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ESTABLISHMENT OF DAPOG RICE SEEDLINGS AND GRAIN YIELD

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INTRODUCTION

For early seedling establishment of transplanted rice, seedlings must be healthy so that they produce new roots, leaves, and tillers fast. Little is known, however, about how early seedling establishment affects grain yields in the tropics. Early seedling establishment may insure a better plant stand but it does not necessarily insure high grain yields. For instance, vigorous seedling growth of a late maturing variety might lead to early mutual shading which results in lower yields. Thus for late maturing varieties, delayed growth during the early stages might even be beneficial during the wet season since it prevents early mutual shading. But, for varieties that have short growth durations, rapid seedling growth is necessary regardless of the cropping season.

The manner of growing the seedlings often determines how fast the seedlings will become established. When farmers grow their seedlings by ordinary wetbed nursery method the seedlings are usually transplanted into the fields when they are 1 to 2 months old. The leaves are severely pruned and the roots are badly damaged at the time of transplanting, resulting possibly in delayed establishment. Early seedling establishment does not seem necessary since the plants have more than enough time to recover. On the other hand, when farmers grow their seedlings by the "dapog" system, the seedlings are transplanted when they are only about 10 days old. In the dapog system seeds are allowed to germinate on a plain flat surface such as banana leaves or plastic film. Since no soil is used in the dapog bed the roots and leaves sustain little damage, hence the seedlings become established early. The dapog system cuts down the nursery period and shortens the time of recovery, so it may be better suited to varieties that have short growth durations.

At present, farmers in the Philippines using the dapog method transplant from two to 40 seedlings per hill. Planting many seedlings per hill gives better assurance of no missing hills and good seedling establishment.

Reports on transplanted rice culture, using the regular wetbed nursery, showed that the number of seedlings per hill has no appreciable effect on grain yield (Khan & Shafi 1956, Bredero 1964, Ahmed 1967, Tsunoda, Ishii & Machida 1971, and IRRI 1971). Although the dapog system is becoming more and more popular in Southeast Asia, there is no published information on the effect of various factors on seedling establishment using the dapog seedlings, and

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on the relationship between seedling establishment and grain yield.

MATERIALS AND METHODS

To prepare seeds for the dapog seedbed, they were soaked in water for 24 hours and then incubated for 48 hours. They were occasionally mixed so that the emerging radicles would grow uniformly. Before the end of incubation, we made a slightly raised seedbed. The surface of the seedbed was leveled, packed tightly, and covered with fresh banana leaves. The sides of the seedbed were bounded by banana leaf sheaths pinned to the bed with thin bamboo sticks. Polyethylene film or concrete beds may be used instead of banana leaves. The idea is to prevent the roots from penetrating the soil.

We sowed the germinated seeds at 1 kg/m^2 over the seedbed and sprinkled them with water. We splashed the germinated seeds with water and pressed them lightly with a wooden board every morning and afternoon for 5 days to keep the roots in contact with the banana leaves.

The seedlings were irrigated continually until they were ready for transplanting, or were 9 to 11 days old. They were protected from insects, especially leafhoppers, by spraying them with insecticides. At transplanting, the mass of seedlings was rolled like a carpet and brought to the field.

Compared with the conventional method, the dapog seedbed method saves 20 to 30 man-days per hectare (Pande and Mittra 1968). The dapog system has other advantages, too. Less root damage occurs, only a small area is needed to raise the seedlings, the costly operation of pulling the seedlings is eliminated, transport of the seedlings is simplified, leaf damage is minimized, and the nursery period is shortened.

Experiment 1. Variety x nitrogen x seedlings per hill – In the 1969 wet season we transplanted the 11-day-old seedlings from the dapog seedbed into field plots fertilized with 40 kg/ha each of P_2O_5 and K_2O and 0 or 80 kg/ha N. Three seedling rates were used: two, eight, and 16 seedlings per hill spaced at 25 x 25 cm. Seedlings shorter than 5 cm were excluded. All treatments were replicated twice with nitrogen as the main plot, and seedlings per hill as subplot. The varieties were randomized. Two semidwarf, medium tillering varieties were used: IR 532-1-218, a 100-day selection from the cross [Peta/2 x Taichung Native 1] x TKM-6, and IR 8, a variety that matures in 125 days.

We took samples periodically until harvest. We assessed seedling establishment on the basis of height, number of tillers per unit area, dry weight, leaf area index (LAI), light transmission ratio, and nitrogen content of leaves 30 days after transplanting.

Experiment 2. Variety x time of nitrogen application x spacing x seedlings per hill – In the 1969 dry season the same varieties and amount of P_2O_5 and K_2O were used as in the preceding experiment. Nitrogen application was 120 kg/ha 30 days after transplanting, or 60 kg/ha basally plus 60 kg/ha 30 days after transplanting, or 120 kg/ha basally. Two spacings were used: 15 x 15 cm and 30 x 30 cm with seedling rates of two and 20 seedlings per hill. The randomized complete block layout had nitrogen application as blocks. All treatments were replicated three times. We took samples as in the previous experiment.

RESULTS AND DISCUSSION

Experiment 1. Variety x nitrogen x seedlings per hill – We obtained better seedling establishment with more seedlings per hill and more nitrogen as indicated by increased plant height, tiller number per square meter, dry weight per square meter, LAI, and number of leaves per square meter and decreased light transmission ratio (Table 1). This result was the same for the two varieties used.

Although an increase in the number of seedlings per hill promoted earlier seedling establishment, it did not affect the grain yield of either variety (Table 2). The increase in number of panicles per square meter with the increase in seedlings per hill did not give higher grain yields because the number of spikelets per panicle decreased as the panicle number increased. The 1,000-grain weight and percentage of filled spikelets were not greatly affected by either the nitrogen level or the number of seedlings per hill.

Experiment 2. Variety x time of nitrogen application x spacing x seedlings per hill – As in the previous experiment, better seedling establishment was obtained with IR8 and the IR532 line with more seedlings per hill and more nitrogen as measured by number of tillers per square meter, number of leaves per square meter, LAI, and shoot weight per square meter. From the same criteria, closer spacing also gave better seedling establishment (Table 3).

The four parameters we used to measure seedling establishment are closely related. Since tiller number per square meter is the easiest to measure and is a non-destructive technique, it was used as the measure of seedling establishment. Tiller number per square meter is highly correlated with number of leaves per square meter ($r = 0.99$), LAI ($r = 0.97$), and shoot weight per square meter ($r = 0.96$).

Although the amount of basal nitrogen added and closer spacing promoted better seedling establishment, they did not greatly affect the grain yields of IR8 and the IR532 line, as long as the total amount of nitrogen applied was the same (Table 4). The difference in grain yield is relatively small compared to the difference in number of tillers per square meter at 30 days after transplanting (Fig. 1). More tillers produced more panicles per square meter at harvest. But, this increase was accompanied by a decrease in number of spikelets per panicle. The decrease in spikelets accounted for most of the failure of grain yields to increase. Such results had been observed previously in many rice varieties (IRRI 1967, Nishio *et al.* 1963).

The plants that received the same total amount of nitrogen during the cropping season showed little difference in grain yields regardless of the time of application of the fertilizer (Table 4). It has been reported many times before that a split application of nitrogen fertilizer does not give any consistent increase in grain yields (IRRI [1965], 1968). Our data show that the growth of the plant after seedling establishment rather than rapid seedling establishment is more critical in determining grain yields.

In all cases, grain yields decreased significantly with increased seedling rates in IR8. The high tillering rate of IR8 coupled with its longer growth duration resulted in lower grain yields with increase in number of seedlings per hill. Hoshino,

Kakimoto & Satake (1957) reported that high seedling number per hill can result in competition and mutual shading within a hill, and this could have happened with IR8 at high seedling rates. The increase in seedling rates did not cause differences in grain yield in the wet season experiment probably because the number of seedlings per hill and the nitrogen level used were not as high as in the dry season experiment.

For the IR532 line, increasing seedling rate generally did not improve grain yields significantly except when nitrogen was topdressed and no basal application was made. Since it is an early variety, the IR532 line should require more seedlings per hill under wide spacing but its vigorous tillering habit makes up for the low numbers of seedlings. Unlike IR8 its short growth duration lessens the severity of mutual shading.

For the IR532 line, if all of the nitrogen is applied basally, a lower seedling rate per hill gives higher yields. If the nitrogen is topdressed 30 days after transplanting, a higher seedling rate per hill gives higher yields. That shows the close relationship between nitrogen and rate of tillering. If the rate of tillering is slow because of low nitrogen, high seedling rates compensate for the slow tillering.

Our experiments show that increasing the number of seedling per hill improves seedling establishment but generally does little to increase grain yields; it may even decrease grain yields. Rates of 10 to 40 dapog seedlings per hill are not necessary. Two seedlings per hill are enough even if the nitrogen level is low or the growth duration is short. The smaller amount of seedlings actually needed lowers the cost of the dapog method.

ABSTRACT

Field experiments were conducted to study seedling establishment of transplanted rice. Seedlings were raised through the dapog seedbed method. Higher seedling rates, higher nitrogen levels in the soil, and closer spacing resulted in better seedling establishment. Seedling establishment was based on plant height, tiller number, dry weight, number of leaves, leaf area index, and light transmission ratio.

Seedling establishment was not correlated with grain yields. Therefore, when dapog seedlings are used, two seedlings per hill may be sufficient. Good plant growth after seedling establishment is more important than good seedling establishment in increasing grain yield.

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Table 1. Physio-morphological observations on seedling establishment taken 30 days after transplanting (wet season 1969).

N level (kg/ha)	Seedlings (no./hill)	Plant height (cm)	Tillers (no./m²)	Dry weight (g/m²)	Leaves (no./m²)	LAI	LTR (%)
			IR532				
0	2	40	235	31	740	0.47	82
	8	45	320	55	1170	0.83	64
	16	43	387	63	1440	0.94	42
80	2	50	486	93	1520	1.41	27
	8	54	682	137	2430	2.33	25
	16	58	891	178	3110	2.79	15
			IR8				
0	2	43	256	45	840	0.64	70
	8	44	331	67	1290	1.08	62
	16	45	378	79	1630	1.32	52
80	2	53	525	108	1710	1.61	24
	8	56	635	140	2260	2.31	20
	16	58	749	187	3000	3.34	19
LSD (0.01)	–	4	85	21	229	0.33	16

Table 2. Yield and yield components of plots with different numbers of seedlings per hill (wet season 1969).

Nitrogen level (kg/ha)	Seedlings (no./hill)	Grain yield (t/ha)	Filled spikelet (%)	Spikelets (no./panicle)	Panicles (no./m²)	1,000-grain weight (g)
			IR532			
0 N	2	4.2	88	97	221	24.5
	8	4.0	87	79	230	24.9
	16	3.9	88	62	299	25.0
80 N	2	5.6	71	91	288	25.8
	8	5.5	84	72	317	25.5
	16	5.6	82	66	387	25.4
			IR8			
0 N	2	5.0	90	106	190	26.2
	8	5.1	89	83	235	26.2
	16	4.8	87	79	280	25.4
80 N	2	6.3	88	94	318	25.9
	8	6.3	91	82	296	26.5
	16	6.0	89	76	334	26.6

Grain yield – LSD (0.01) = 0.8

Table 3a. Seedling characters of IB532 30 days after transplanting (dry season, 1971).

Nitrogen	Spacing (cm)	Seedlings (no./hill)	Height (cm)	Tillers (no./m²)	Leaves (no./m²) (1 × 10³)	LAI	Shoot (wt./m²)
0–120	15 × 15	2	48 fg	364 f	16 ef	1.47 fg	94 ef
		20	46 g	893 c	34 c	2.75 cd	160 d
	30 × 30	2	50 f	196 h	7 h	0.58 h	38 h
		20	50 f	354 f	15 efg	1.20 gh	65 gh
60–60	15 × 15	2	57 de	569 d	23 d	2.25 de	156 d
		20	59 cd	1155 b	49 b	4.85 b	284 b
	30 × 30	2	54 e	291 g	10 gh	0.80 h	55 gh
		20	59 cd	468 e	20 de	1.89 ef	155 e
120–0	15 × 15	2	61 bc	795 c	32 c	3.32 c	197 c
		20	68 a	1444 a	62 a	6.93 a	376 a
	30 × 30	2	57 de	346 fg	11 fgh	1.13 gh	71 fg
		20	64 b	591 d	25 d	2.77 cd	160 d

Any two means followed by the same letter are not significantly different at 5 percent level.

Table 3b. Seedling characters of IR8 30 days after transplanting (dry season, 1971).

Nitrogen	Spacing (cm)	Seedlings (no./hill)	Height (cm)	Tillers (no./m²)	Leaves (no./m²) (1 × 10³)	LAI	Shoot (wt./m²)
0–120	15 × 15	2	46 d	396 f	16 fg	1.47 fg	91 ef
		20	40 e	991 c	38 c	2.50 de	138 d
	30 × 30	2	45 d	173 h	6 h	0.41 i	26 h
		20	48 d	297 g	12 g	1.10 gh	56 gh
60–60	15 × 15	2	53 c	547 e	21 de	2.16 ef	135 d
		20	56 c	1231 b	50 b	5.30 b	273 b
	30 × 30	2	53 c	268 g	9 gh	0.82 i	46 gh
		20	55 c	460 f	19 f	1.74 fg	104 e
120–0	15 × 15	2	62 b	720 d	28 d	3.17 c	183 c
		20	66 a	1538 a	68 a	6.57 a	322 a
	30 × 30	2	55 c	310 g	10 f	0.93 hi	65 fg
		20	60 b	601 e	25 de	2.83 cd	146 d

Any two means followed by the same letter are not significantly different at 5 percent level.

Table 4. Grain yield of IR532 and IR8 planted at different spacings, seedlings per hill, and nitrogen application (dry season, 1971).

Spacing	Seedlings (no./hill)	Nitrogen application (kg) 0–120	60–60	120–0	LSD (.05)
		IR532			
15 x 15	2	7.5	8.2	8.0	0.7
	20	8.1	7.8	7.2	0.7
30 x 30	2	7.2	7.7	7.9	0.7
	20	8.2	7.6	7.4	0.7
		IR8			
15 x 15	2	8.4	8.9	8.5	0.7
	20	6.6	7.4	7.4	0.7
30 x 30	2	7.9	8.0	8.2	0.7
	20	7.3	7.4	7.3	0.7
LSD (.05)		0.6	0.6	0.6	

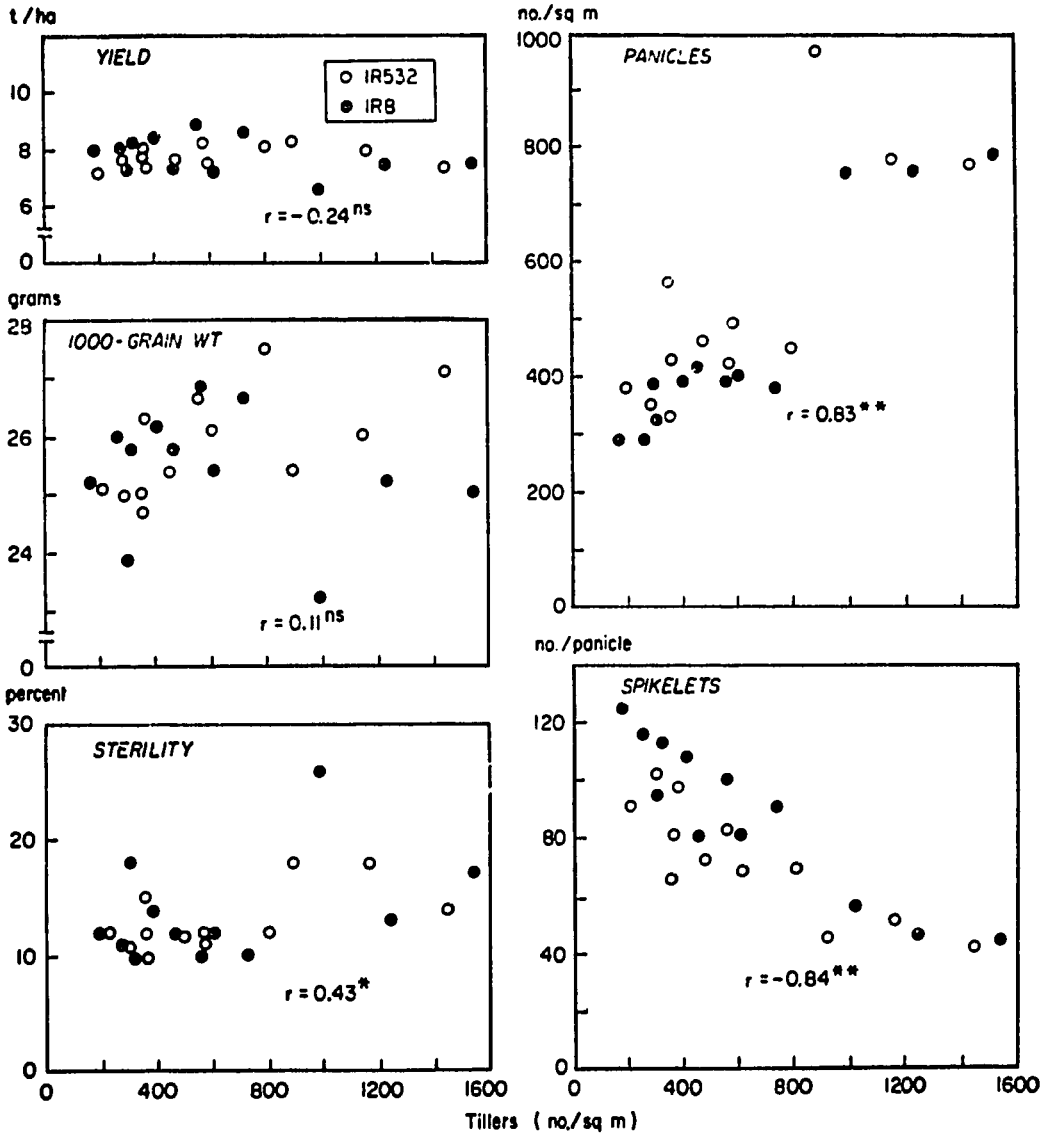

Fig. 1. Seedling establishment of IR8 and IR532 (tiller number 30 days after transplanting) in relation to grain yield and yield components.