Haque (1975) found out that IR2061- U23, IR2145-20-4 and IR1924-36-22 possessed high ratooning ability. In India, C3810, Ratna, CR20-66, and CR156-5021-207 showed superiority in ratooning and yield ability (Das and Ahmed, 1982). In China, some hybrid rices produced high grain yields and had high ratooning ability. The hybrid Zaishelgyou produced the highest main and ratoon.

Tillering ability is probably the most important genetic factor affecting ratoon performance of grasses. Because there are high and low tillering rice, ratoon depends to a large extent on the inherit tillering capacity of a cultivar (Plucknett *et al.*, 1984). Different varieties produce ratoon tillers differently (Volkova and Smetanin, 1971). Kuban grew tillers from all nodes of the stubble, whereas Klasnodarskii 424 developed tillers mainly from the third node. Findings indicated that the ratoon crop yields well if main crop stubble is left with 2-3 nodes. Elalaoui and Simons (1988) indicated that the initial tillering variety may be beneficial because it can transport photo assimilates from the non- surviving tillers before they die under dense plant community. In ratoon crop the effective tillers are fewer compared to the main crop. However, the actual number of tillers may be higher in the ratoon crop than in the main crop (Balasubramanian *et al.*, 1970); Bahar and De Datta (1977). Except for seed variability, all other characters (plant height, panicle length, spikelet size, number of productive tillers, and grain setting) were less pronounced in the ratoon crop than in the main crop (Reddy and Pawar, 1959). Looking the above facts it is prime important to identify the varietal potentiality for ratoonability and grain yield to sum-up the grain yield with the main crop yield as intensive farming.

Materials and Methods

The field experiment was conducted to evaluate the ratooning ability of 30 paddy cultivars/lines under lowland conditions during dry season and wet season at Philippine Rice Research Institute (PhilRice) located at Maligaya, Munoz, Nueva Ecija, Philippines. The experiment was laid-out in RCBD, Split-Plot-Design, where 30 cultivars/lines received three stubble cutting heights (C), i.e. 10, 20 and 30 cm above ground level. For sowing main crop the two plowings and two harrowings were done. The second harrowing was the final harrowing done 1-2 days before transplanting. The seeds were soaked for 12 hours and incubated for another 12 hours in cloth bags. The pre-germinated seeds were seeded in seedbeds. Twenty days old seedlings of different varieties and promising lines were transplanted at 20 x 20 cm plant spacing.

Varieties Tested: Thirty varieties and promising lines belonging to early and medium maturity collected form PhilRice. Twelve varieties/lines used were from Philippine Seed Board and eighteen were promising lines from PhilRice. The list is as under:

Fertilizers: Basal fertilizer for the main crop was 60-30-30 kg NPK.ha^{-1}. This was applied at final harrowing, while, the remaining 40 kgN.ha^{-1} was top dressed in two equal splits i.e at active tillering and at panicle initiation stage. In ratoon crop, 40 kg N.ha^{-1} was applied in two equal splits, first at harvest of main crop as basal N and second at 20 days after harvest of main crop.

Water Management: Recommended water level 4-5 cm (flooded condition) was maintained in all plots after transplanting upto five days before harvesting. The plots were drained five days before the harvesting date. The first irrigation to ratoon crop was applied five days after harvest of main crop.

Harvesting the Main Crop: The main crop was harvested 30 days after heading and more specifically at the start of yellowing of culm (Saran and Prasad, 1952; Parago, 1963).

Ratoon Vigour: This was measured using the following scale:

1= Excellent growth (The plants were free from disease, insect pests and had 20 tillers).

5= Intermediate growth (The plants were free from disease, insect pest and possessed 10-20 tillers).

9=tillers were very small and weak, and were few in number at most 5.

Ratoon Rating: This Was Computed as Follows:

Ratoon Rating = (1-0.1 ratoon vigour)x 1 (Missing hills/plot)/(total hills/plot) x (Total tillers/hill/16)

Results and Discussion

Nodal and Basal Tillers, Missing Hills and Ratoon Rating: Analysis of variance for stubble cutting height showed significant differences for nodal and basal tiller formation at 30 Days After Harvest (DAH). The cutting height was equally effective irrespective of variety. The number of nodal tiller regeneration increased as cutting heights of the stubbles increased. The reason behind regeneration of nodal tillers at higher cuttings of stubbles was presence of more auxillary buds on the stubbles. The basal tillers at 30 DAH were found maximum at 10 cm stubble cuttings compared to 30 cm stubble cutting. Irrespective of growth period all the varieties produced maximum nodal tillers from higher nodes and basal tillers at ground level. This trend was observed in all the stubble cuttings above ground level. Thus, cutting height determines the origin of ratoon tillers (Sun Xiaohui *et al.*, 1988), while stubble height determines the number of buds available for regrowth. The results confirms the findings of Sun Xiaohui *et al.*, (1988) who observed the optimal to higher stubble cutting keep all buds with regrowth potential. It contradicted the report of Volkova and Smetanin (1971) which revealed that some varieties ratooned from high nodes, other produced basal ratoons that were unaffected by cutting height.

PR 23373-13	IR 54950-181-2-1-2-3	IR-59682-49-16-1-3	C 3563-B-5-1
IR 57311-95-2-3	PR 22909	PR 22378-848	PR 22892-235
PR 22186-446	PR 23364-13	IR 58082-126-1-2	PR 23352-7
C 3008-8-2-2-1-2	IR 5809941-2-3	IR 57298-31-2-2	PR 23468-1
IR 56381-139-2-2	MRC 23365-12	IR 66	IR 65
IR 62	IR 72	IR 36	IR 56
PSB Rc 8	IR 64	BPI Ri 12	BPI Ri 10
PSBRc 6	PSBRc 4		

Table 1: Nodal Tillers (30 Dah) of Different Varieties/lines as Affected by Varying Stubble Cutting Heights

VARIETY (V)	Stubble cutting heights			V-MEAN
	10 cm	20 cm	30cm	
PR 23373-13	12.83^{c-g}	12.18^{c-g}	11.52^{cde}	12.18
IR 54950-181-2-1-2-3	12.22^{c-h}	12.47^{c-g}	12.02^{cde}	12.24
IR 59682-49-16-1-3	12.94^{c-f}	13.20^{bcd}	12.64^{abc}	12.93
C 3563-B-5-1	11.37^{hij}	10.29^{ijk}	9.73^{g}	10.46
IR 57311-95-2-3	12.16'	9.25^{klm}	7.27^{ij}	9.56
PR 22909	13.16^{cde}	8.52^{lm}	7.87^{i}	9.85
PR 22378-848	11.83^{fgh}	12.77^{c-f}	12.48^{bcd}	12.36
PR 22892-235	12.01^{e-h}	10.67^{hij}	9.47^{gh}	10.72
PR 22186-446	11.95^{e-h}	11.39^{ghi}	11.68^{cde}	11.67
PR 23364-13	8.3^{lk}	6.75^{n}	6.42^{j}	7.16
IR 58082-126-1-2	12.98^{c-f}	11.29^{ghi}	8.39^{hi}	10.88
PR 23352-7	11.27^{hij}	6.46^{n}	6.12^{j}	7.95
C 3008-8-2-2-1-2	4.77^{l}	4.31^{o}	3.68^{k}	4.25
IR 5809941-2-3	11.64^{ghi}	11.79^{fgh}	11.41^{cde}	11.61
IR 57298-31-2-2	13.08^{c-f}	11.96^{d-g}	11.19^{ef}	12.07
PR 23468-1	10.29^{j}	9.91^{jk}	9.75^{g}	9.99
IR 56381-139-2-2	13.37^{bcd}	13.06^{cde}	11.58^{cde}	12.67
MRC 23365-12	12.37^{c-h}	11.83^{e-h}	10.16^{fg}	11.46
IR 66	12.75^{c-g}	12.10^{c-g}	11.69^{cde}	12.18
IR 65	12.99^{c-f}	12.33^{c-g}	10.23^{fg}	11.85
IR 62	9.16^{k}	8.66^{lm}	8.06^{i}	8.63
IR 72	13.04^{c-f}	12.25^{c-d}	11.67^{cde}	12.32
IR 36	10.58^{ij}	9.25^{klm}	8.41^{hi}	9.41
IR 56	11.25^{hij}	8.3^{lm}	6.41^{j}	8.66
PSBRC 8	15.46^{a}	14.23^{ab}	13.46^{ab}	14.38
IR 64	11.16^{hij}	9.67^{jkl}	9.56^{g}	10.13
BPI Ri 12	14.39^{ab}	11.48^{gh}	10.18^{fg}	12.02
BPI Ri 10	14.73^{a}	13.35^{abc}	13.33^{ab}	13.80
PSBRC 6	14.92^{a}	14.35^{a}	13.66^{a}	14.31
PSBRC 4	13.48^{bc}	12.29^{c-g}	11.39^{de}	12.38
C-Mean	12.08X	10.87Y	10.04Z	11.00

In a column, means followed by a common letter are not significantly different at the 5% level by DMRT.

Table 2: Basal Tillers (30 Dah) of Different Varieties/lines as Affected by Varying Stubble Cutting Heights

VARIETY (V)	Stubble cutting heights			V-MEAN
	10 cm	20 cm	30cm	
PR 23373-13	2.37^{def}	2.04^{def}	1.91^{bc}	2.11
IR 54950-181-2-1-2-3	2.75^{c}	2.00^{d-g}	1.87^{bcd}	2.24
IR 59682-49-16-1-3	2.37^{def}	2.21^{cd}	1.08^{g-j}	1.89
C 3563-B-5-1	3.12^{ab}	2.46^{bc}	2.12^{ab}	2.57
IR 57311-95-2-3	2.08^{fgh}	1.71^{f-i}	1.54^{def}	1.77
PR 22909	1.91^{ghi}	1.62^{hij}	1.37^{efg}	1.63
PR 22378-848	2.21^{efg}	1.71^{f-i}	1.08^{f-j}	1.66
PR 22892-235	2.49^{cde}	1.66^{g-j}	1.33^{e-h}	1.83
PR 22186-446	3.125^{ab}	1.56^{h-k}	0.77^{jk}	1.82
PR 23364-13	2.12^{fgh}	1.54^{h-k}	0 .71^{kl}	1.46
IR 58082-126-1-2	2.23^{efg}	1.81^{e-h}	1.19^{f-i}	1.74
PR 23352-7	2.64^{cd}	2.12^{de}	1.50^{ef}	2.09
C 3008-8-2-2-1-2	2.60^{cd}	1.87^{d-h}	1.04 $^{g-k}$	1.84
IR 5809941-2-3	2.00^{ghi}	0.91^{mn}	0.75^{jk}	1.22
IR 57298-31-2-2	2.41^{c-f}	2.08^{de}	1.66^{cde}	2.05
PR 23468-1	3.08^{b}	2.52^{bc}	1.92^{bc}	2.50
IR 56381-139-2-2	2.41^{c-f}	1.14^{lmn}	1.00^{h-k}	1.52
MRC 23365-12	2.70^{cd}	1.22^{klm}	0.93^{ijk}	1.62
IR 66	3.21^{ab}	2.91^{a}	2.12^{ab}	2.75
IR 65	3.29^{ab}	2.58^{ab}	1.85^{bcd}	2.57
IR 62	1.71^{ij}	1.33^{jkl}	1.29^{f-i}	1.44
IR 72	3.25^{ab}	2.71^{ab}	2.21^{f-i}	2.39
IR 36	1.29^{k}	0.87^{n}	0.41^{lm}	0.86
IR 56	2.25^{efg}	1.43^{i-l}	1.27^{f-i}	1.65
PSBRC 8	3.46^{a}	2.89^{a}	1.91^{bc}	2.75
IR 64	1.47^{jk}	0.37^{o}	0.29^{m}	0.71
BPI Ri 12	2.49^{cde}	1.41^{i-l}	1.12^{ghi}	1.66
BPI Ri 10	3.33^{ab}	2.54^{bc}	2.29^{a}	2.72
PSBRC 6	3.25^{ab}	2.46^{bc}	2.29^{a}	2.66
PSBRC 4	1.85^{hi}	1.12^{lmn}	0.93^{ijk}	1.30
C-Mean	2.52X	1.83Y	1.36Y	1.90

In a column, means followed by a common letter are not significantly different at the 5% level by DMRT.

Table 3: Missing Hills per Plots (30 Dah) of Different Varieties/lines as Affected by Varying Stubble Cutting Heights

VARIETY (V)	Stubble cutting heights			V-MEAN
	10 cm	20 cm	30cm	
PR 23373-13	35.67^{a-d}	31.67^{abc}	27.00^{d-l}	32.11
IR 54950-181-2-1-2-3	32.00^{a-e}	27.00^{b-g}	26.33^{e-j}	28.67
IR 59682-49-16-1-3	21.67^{hij}	18.67^{k}	16.67^{no}	19.00
C 3563-B-5-1	34.33^{a-d}	25.67^{e-h}	25.00^{f-k}	28.33
IR 57311-95-2-3	18.00^{jkl}	17.67^{k}	15.33^{o}	17.00
PR 22909	36.67^{a}	31.67^{abc}	27.67^{c-h}	32.00
PR 22378-848	34.67^{a-d}	31.67^{abc}	27.33^{d-l}	31.22
PR 22892-235	35.67^{ab}	27.33^{c-g}	24.33^{g-l}	29.11
PR 22186-446	22.33^{hij}	17.33^{k}	17.67^{mno}	19.11
PR 23364-13	27.67^{efg}	30.67^{bcd}	26.33^{e-j}	28.22
IR 58082-126-1-2	33.33^{a-d}	30.33^{b-e}	32.33^{abc}	32.00
PR 23352-7	25.00^{ghl}	25.00^{f-i}	30.67^{a-e}	26.89
C 3008-8-2-2-1-2	35.33^{abc}	29.67^{b-f}	35.00^{a}	33.33
IR 5809941-2-3	30.00^{def}	25.33^{f-i}	23.00^{h-l}	26.11
IR 57298-31-2-2	33.67^{a-d}	35.67^{a}	31.67^{a-d}	33.67
PR 23468-1	32.33^{a-e}	26.00^{d-h}	22.00^{j-m}	26.78
IR 56381-139-2-2	34.67^{a-d}	28.33^{b-g}	32.67^{ab}	31.89
MRC 23365-12	31.67^{b-e}	27.33^{c-g}	28.33^{b-g}	29.11
IR 66	22.00^{hij}	19.67^{jk}	20.00^{lmn}	20.55
IR 65	31.67^{b-e}	26.33^{d-h}	22.67^{i-l}	26.89
IR 62	20.67^{ijk}	24.67^{ghi}	26.33^{e-j}	23.89
IR 72	30.67^{cde}	32.33^{ab}	28.67^{b-g}	30.55
IR 36	23.67^{ghi}	20.67^{ejk}	23.00^{h-l}	22.44
IR 56	25.67^{fgh}	27.33^{c-g}	28.67^{b-g}	27.22
PSBRC 8	14.00^{l}	21.67^{h-k}	25.67^{f-k}	20.44
IR 64	24.33^{ghi}	23.67^{g-j}	21.33^{klm}	23.11
BPI Ri 12	16.33^{kl}	24.67^{ghi}	21.33^{klm}	20.78
BPI Ri 10	17.00^{kl}	18.67^{k}	21.00^{k-n}	18.89
PSBRC 6	16.33kl	19.67jk	21.00k-n	19.00
PSBRC 4	33.33^{a-d}	21.67^{h-k}	29.33^{b-f}	28.11
C-Mean	27.64X	25.62Y	25.28Y	26.18

In a column, means followed by a common letter are not significantly different at the 5% level by DMRT.

Table 4: Ratoon Vigor (30 Dah) of Different Varieties/lines as Affected by Varying Stubble Cutting Heights

VARIETY (V)	Stubble cutting heights			V-MEAN
	10 cm	20 cm	30cm	
PR 23373-13	5.00^{b}	5.00^{d}	5.00^{d}	5.00
IR 54950-181-2-1-2-3	5.00^{b}	5.00^{d}	5.00^{d}	5.00
IR 59682-49-16-1-3	5.00^{b}	5.00^{d}	5.00^{d}	5.00
C 3563-B-5-1	5.00^{b}	5.00^{d}	5.00^{d}	5.00
IR 57311-95-2-3	5.00^{b}	5.00^{d}	6.30^{c}	5.40
PR 22909	5.00^{b}	6.30^{c}	9.00^{a}	6.80
PR 22378-848	5.00^{b}	5.00^{d}	5.00^{d}	5.00
PR 22892-235	5.00^{b}	5.00^{d}	5.00^{d}	5.00
PR 22186-446	5.00^{b}	5.00^{d}	5.00^{d}	5.00
PR 23364-13	5.00^{b}	9.00^{a}	9.00^{a}	7.70
IR 58082-126-1-2	5.00^{b}	5.00^{d}	9.00^{a}	6.30
PR 23352-7	5.00^{b}	9.00^{a}	9.00^{a}	7.70
C 3008-8-2-2-1-2	9.00^{a}	9.00^{a}	9.00^{a}	9.00
IR 5809941-2-3	5.00^{b}	5.00^{d}	5.00^{d}	5.00
IR 57298-31-2-2	5.00^{b}	5.00^{d}	5.00^{d}	5.00
PR 23468-1	5.00^{b}	5.00^{d}	5.00^{d}	5.00
IR 56381-139-2-2	5.00^{b}	5.00^{d}	5.00^{d}	5.00
MRC 23365-12	5.00^{b}	5.00^{d}	5.00^{d}	5.00
IR 66	5.00^{b}	5.00^{d}	5.00^{d}	5.00
IR 65	5.00^{b}	5.00^{d}	5.00^{d}	5.00
IR 62	5.00^{b}	6.30^{c}	9.00^{a}	6.80
IR 72	5.00^{b}	5.00^{d}	5.00^{d}	5.00
IR 36	5.00^{b}	7.70^{b}	9.00^{a}	7.20
IR 56	5.00^{b}	7.70^{b}	9.00^{a}	7.20
PSBRC 8	5.00^{b}	5.00^{d}	5.00^{d}	5.00
IR 64	5.00^{b}	6.30^{d}	7.00^{b}	6.30
BPI Ri 12	5.00^{b}	5.30^{c}	5.00^{d}	5.00
BPI Ri 10	5.00^{b}	5.00^{d}	5.00^{d}	5.00
PSBRC 6	5.00^{b}	5.00^{d}	5.00^{d}	5.00
PSBRC 4	5.00^{b}	5.00^{d}	5.00^{d}	5.00
C-Mean	5.10Y	5.70X	6.20X	5.70

In a column, means followed by a common letter are not significantly different at the 5% level by DMRT.

Table 5: Ratoon Rating (30 Dah) of Different Varieties/lines as Affected by Varying Stubble Cutting Heights

VARIETY (V)	Stubble cutting heights			V-MEAN
	10 cm	20 cm	30cm	
PR 23373-13	0.42^{c-f}	0.40^{c-f}	0.38^{bcd}	0.40
IR 54950-181-2-1-2-3	0.42^{c-f}	0.41^{b-e}	0.40^{abc}	0.41
IR 59682-49-16-1-3	0.44^{cde}	0.45^{a-d}	0.40^{abc}	0.43
C 3563-B-5-1	0.41^{def}	0.37^{def}	0.33^{cde}	0.37
IR 57311-95-2-3	0.41^{def}	0.32^{f}	0.04^{f}	0.26
PR 22909	0.42^{c-f}	0.21^{g}	0.05^{f}	0.23
PR 22378-848	0.40^{d-g}	0.41^{b-e}	0.38^{bcd}	0.40
PR 22892-235	0.41^{def}	0.35^{ef}	0.30^{de}	0.35
PR 22186-446	0.44^{cde}	0.38^{c-f}	0.37^{cde}	0.40
PR 23364-13	0.30^{h}	0.04^{i}	0.03^{f}	0.13
IR 58082-126-1-2	0.42^{c-f}	0.37^{def}	0.05^{f}	0.28
PR 23352-7	0.39^{d-g}	0.04^{i}	0.04^{f}	0.16
C 3008-8-2-2-1-2	0.04^{i}	0.03^{i}	0.02^{f}	0.03
IR 5809941-2-3	0.39^{d-g}	0.37^{def}	0.35^{cde}	0.37
IR 57298-31-2-2	0.45^{cde}	0.39^{c-f}	0.36^{cde}	0.40
PR 23468-1	0.38^{d-h}	0.37^{def}	0.34^{cde}	0.36
IR 56381-139-2-2	0.44^{cde}	0.40^{cde}	0.35^{cde}	0.40
MRC 23365-12	0.43^{c-f}	0.37^{def}	0.31^{cde}	0.37
IR 66	0.46^{bcd}	0.43^{b-e}	0.40^{abc}	0.43
IR 65	0.46^{bcd}	0.42^{b-e}	0.35^{cde}	0.41
IR 62	0.32^{gh}	0.21^{g}	0.05^{f}	0.19
IR 72	0.45^{cde}	0.42^{b-e}	0.37^{cde}	0.41
IR 36	0.34^{fgh}	0.14^{gh}	0.04^{f}	0.17
IR 56	$.39^{d-g}$	0.13^{h}	0.04^{f}	0.18
PSBRC 8	0.56^{a}	0.51^{a}	0.45^{ab}	0.51
IR 64	0.37^{e-h}	0.21^{g}	0.28^{e}	0.29
BPI Ri 12	0.50^{abc}	0.37^{def}	0.33^{cde}	0.40
BPI Ri 10	0.54^{ab}	0.46^{abc}	0.46^{a}	0.49
PSBRC 6	0.54^{ab}	0.49^{ab}	0.46^{a}	0.50
PSBRC 4	0.43^{c-f}	0.39^{c-f}	0.35^{cde}	0.39
C-Mean	0.41X	0.33Y	0.27Z	0.34

In a column, means followed by a common letter are not significantly different at the 5% level by DMRT.

Table 6: Grain Yield (T/ha) of Different Varieties/lines as Affected by Varying Stubble Cutting Heights

Variety (v)	Stubble cutting heights			V-Mean
	10 cm	20 cm	30cm	
PR 23373-13	1.08^{kl}	0.60^{kl}	0.59^{i-l}	0.76
IR 54950-181-2-1-2-3	1.08^{kl}	0.55^{lm}	0.50^{klm}	0.71
IR 59682-49-16-1-3	1.20^{jk}	0.80^{ij}	0.68^{h-k}	0.89
C 3563-B-5-1	1.43^{i}	1.11^{h}	1.08^{g}	1.20
IR 57311-95-2-3	1.69^{gh}	1.32^{g}	0.61^{i-l}	1.20
PR 22909	1.01^{lm}	0.48^{lm}	0.21^{n}	0.57
PR 22378-848	1.88^{f}	1.34^{g}	1.02^{g}	1.41
PR 22892-235	1.66^{gh}	1.35^{g}	1.07^{g}	1.36
PR 22186-446	2.16^{e}	1.93^{d}	1.41^{de}	1.84
PR 23364-13	0.40^{n}	0.25^{n}	0.15^{n}	0.27
IR 58082-126-1-2	1.44^{i}	1.05^{h}	1.21^{fg}	1.23
PR 23352-7	0.48^{n}	0.39^{mn}	0.39^{m}	0.42
C 3008-8-2-2-1-2	0.40^{n}	0.26^{n}	0.15^{n}	0.27
IR 5809941-2-3	1.46^{i}	0.85i	0.71^{hij}	1.02
IR 57298-31-2-2	2.26^{de}	1.61^{f}	0.76^{hi}	1.54
PR 23468-1	1.37^{ij}	0.76^{ijk}	0.52^{j-m}	0.88
IR 56381-139-2-2	2.16^{e}	1.59^{f}	0.75^{hi}	1.50
MRC 23365-12	2.16^{e}	1.68^{ef}	1.17^{fg}	1.62
IR 66	2.53^{c}	1.97^{d}	1.05^{g}	1.85
IR 65	2.41^{cd}	1.40^{g}	1.03^{g}	1.61
IR 62	1.13^{kl}	0.79^{ijk}	0.81^{h}	0.91
IR 72	1.78^{fg}	1.35^{g}	1.27^{ef}	1.47
IR 36	0.96^{lm}	0.85^{i}	0.63^{h-k}	0.81
IR 56	1.51^{hi}	1.04^{h}	0.48^{klm}	1.01
PSBRC 8	3.05^{a}	2.86^{a}	2.00^{b}	2.64
IR 64	2.40^{cd}	1.29^{g}	1.16^{fg}	1.62
BPI Ri 12	2.71^{b}	1.81^{de}	1.51^{d}	2.01
BPI Ri 10	2.95^{a}	2.58^{b}	2.17^{a}	2.57
PSBRC 6	2.93^{a}	2.40^{b}	1.72^{c}	2.35
PSBRC 4	0.84^{m}	0.62^{jkl}	0.43^{lm}	0.63
C-Mean	1.68X	1.23Y	0.91Z	1.27

In a column, means followed by a common letter are not significantly different at the 5% level by DMRT.

Missing hills with respect to different cutting heights and variety were significantly different at 30 DAH. In most of the varieties, the number of missing hills decreased as the cutting height increased, but some varieties/lines showed reversed performance. The results agreed with the findings of Bahar and De Datta (1977) that main crop stubbles should be cut at 10-15 cm to minimize number of missing hills. Thus, 15 cm is the optimal cutting because low percentage of missing hills tend to offset relatively low number of ratoon tillers per plant at higher cutting height.

All the varieties at 30 DAH showed similar ratoon vigour except C3008- 8-2-2-1-2 line at 10 cm stubble cutting height and PR23364-13, PR23352-7, C3008-8-2-2-1-2, IR36 and IR56 at 20 cm stubble cutting height. The proportion of the varieties/lines with poor ratoon tiller growth was increased at 30 cm stubble cutting.

Ratoon rating was significantly different among the different varieties/lines at varying cutting heights at 30 DAH. varieties/lines showed their maximum ratoon rating at 10 cm stubble cutting due to maximum regeneration of tillers and ratoon vigour. Among the tested varieties/lines, PSB Rc8, PSB Rc6 and BPI Ri10 proved themselves efficient in ratoon rating. This result did not agree with the findings of Zhang Jing guo (1991) who reported optimum cutting height from 30 to 40 cm above ground. The present results showed 10 cm cutting height of stubble as effective for higher ratoon rating although Bardhan Roy and Mondal (1982) reported that cutting height did not significantly affect ratoon ability.

Grain yield: Grain yield had highly significant difference across the varieties/line, cutting heights and their interaction. Different tested varieties/lines had different yield potential considering vigour and ratooning ability. In all the varieties, grain yield significantly increased as the cutting height was decreased. However, among all varieties/lines evaluated, PBS RC8 had the maximum grain yield followed by BPI Ri10 and PSBRc6 when ratooned at 10 cm. The increase in yield was due to ratoon vigour and ratooning ability. Sun Xiaohui *et al.* (1988) reported that Aiyou 1 outyielded all the rest because of its wide adoptability and strong ratooning ability.

The possible reason behind maximum yield on 10 cm stubble cutting height might be the presence of vigorous tillers, which produced few, and short panicles, which did not contribute in boosting grain, yield. Furthermore, Calendacion *et al.* (1987) reported that a lower cutting height tend to increase grain yield. These researchers had also fully supported the results. But, Bardhan Roy and Mondal (1982) reported that stubble cutting heights did not significantly affect ratoon yields, whereas Andrade *et al* (1985) reported that cultivars at 10, 20 and 30 cm cutting heights yield best at higher cuttings (30 cm) which has a deviation from the results obtained.

Recommendations

The result of this study was the bases of the following advantages of ratoon culture of rice:

(i) Does not need land preparation, sowing or seeding/transplanting.
(ii) Requires minimum amount of fertilizer
(iii) Has short growth duration
(iv) Requires less labour and irrigation frequencies.

Therefore, the ratoon culture of rice is strongly recommended to increase cropping intensity and supplement yield potentials by 50%.Varietal characteristics are the most important consideration in determining the ratoonability, regrowth potential and ratoon yield. Based on the results of this study PSBRc8 and PBIRi10 are recommended to use in ratoon culture of rice and the stubble cutting height should be performed at 10 cm.

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