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Effect of Planting Methods on Lodging Reaction in Lowland Rice.

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Summary

This experiment was conducted at the IRRI experimental fram, Los Banos, Philippines to determine the effects of planting methods on lodging in rice, and to determine plant characteristics that induce lodging. Moderately lodging-susceptible IR36, lodging-susceptible line IR21820-3-2-2-3 and lodging-resistant IR8 and IR64 were tested.

Except in IR8, lodging resistance of all test rices was higher when transplanted than when broadcast-seeded. Transplanted rices yielded higher than did broadcast-seeded rices except with broadcast-seeded IR8. Yield reduction due to lodging varied from 0.6 to 1.5 t/ha.

Yield components and vegetative characteristics did not differ significantly between planting methods. However, higher culm K content was observed in transplanted rice, and it consequently increased lodging resistance. Phosphorus ans Si comtents did not significantly affect culm strength.

Introduction

The problem of lodging in cereals has received the attention of the plant breeders due to severity of damage caused to the crop and the consequant loss in yield and quality of the grain.

Grain yield considerably decrease when rice plants lodge during the ripening stage due to adverse environmental condition. The grain yield decrease is due to disturbance of the physiological activities and functions of the plants lodging, especially at arrest dry matter synthesis, uptake, and nutrient assimilation, thus significantly reducing yield.

Cultural practices such as high density seeding irrigation and time of sowing play an important role in bring about lodging.

Shallowness of planting, especially when the seed is broadcast, usually results in the root system having an in secure hold on the soil, such plants are readily suseceptible to lodging even under only slightly adverse environmetal conditions.

Several studies have been reported to determine the properties of biological materials.

Kobayashi and Washio(1976) reported that lodging resistance in hill-seeded and drill-seeded rice

plant is as strong as in transplanted rice plants, as long as sowing is not dense.

However, hill-seeded and drill-seeded rice plants have a greater degree of lodging under field conditions because of their short culms under the soil surface.

Mixed sowing under one row of alternate mixture affects productive structures more than under two rows of alternate mixture. Increased lodging resistance by mixed sowing is related to the improvement of light-receiving structures at the early ripening stage, through the maintenance of activities in the leaves and leaf sheath (Takaya and Honda, 1983).

According to Singh and Burkhardt(1974), shallowness of planting, especially when the seed is broadcast into water, usually results in a root system with poor anchorage, Such plants are readily susceptible to lodging even under only slightly adverse environmental conditions. To counteract this, Kanzaki and One(1969) recommened hill-pressing at early stages to enhance root development. Rice plants pressed with a crank-type implement produce many secondary root which spread vertically and widely on the surface soil during the later stage of growth. The supporting ability of rice plants increases due to the development of such roots.

The objective of this paper was to examine response of lodging at different rice varieties under different culture methods and study differences in lodging resintance among several rice Varieties and breeding lines.

Material and Methods

Experiment was conducted in IRRI in 1986 DS. A randomized complete block design with three replications was used. Each of the 24 plots (4×5m) consisted of 18 rows with 21 hills/row. Lodging-resistant IR8 and IR64, moderately lodging-susceptible IR36 and lodging-susceptible line IR21820−154−3−2−3 were used as the test varieties.

Seeds of IR8, IR36, IR64 and IR21820−154−3−2−3 at 50kg/ha were soaked, incubated for 48 hours then sown on well-prepared seedbeds. Seedlings were raised using the wet-bed methods.

Pregerminated seeds were broadcast uniformly on a raised bed of puddled soil. Twenty-one-day-old seedlings were transplanted at 2-3 seedlings/hill 5 days after the field was plowed and harrowed once. Single-plant hills were spaced 20×20cm apart.

For broadcast-seeded rice, pregerminated seeds at 100kg/ha were sown evenly on leveled plots after field preparation, which is similar to that in transplanted rice culture.

Nitrogen fertilizer as urea, P as superphosphate, and K as muriate of potash each at 60kg/ha were basal broadcast and incorporated(BB&I) using a power weeder. The remaining 30kg N/ha was top−dressed at panicle initiation(PI).

Plots were flooded to a 2 to 3-cm depth at 5days after trans-planting(DT) and maintained at 5cm until ripening stage. Drainage was imposed at 12 days before harvesting(DBH).

Thiobencarb(S-((4-chlorophenyl) methyl) diethyl carbamothioate) at 1.0kg ai/ha + 2, 4-D (2, 4-dichlorophenoxy acetic acid) at 0.5kg ai/ha was applied at 5DT for weed control. Hand weeding was done when necessary while insect and disease control were optimum.

Harvesting was done when more than 90% of the spikelets had ripened. Grains were harvested from a 5-m2 harvest area that was free from borer effects.

Grain yield was determined from 125 hills at the center of each plot and converted to tons per hectare at 14% moisture content.

Eight hills were sampled outside the 5-m^2harvest area to date mine yield components using the procedures described by Gomez (1972).

Four places, each measuring 0.08^2, were selected for plant sampling at harvest time. Stem and leaf dry weight, bending index degrees of lodging and nutrient.Composition were then measured. Bending index was measured with a spring scale and expressed as stress in grams needed to buckle the middle portion of a plant to 30° underfield conditions; wherein 0.1 bending index=100% pushing force, 1.0=1000g and so on. Degree of lodging was rated by visual scoring.

Plant height was measured at harvest from the base of the plant to the tallest panicle. Tillers were counted from 8 designated hills/plot and converted to tiller number per hill.

Percent N, percent P, percent K and percent Si were determined before harvest from plant samples collected outside the harvest and sampling areas.

Results and Discussions.

Lodging Reaction

The four varieties greatly differed in lodging resistance at both planting methods(Table 1). The lodging-resistant variety IR8 did not lodge at both planting method. IR64 lodged when broadcast-seeded but not when transplanted. On the other hand, the lodging-susceptible varieties generally showed more lodging whether transplanted or broadcast-seeded.

Shallow planting, especially with broadcast seeding into water, usually results in poor anchorage of the root system in the soil. This makes plants readily susceptible to lodging even under slightly adverse environmental conditions. Further broadcast seeding results in weak straw mainly due to etiolation. Etiolation is caused by insufficient light conse-

Table 1. Effect of transplanting and broadcast seeding on lodging of test rices. IRRI, 1986 DS.

VARIETY	LODGING(%)[a]	
	Broadcast Seeding	Transplanting
IR8	0 c	0 b
IR36	53 a	18 a
IR64	30 b	0 b
IR21820-154-3-2-3	60 a	8 ab

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

quently resulting in longer lower internodes with thin cells. The crop's stand when broadcast-seeded appeared to contribute to the crop's lodging.

Bending Resistance

In all test varieties, seeding method did not influence the force required to lodge the rice plants(Fig. 1). However, IR8 and IR64 showed higher bending resistance than did IR36 and IR21820-154-3-2-2-3 whether transplanted or broadcast-seeded. Bending resistance was directly correlated with the degree of lodging resistance which invloves not only culm strength but also culm elasticity.

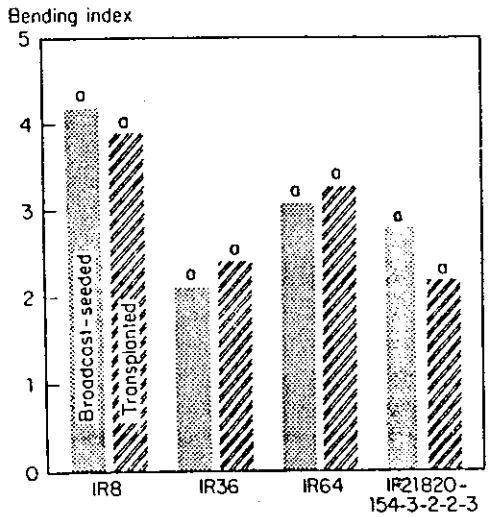

Fig. 1. Bending index of four rices as affected by planting method. IRRI, 1986 DS. Within a variety or line, bars with a common letter are not sighificantly different at the 5% level by DMRT.

Grain Yield

Grain yields were higher in transplanted than in broadcast-seeded rice except with lodging-resistant, brodcast IR8(Fig. 2) Yield reduction due to

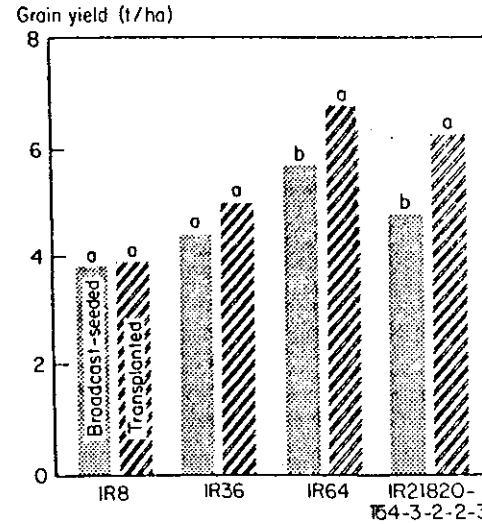

Fig. 2. Grain yield of four varieties as affected by planting method. IRRI, 1986 DS. Within a variety or line, bars with a common letter are not significantly different at the 5% level by DMRT.

lodging varied from 0.6 to 1.5 t/ha. This result suggests that broadcast seeding rice may result in increased grain yield if lodging is controlled either by proper cultural or chemical methods.

Roots of transplanted rice are suspected to penetrate deeper into the mud, thus absorbing more nutrients and increasing yield. Transplanted IR64 yielded 6.8 t/ha and 5.7 t/ha when broadcast-seeded, although Cia (1986) reported that IR64 yielded significantly higher when broadcast-seeded than when transplanted.

Lodging is one of the major constraints in direct seeding. Immer and Stevenson (1928) found yield and lodging to be highly correlated when other variables were held constant. Lodging resistance is higher with seeding at a 3-cm depth (Hitaka, 1968). However, germination and emergence from this depth are difficult because of oxygen deficiency. Moreover, the

number of culms per unit area tends to be larger with direct seeding, resulting in thinner culms which reduce lodging resistance.

Yield Components

Broadcasting IR21820-154-3-2-2-3 gave a lower percentage of filled spikelets than did transplanting, although the difference was not significant. No significant difference on the same trait was observed with the other varieties at both seeding methods (Figure 3)

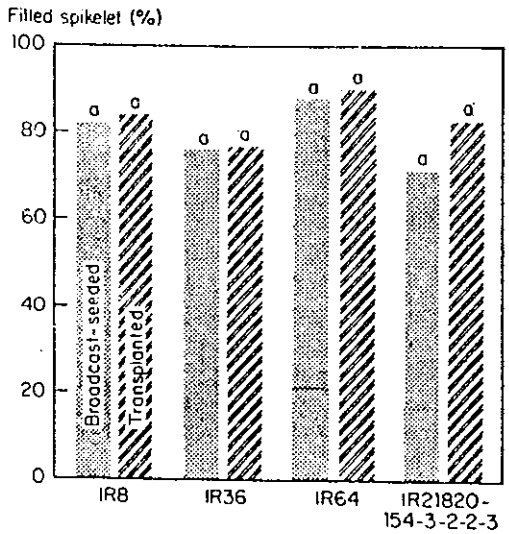

Fig. 3 Filled spikelet percentage of four rices as affected by planting method. Within a variety or line, bars with a common letter are not significantly different at the 5% level by DMRT.

Figure 4 shows a nonsignificant difference in panicle length between transplanting and broadcast seeding. However, difference was significant among varieties. IR21820-154-3-2-2-3 had the longest panicle (25 cm) while IR36 had the shortest.

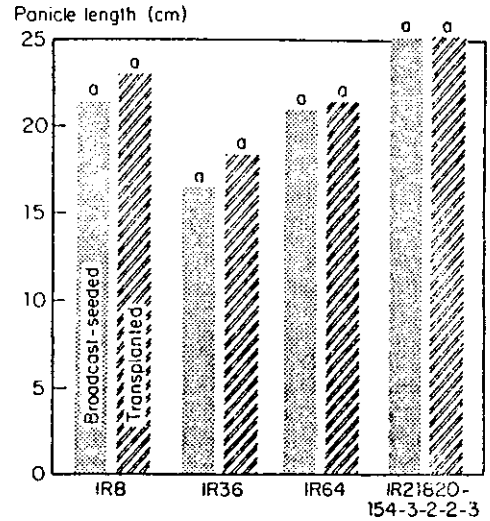

Fig. 4. Panicle length of four rices as affected by planting method. IRRI, 1986 DS. Within a variety or line, bars with a common letter are not significantly different at the 5% level by DMRT.

Likewise, panicle weight did not significantly differ among varieties except in IR36, where transplanting produced heavier panicles than did broadcast seeding (Figure 5).

Lodging was more frequent in varieties which produced heavy panicles than small panicles (Hashimoto and Masumoto, 1959). However, these data were obtained at harvest when plants lodged. This might have decreased panicle weight of broadcast-seeded rice.

Transplanting gave higher straw weights than did broadcast seeding (Figure 6). Verma(1965) reported that decreased straw yields are due to lodging, with the maximum reduction occurring at booting stage and the minimum at ripening stage. However, the reductions were not significantly different from those in the control plots.

At both seeding methods, only broadcast IR36

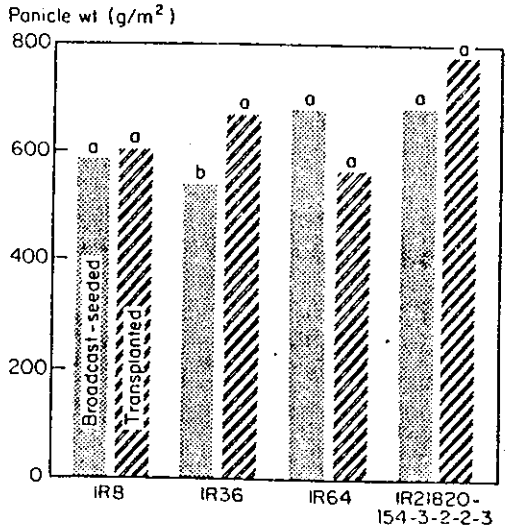

Fig. 5. Panicle weight of four rices as affected by planting method. Within a variety of line, bars with a common letter are not significantly different at the 5% level by DMRT.

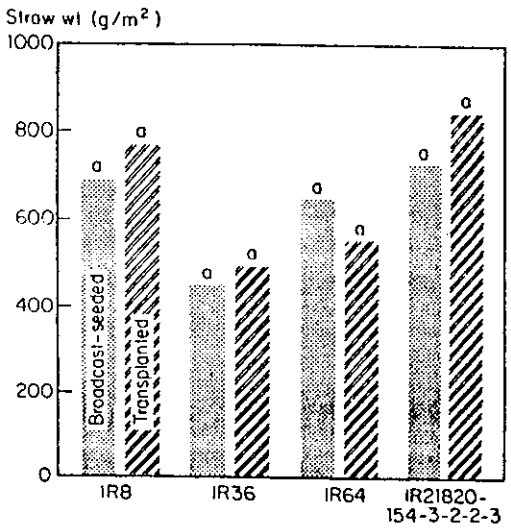

Fig. 6. Straw weight of four rices as affected by planting method. Within a variety or line, bars with a common letter are not significantly different at the 5% level by DMRT.

had a significantly lower 100-grain weight. The 100-grain weight of other varieties did not significantly differ when transplanted or broadcast-seeded(Figure 7).

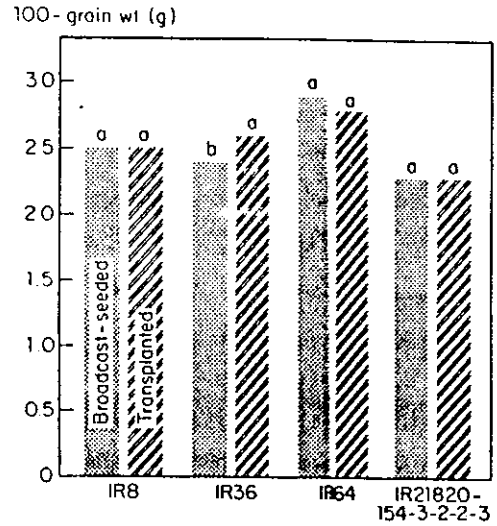

Fig. 7. 100-grain weight of four rices as affected by planting method. Within a variety or line, bars with a common letter are not significantly different at the 5% level by DMRT.

Generally, no significant differences in yield components were observed with both broadcast seeding and transplanting.

Vegetative Characteristics

Plant height at harvest differed among varieties (Figure 8), but not between the seeding methods. IR21820−154−3−2−2−3 plants were shorter when broadcast-seeded.

Plant height is related to lodging as it contributes to top weight and distance between the panicle and root system. Tall and top-heavy varieties may be-

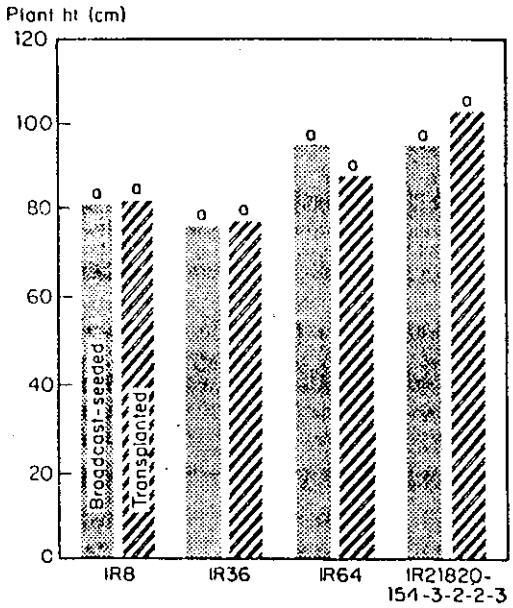

Fig. 8. Plant height of four rices as affected by planting method Within a variety or line, bars with a common letter are not significantly different at the 5% level by DMRT.

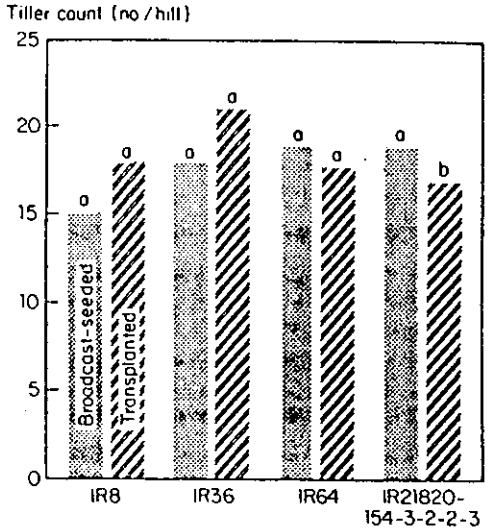

Fig. 9. Tiller count of four rices as affected by planting method. Within a variety or line, bars with a common letter are not significantly different at the 5% level by DMRT.

come susceptible to lodging in strong winds and other adverse environmental conditions. In this experiment, however, no correlation between plant height and lodging was observed. Ramiah and Dharmalingam (1934) and Harrington and Waywell (1950) also found no correlation between plant height and lodging in rice.

IR8 and IR36 had more tillers per hill when transplanted than when broadcast-seeded. Tiller number per hill for IR64 was not different between the two treatments, while IR21820−154−3−2−2−3 had high tiller number when broadcast-seeded than when transplanted (Figure 9).

The relationship of tiller number with lodging behavior of plants is still unclear. Early reports show no correlation between tillering and lodging although Malkani et al. (1959) obtained a negative but significant correlation between lodging and tiller number.

Nutritional Aspect

The relationship between nutritional status and lodging is essential since improper and imbalanced fertilizer application and inherent fertility variations in soil often lead to excessive lodging.

At harvest, IR8 and IR64 had a higher culm N content when transplanted than when broadcast-seeded. On the other hand, IR36 and IR21820−154−3−2−2−3 had higher culm N content when broadcast-seeded. IR21820-154−3−2−2−3 and IR8 and significantly different culm N contents between the two planting methods (Fig. 10)

These results agree with Shad (1983) that in susceptible varieties, total N uptake at the early stage is higher with direct seeding than with transplanting.

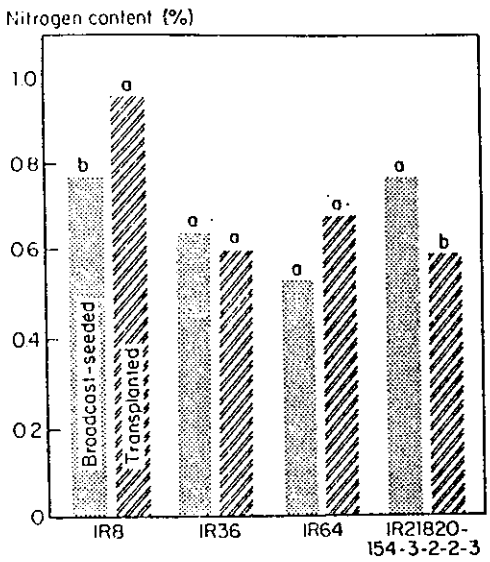

Fig. 10. Culm N content of four rices as affected by planting methods. IRRI, 1986 DS.
Within a variety or line, bars with a common letter are not significantly different at the 5% level by DMRT.

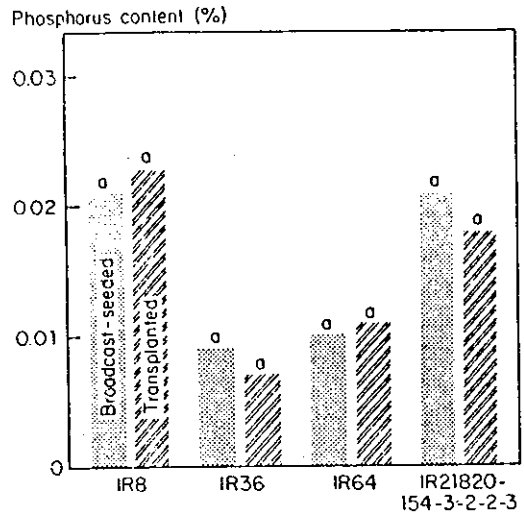

Fig. 11. Culm P content of four rices as affected by planting methods. IRRI, 1986 DS.
Within a variety or line, bars with a common letter are not significantly different at the 5% level by DMRT.

At PI, however, N uptake was similar in both methods.

Phosphorus content of IR8 and IR21820−154−3−2−3 was high regardless of planting method. No correlation was observed with P content and variety (Fig. 11).

Nampoothiri et al. (1968) reported that K content of the lower internode does not influence nature of lodging, but in this experiment, K generally had a consistent relationship with lodging. However, no significant difference in culm K content among varieties was observed (Fig. 12). IR36, IR64 and IR21820−154−3−2−2−3, had higher culm K content than IR8. Transplanted rices also had higher K content than broadcast-seeded rices.

In all varieties except for IR8, there was a high

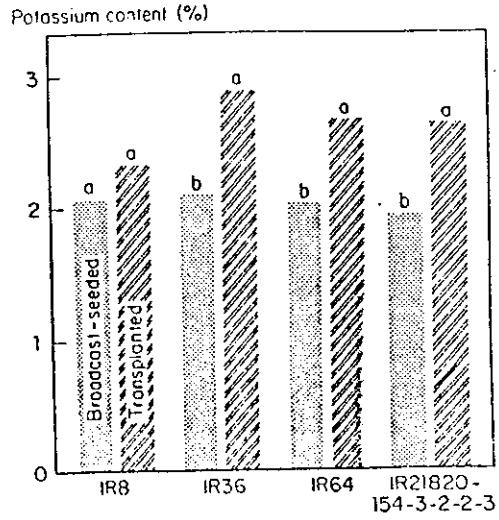

Fig. 12. Culm K content of four rices as affected by planting methods. IRRI, 1986 DS.
Within a variety or line, bars with a common letter are not significantly different at the 5% level by DMRT.

correlation between lodging and culm K content. This might be due to varietal differences, another factor which affects lodging.

In other cereal crops like barley and wheat, some authors observed higher K content in nom-lodging types (Tubbs, 1930; Philipps et al., 1936).

Culm Si content did not significantly differ between planting methods except in IR21820−3−2−2−3 (Figure 13).

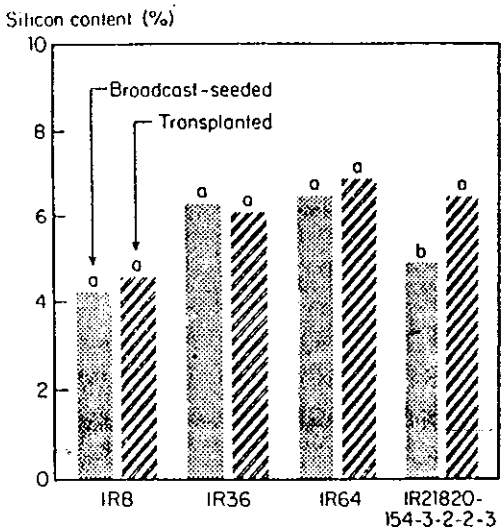

Fig. 13. Culm Si content of four rices as affected by planting method. Within a variety or line, bars with a common letter are not significantly different at the 5% level by DMRT.

IR36 and IR64 had higher culm Si content than IR8 and IR21820−154−3−2−2−3. Silicon accumulation in the leaves was higher in transplanted than broadcast-seeded rice (Figure 14).

Resistant varieties IR8 and IR64 did not significantly differ in leaf Si content at both seeding methods. Welton and Morris (1931) observed that maximum Si accumulation is in leaves, not in stems. Phillips et al. (1936) also associated lack of Si with lodging in wheat.

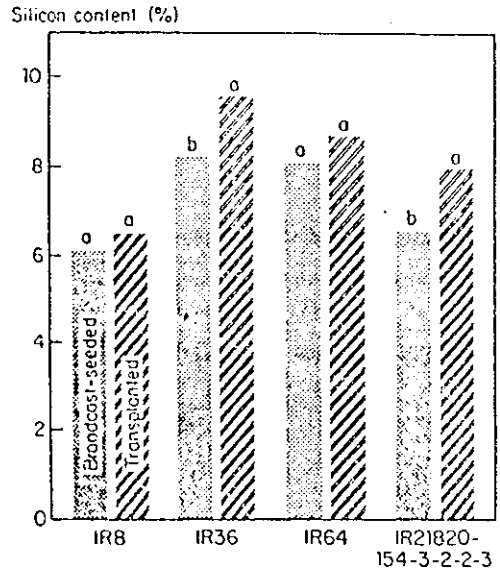

Fig. 14. Leaf Si content of four rices as affected by planting method. Withina variety or line, bars with a common letter are not significantly different at the 5% level by DMRT.

적 요

수도 주요 품종들의 재배방식에 따른 도복양상과 형질의 차이를 구명하기 위해 내도복성품종 IR8과 IR64중간정도의 내도복성을 나타내는 IR36 그리고 도복성품종인 IR21820−154−3−2−2−3를 공시하여 각 품종간에 도복을 유발시키는 형질간의 비교와 식물체의 구성성분을 조사하였던 바, 그 결과를 요약하면 다음과 같다.

IR8을 제외하고는 공시된 모든품종은 손이양재배가 산파재배한 것보다 도복저항상이 크게 나타났으며 수량에 있어서도 대체로 손이양재배에서 높게 나타났다. 산파재

배에 있어서 도복에 의한 수량손실은 손이앙에 비하여 0.6톤에서 1.5톤으로 품종에 따라 각각 수량이 감소되었다. 그러나 재배방식에 따른 수도의 생육변이와 수량구성요소는 차이를 보이지 않았으며 줄기내의 칼륨함량은 손이앙재배가 산파재배 보다는 높게 나타났는데 이것이 도복의 저항성을 증대 시킨 것으로 사료된다. 한편 인산이나 규산의 함량은 줄기의 강도를 증대시키는데 아무런 영향도 미치지 못하였다.

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