Technical Report No. SP－1

EXPERIMENT and TRAINING ACTIVITIES REPORT

1979-1985

DR. TETSUJIRO SUGAHARA

SUPHAN BURI EXPERIMENT AND TRAINING CENTER

MARCH 1985

THAI IRRIGATED AGRICULTURE DEVELOPMENT PROJECT

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JAPAN INTERNATIONAL COOPERATION AGENCY

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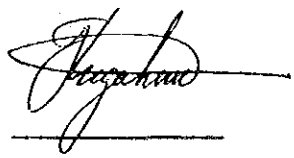
PREFACE

Suphan Buri Experiment and Training Center under Department of Agriculture is one of the three-sub-projects of Irrigated Agriculture Development Project. The main building of Suphan Buri Experiment and Training Center was granted by the Japanese Government. The official opening ceremony of this center was held on March 10th, 1979 and this project is going to close at the end of March, 1985.

Suphan buri Experiment and Training Center has given various trainings to government officers, farmers and students concerning irrigated rice cultivation and carried out the research works for increasing rice yield as well as income of farmers by means of multi-cropping and integrated farming.

Sugahara, one of the authors, was dispatched by Japan International Cooperation Agency on August 31st, 1978 to March 31st, 1985.

This report is the results from the field experiments and training activity works which have been carried out with Thai staff since March 1979 upto March 1985.



T. SUGAHARA

Suphan Buri Experiment and Training Center

March 1985

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Exp. 1

Experiment and Research Record

Annual for year 1979

Experiment of different Mat soil and Fertilizer for box seedling.

Tetsujiro SUGAHARA

and

Vichien SASIPRAPA

Experiment of different Mat soil and Fertilizer for box seedling.

This experiment was carried out in order to find out adaptable mat materials and fertilizer application for rice planter seedling on heavy clay soil in Thailand.

I. Materials and methods.

1. Variety : RD 7 Sowing : 21st March 1979.

2. Seed rate : 130 gm. dry seed/box. (box size 58cm×28cm×3cm)

3. Treatment : Completely Randomized Design 2 replications with 24 treatment

Fertilizer \ Mat soil	Soil	Black ash	Compost	mixed S × B	mixed S × C	mixed B × C
No	S-0	B-0	C-0	SB-0	SC-0	BC-0
Basal only	S-B	B-B	C-B	SB-B	SC-B	BC-B
Top only	S-T	B-T	C-T	SB-T	SC-T	BC-T
Basal & Top	S-BT	B-BT	C-BT	SB-BT	SC-BT	BC-BT

Mixed rate ; 1:1

Basal ; Ammophos 3 gm/box. (N = 0.48, P = 0.6 gm.)

Top dressing ; Urea 1.04 gm/box. (N = 0.48 gm.)

Top dressing supply one week after sowing.

4. Investigation.

1) One week after sowing : leaf age and plant height for 10 seedlings.

2) Two weeks after sowing : leaf age and plant height for 20 seedlings.

: New root test for 10 seedlings. * (Block I only.)

3) 20 days after sowing : Leaf age and plant height for 20 seedlings.

: Dry top weight for 30 seedlings.

: New root test for 10 seedlings.

: Observe leaf color.

* Counting number of new root and length of the longest root at 6 days diped in water after cutting old root.

5. General Management :

Seed rate/box : 130 gm. dry seed weight after selection.

Soaking and Disinfection : 12 hours with Ceresan solution (1 gm/ 1 Kg.seed).

Incubation : 24 hours at temperature. (30-35 c)

II. Result.

1. Plant height.

The plant height as shown in table 1 and table 7.

Among different fertilizer treatments, basal and top dressing box was the highest, basal or top dressing only were medium and the lowest was non fertilizer plot.

Among different mat materials, mixed soil plots were better than single soil plots and especially soil alone, the plant height was clearly low.

2. Leaf age.

The leaf age was shown in table 2 and table 8

Among different fertilizer treatments, basal and top dressing plot was the most progress of leaf development, the next was only top dressing or only plots, the least progress was non fertilizer as same as the plant height at 2 weeks stage after sowing, however no significant difference at 20 days after sowing.

For different mat materials, compost only or compost mixed soil was more progress than other soils and the least progress was the only soil plot.

3. Recovering development of new root

New root recovering as indicator of rooting ability was shown in table 3 and table 9.

Non fertilizer plant was the most development of new roots and the least was basal and top dressing one.

Among mat materials, only soil plot was the most development of new root recovering, the next was mixed soil plots but the balck ash, compost and balck ash mixed with compost plots were very poor in development.

4. Dry matter of top plant. (table 4)

Mixed soil plots were heavier in weight than other plots.

Among the fertilizer plots, the difference was not clear.

5. Leaf color. (table 5)

Leaf color was determined by visual score.

Among mat materials, leaf color was very much defferent. Only soil and mixed soil plots were always green while the other plots werw yellow from the period of one week to 20 days after sowing.

6. Growth uniformity of seedling. (table 6)

Uniformity growth is very important for transplanter.

Only soil and mixed soil plots were more uniform in plant growth than other fertilizer supplied plots.

III. Discussion

Suitable seedlings for the Japanese rice planter machine are 15-25 cm in height, 3-3.5 leaf age. Uniformity growth and strong seedling is better.

1. The plots those satisfied the mention above seem to be the soil mixed with black ash and the soil mixed with compost plots. For seedlings grow uniformity, leaves were always green and the plant height is about 15-20 cm in the last stage, and development of new root recovery is much more than other plots.
2. The only soil plot (clay soil) is also suitable for the rice planter machine. Although the seedlings grow uniformity, leaves are green and new root recovery is the best but the plant height is too short only 11-14 cm.

Owing to the condition of the clay soil, it will be contracted or expanded by the quantity of moisture in the soil. it is necessary to irrigate many times a day and to adjust mat moisture before machine operation time.

3. The only black ash, only compost and black ash mixed with compost plots seedling was appeared in the yellowish leaves since the initial time to the last stage. It seems to be the nitrogen deficiency, so that the new recovered root was very poor, seedlings were very soft and not uniformity in growth. These plots were not suitable for rice planter machine.

Conclusion

The mat soil mixture between soil and Carbon husk at the ratio of 6:4 is the best material in raising of seedling in box for transplanter.

The application of fertilizer in the box-seedling for transplanter seems to be not necessary, because even the growth of seedling were good when supplying fertilizer, the recovering of new root after planting are poorer than non-fertilizered.

Table 1 Plant-height

After sowing	Mat / Fertilizer	S	B	C	SB	SC	BC	F test Significant
one week	0	6.0	5.8	6.8	6.8	6.9	6.3	5 % among Mat.
	B	7.5	7.1	6.9	9.1	9.3	7.1	1 % between Fertili
two weeks	0	9.4	11.5	11.9	11.2	11.2	11.1	
	B	10.0	11.6	12.4	13.1	14.2	12.8	1 % among Mat,
	T	10.2	11.8	12.8	12.1	13.7	12.4	Fertilizer.
	BT	12.1	12.1	13.6	15.1	15.4	15.5	
20 days	0	11.1	15.2	15.7	13.5	15.0	13.7	
	B	11.2	15.2	16.2	15.6	17.6	16.0	1 % among Mat,
	T	11.6	14.8	15.8	16.2	17.0	14.6	Fertilizer.
	BT	13.7	14.7	16.6	17.8	20.7	17.0	

Table 2 Leaf age.

After sowing	Mat / Fertilizer	S	B	C	SB	SC	BC	F test Significant
one week	0	1.5	1.8	2.0	1.7	1.7	1.9	5 % among Mat.
	B	1.8	1.9	2.0	2.0	2.0	2.0	1 % between Fertili
two weeks	0	2.2	2.7	2.9	2.5	2.5	2.7	
	B	2.2	2.9	2.9	2.6	2.9	3.0	1 % among Mat,
	T	2.4	2.9	3.0	2.9	2.8	2.8	Fertilizer.
	BT	2.6	3.0	3.0	2.9	3.0	3.0	
20 days	0	3.0	3.1	3.2	3.2	3.0	3.2	
	B	2.9	3.0	3.1	3.1	3.0	3.2	1 % among Mat.
	T	2.9	3.2	3.3	3.2	3.0	3.1	no significant amo
	BT	3.0	3.1	3.2	3.1	3.1	3.4	Fertilizer.

Table 3 Recover new root (Number × Length per seedling).

After sowing	Mat / Fertilizer	S	B	C	SB	SC	BC	F test Significant
two weeks	0	15.1	4.0	2.9	13.9	13.1	3.5	
	B	14.9	4.0	5.9	18.7	17.8	2.9	No replication.
	T	15.3	5.2	1.6	11.0	14.5	0.5	
	BT	18.9	1.0	1.9	17.4	15.0	1.4	
20 days	0	18.0	5.5	1.0	13.4	14.6	1.3	
	B	16.9	2.9	1.0	15.3	7.9	0.6	1 % among Mat,
	T	18.3	0.6	0.4	5.8	6.9	0.1	Fertilizer.
	BT	13.6	0.6	1.3	7.8	1.1	0.2	

Table 4 Top dry weight (mg. per seedling).

After sowing	Mat / Fertilizer	S	B	C	SB	SC	BC	F test Significant
20 days	0	15.7	13.9	14.0	15.9	16.8	14.5	
	B	14.7	14.4	15.7	18.7	18.0	14.9	1 % among Mat,
	T	15.4	15.0	15.0	16.0	18.0	13.5	Fertilizer.
	BT	17.7	14.0	16.0	21.0	19.5	15.3	

Table 5 Leaf colour.

After sowing	Mat Fertilizer	S	B	C	SB	SC	BC	Note
one week	0	G	Y	Y	G	G	Y	G = Green
	B	G	Y	Y	G	G	Y	LY = Slightly yellow
20 days	0	G	LY	Y	G	G	Y	Y = Yellow
	B	G	LY	YY	G	G	LY	YY = Heavy yellow
	T	G	Y	YY	G	G	YY	
	BT	G	YY	YY	G	G	YY	

Yellow colour seem to nitrogen deficiency.

Table 6 Growth uniformity.

After sowing	Mat Fertilizer	S	B	C	SB	SC	BC	Note
20 days	0	yes	me	me	yes	yes	me	yes = Uniformity
	B	me	yes	no	me	me	me	me = Medium
	T	me	me	me	yes	yes	no	no = Not uniformity
	BT	yes	no	no	yes	me	no	

Table 7 Group comparison of the plant height (Duncan's Multiple Range Test).

1) Plant height on main effect comparisons of mats ;

2 weeks after sowing		20 days after sowing	
plot	height(cm.)	plot	height(cm.)
SC	13.59	SC	17.54
BC	12.94	C	16.04
SB	12.85	SB	15.70
C	12.63	BC	15.30
B	11.78	B	14.96
S	10.41	S	11.88

2) Plant height on main effect comparisons of fertilizer ;

2 weeks after sowing		20 days after sowing	
plot	height(cm.)	plot	height(cm.)
BT	13.95	BT	16.71
B	12.35	B	15.27
T	12.13	T	14.95
0	11.03	0	14.02

Table 8 Group comparison of the leaf age (D.M.R.T.).

1) Leaf age on main effect comparisons of mats ;

2 weeks after sowing		20 days after sowing	
plot	leaf age	plot	leaf age
C	2.95	BC	3.21
BC	2.85	C	3.15
B	2.84	SB	3.11
SC	2.76	B	3.06
SB	2.71	SC	3.01
S	2.32	S	2.91

2) Leaf age on main effect comparisons of fertilizer ;

2 weeks after sowing		20 days after sowing	
plot	leaf age	plot	leaf age
BT	2.88	BT	3.13
T	2.78	O	3.08
B	2.72	T	3.08
O	2.58	B	3.03

no significant

Table 9 Group comparison of new root (D.M.R.T.).

1) Number x length of new root on main effect comparisons of mats ;

20 days after sowing

plot	
S	23.56
SB	10.55
SC	7.60
B	2.39
C	0.91
BC	0.50

2) Number x Length of new root on main effect comparisons of fertilizer ;

20 days after sowing

plot	
O	8.94
B	7.42
T	5.32
BT	4.08

Exp. 2

Experiment and Research Record

Annual for year 1979

Effect on Different Planting Times on Growth and Yield of R.D.7

Tetsujiro SUGAHARA

and

Vichien SASIPRAPA

This experiment was carried out for investigation on the effect of seasonal change on the growth, yield and components of less-sensitive rice variety R.D.7 at 15 days planting interval planted by transplanting machine. At the same time was used as the material for training pruposes for trainees and visitors to have a good chance to observe the growth of rice plant at different stage of growth from seedling up to ripening stage at that moment.

Experiment method:

1. Variety:R.D.7
2. Seed rate: 130 g./box (as dry seed)
3. Seed mat materials: black ash or husk: paddy soil 4 mixed.
4. Method of transplanting: using of rice transplanter.
5. Times of planting: 15 days interval

   1st—26 June - last 28 December (13 times)
6. Seedling age: 15 days.
7. fertilizer applied: 9-6-0 kg./rai

   1st—application 1 week after transplanting (1.6-2-0)

   2nd " 2 " " " (3.2-4-0)

   3rd " 40 days " " (4.2-0-0)

8. Weed control: 4 days after transplanting with Saturn G (4 kg./rai)

9. Insect control: Furadan applied at

1st	7	days after	transplanting	3	kg./rai
2nd	35	"	"	"	"	4	"
3rd	60	"	"	"	"	4	"

plus spray insecticide if necessary

10. Plot size: total 4,800 m^2, each plot 600 m^2 single design

1st crop	2nd crop
No. 1	No. 9
No. 2	No. 10
No. 3	No. 11
No. 4	No. 12
No. 5	No. 13
No. 6	-
No. 7	-
No. 8	-

Result

Date of growth

	Treatment no.	Sowing	Transplanting	Heading	Harvest	Note
1st crop	1	11 Jun.	26 Jun.	-	12 Oct.	Bird damage
	2	27 Jun.	11 July	-	-	" "
	3	11 July	26 July	7 Oct.	9 Nov.	Cover net
	4	26 July	10 Aug.	21 Oct.	23 Nov.	" "
	5	10 Aug.	24 Aug.	6 Nov.	11 Dec.	" "
	6	24 Aug.	10 Sep.	24 Nov.	24 Dec.	" "
	7.	10 Sep.	25 Sep.	12 Dec.	10 Jan.	
	8	25 Sep.	11 Oct.	24 Dec.	28 Jan.	
2nd crop	9	10 Oct.	25 Oct.	15 Jan.	12 Feb.	
	10	26 Oct.	9 Nov.	1 Feb.	27 Feb.	
	11	9 Nov.	28 Nov.	16 Feb.	11 Mar.	Cover net
	12	23 Nov.	11 Dec.	29 Feb.	26 Mar.	Cover net, Rat damage
	13	12 Dec.	28 Dec.	14 Mar.	7 Apr.	" "

Yield and Yield Components

No.	Hills/m^2	Panicles/m^2	Spiklets/panicle	Ripen %	weight of 1,000 grains	yield rai(kg)	ha	
1			Bird damage					
2			Bird damage					
3	20.5	203	109	70	29	710	4438	
4	21.5	172	119	74	28	668	4175	
5	21.1	215	117	62	27	692	4325	1st crop
6	19.5	261	80	63	26	553	3456	
7	20.1	320	78	65	26	657	4106	
8	19.8	275	72	65	26	526	3288	
9	22.0	224	69	73	26	473	2956	
10	19.2	257	68	71	24	479	2994	
11	20.5	250	76	75	27	612	3825	2nd crop
12	22.8	262	76	68	25	537	3356	
13	21.3	200	74	70	26	428	2675	

Sample number is 100 hills at each plots.

YIELD - COMPONENT OF DIFFERENT PLANTING DATE (R.D.7)

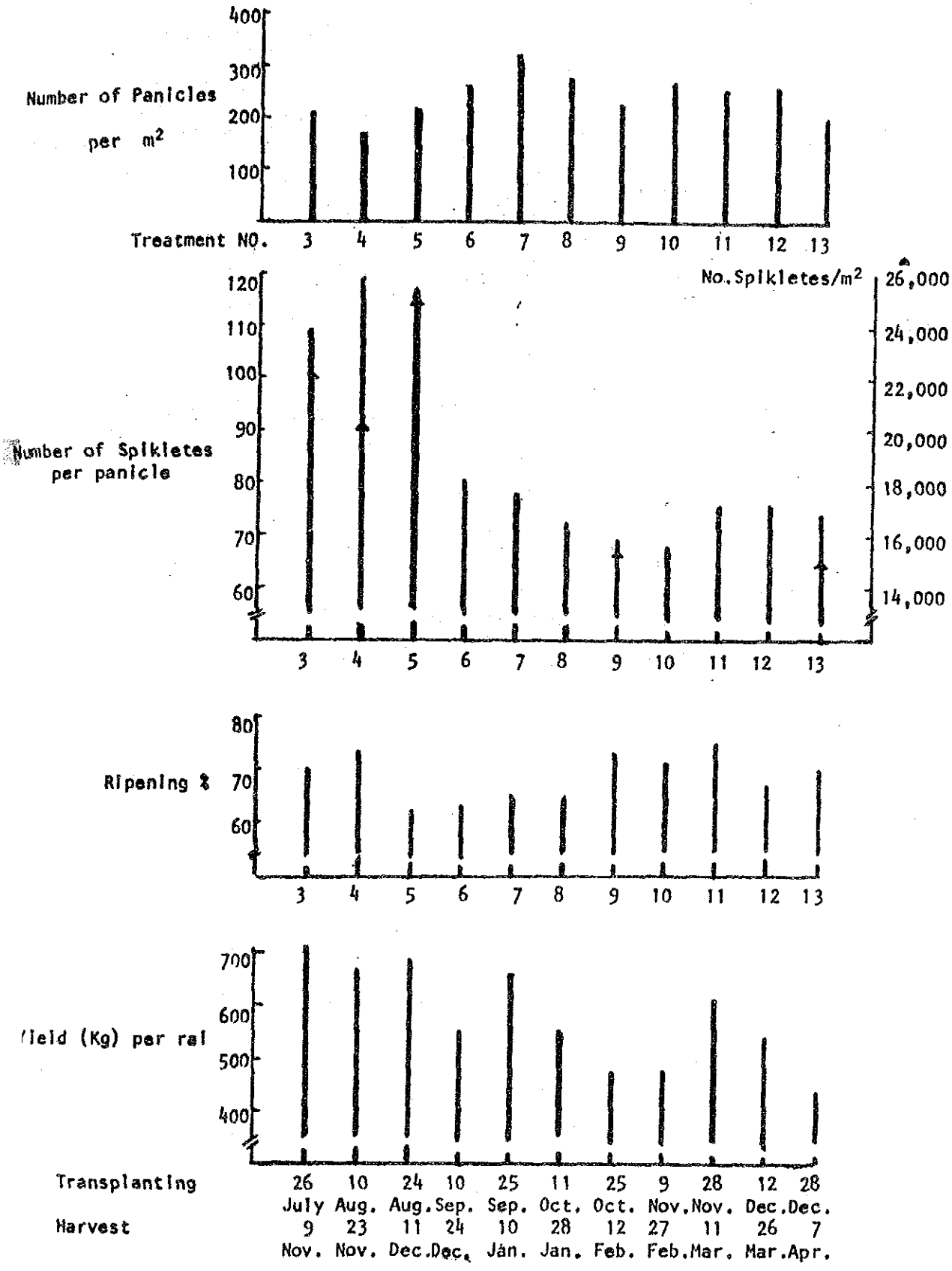
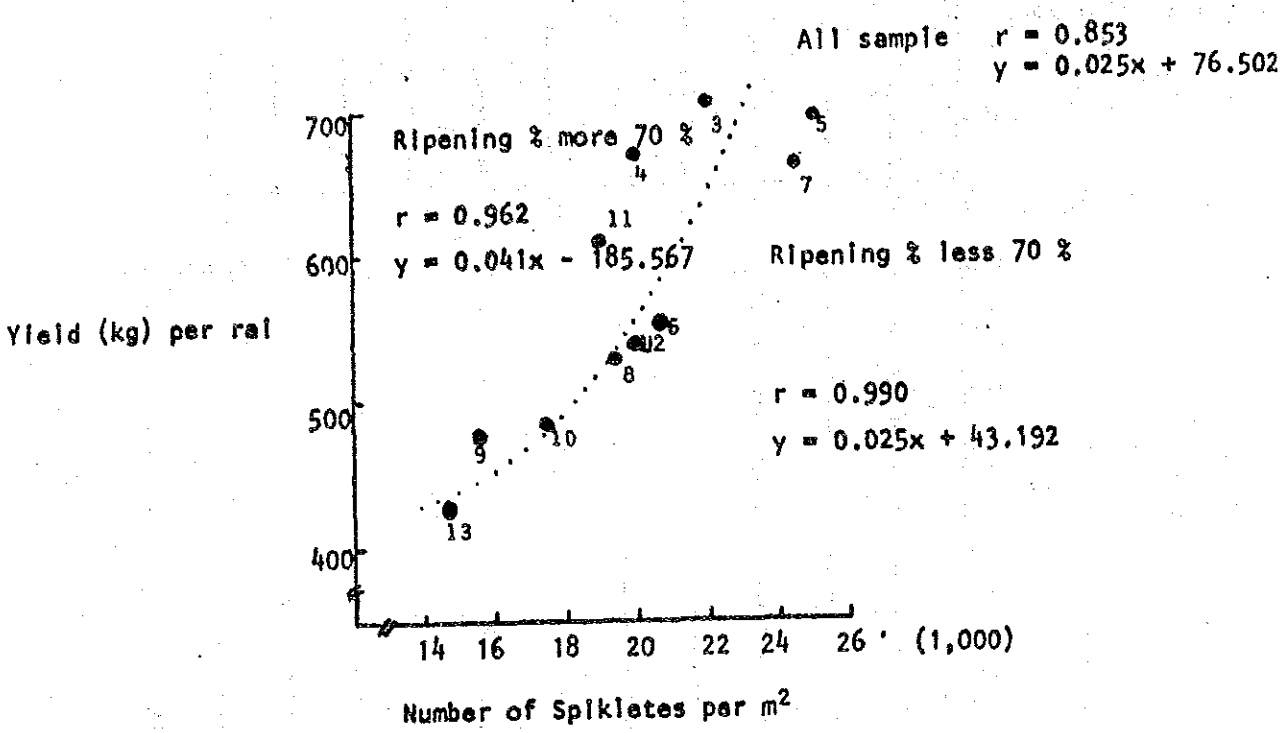


Fig. 1 Correlation between the yield and number of spikletes per m^2



Result

This experiment was done thirteen times, first transplanting is on 26 July 1979 and the last on on 28 December 1979.

Omitted for 1st and 2nd planting plots due to heavy birds damage at the milky stage, if necessary, nets are used for preventing of bird damage from the third planting up to 13th planting.

High yield plots were obtained from No.3, 4 and 5 which are in the normal period of transplanting by general farmers in such area. From No.6 to No.13 planting time is in critical period which day length is shorter and temperature is low comparing to dry season.

Concerning to yield components, July and August planting plots have great number of spikelets per panicle, in the other hand Sep. - Oct.planting plots have more panicles unit area but lower in number of spikelets per panicle. For low yield plots, it appeared to be less in number of spikelets per panicle, even the percentage of ripening is rather high. No.13 plot which was obtained the lowest yield in this trial is also lowest in all components.

From Fig.1, it is quite clearly shown that yield of R.D.7 have closed correlation to the number of spikelets per unit area and ripening percentage rather than the other components.

Owing to the land, it is necessary to construct dormitory for Trainees. This experiment was stopped after the harvesting of 13th crops which was in April 1980.

From the result of this experiment, many things were left for solving in the future such as how to increase the number of panicle per unit area, how to avoid in dropping of ripening percentage when the number of spikelets per panicle is increased, how to adapt all components which are suitable for different planting time around the year.

Exp. 3

Comparison of yield of different planting date by transplanter

1979

Mr. Vichien Sasiprapa

Dr. Tetsujiro Sugahara

Experiment methods

1. Variety : R.D. 7
2. Planting date : 15 February and 10 March 1979
3. Seed rate : 15 February 160 gm./box (28 × 58 cm.)
   10 March 150 gm./box (28 × 58 cm.)
4. Seedling age : 20 days seedling
5. Fertilizer at Main field : N:P:K

	General			Heavy			
	N	P	K	N	P	K	
1st week	1.6 :	2.0 :	0	1.6 :	2.0 :	0	Kg/rai
2nd week	3.2 :	4.0 :	0	3.2 :	4.0 :	0	Kg/rai
45 days	4.2 :	0 :	0	4.2 :	0 :	0	kg/rai
Booting stage		-		4.0 :	0 :	0	
Total	9 :	6 :	0	13 :	6 :	0	

6. Harvesting date : 15 Feb. planting plot on 5 June 1979
   10 Mar. planting plot on 29 June 1979

Result :

Items	15 February General	15 February Heavy	10 March General
Yield Kg./rai (Kr./ha.)	750 (4688)	933 (5831)	956 (5975)
Components			
No. of hills/m^2.	20.7	20.7	20.7
No. of panicles/m^2.	145	167	158
No. of spikelets/panicle	97.6	103.1	100.7
Percentage of full grain	59.3	60.4	67.2
1,000 grain weight	27.0	27.1	27.0

Yield of March transplanting is higher than February transplanting.

One thing which can be observed very clearly in this experiment was that the percentage of full grain which was caused by low temperature during flowering stage is very high.

For the heavy fertilizer plot at February transplanting which supplied the booting stage, number of spikelets and number of panicles was increased.

Estimate of yield and yield components depend on simple sampling method that it is randomed choice 10 rows and get 10 hills at each row.

After dry, yield components sample was picked up panicles ¼ into panicle of 100 hills.

Ripening test used 1.12 specific gravity and grain weight is adjusted 14% moisture.

1 9 8 0

Exp.1 Effect of under drainage on the growth and yield of rice

Exp.2 Intensive cultivation techniques for increasing rice yield

Exp. 1

Effect of Under Drainage on the Growth and Yield of Rice

(Wet Season 1980)

Mr. Vichien Sasiprapa
Mr. Yoshiya Takashima
Dr. Tetsujiro Sugahara

Introduction

For the paddy area in the Central plain of Thailand, heavy clay soil is widely distributed. Under submerge condition percolation, it became very less or even zero, the soil layer of rice root zone is in reductive condition which caused of poor growth of rice plant and lowered in number of tillers.

To clearify the possibility and effectiveness of under drainage to cover up the maximum potential rice yield by means of under drainage for heavy clay soil, this experiment was carried on.

Methods and materials

This experiment field is a part of Suphan Buri Rice Experiment Station, the under drainage facilities are installed as shown in the attach drawing.

1. Variety	RD.7
2. Design and plot	Randomized Complete Block Design 3 treatments and 2 replications plot size 5 m. x 6 m. (30 m^2)
3. Sowing	22 September 1980.
Transplanting	9 October 1980.
Harvesting	January 1981.
4. Spacing	20 cm. x 20 cm. = 25 hills/sq.m. 25 cm. x 25 cm. = 16 hills/sq.m.

5. Treatment

Treatment	Planting density (hills/m^2)		Water management
Control	25	16	flooding
Drainage	25	16	dried up for 7 days
Drainage & mixing husk	25	16	at 30 DAT.

6. Fertilizer kg./rai

DAT	N	P	K	Growth period
7	5	12	6	rooting stage
20	5	-	-	maximum tiller number stage
40	8	-	-	panicle formation stage
total	18	12	6	

Result

1. Vegetative stage

No any difference of plant height among treatments of under drainage and control or even between spacings as shown in table 1.

Regarding the number of tillers (table 2) doesn't show any significant difference in both of spacing and drainage.

2. Leaf Area Index

As shown in table 3 the Leaf Area Index is bigger in the control plot than the drainage plot at maximum tillering stage and heading stage, it seems to be the effect of drying up the soil at 30 days for about 1 week.

3. Water management

When underdrainaged plot was dried up at 30 days after transplanting, the soil surface appeared to lose the moisture from the third day after draining out the water. In the fourth day, the moisture content in the soil at 10 cm. and 15 cm. layer are are sharply decreased but less change in 20 cm. depth as shown in figure 1. It is clearly understood that under submerged condition the moisture supplemented to rice root zone are from the lower layer.

4. Water requirement in depth

Figure 2. indicated that the water requirement in depth of the drainage plots are somewhat larger than the control plot about 0.5-1.0 mm./day but still very low when comparing with the data available in some country like Japan, these were due to the characteristic of heavy clay soil which has very low in water permeability. The amount of evapotranspiration has big difference according to the growth period, it was 3-7 mm./day at initial growth stage of rice plant and increase to 5-9 mm./day at the reproductive growth stage.

5. Yield and its component

As shown in table 4-5, the yield of paddy obtained from this experiment is rather high about 6.5 tons/hactare in all treatments. The effect of drainage and undrainage are almost nonsignificant difference, expect for the densed spacing (25 hills/m.) are better than the widered on.

The yield are closely correlation to the number of panicle and number of spikelets per m^2 than the other two component, namely percentage of ripening grain and one thousand grain weight.

Conclusion

This experiment was carried out to find out the effective of underground drainage for increasing rice yield, percolation degree of clay soil and posibility of rebinifit for constructed cost.

Drainage for increasing rice yield about 40 kg./rai was more effective than control plot. This method cannot repay constructed cost.

The percoolation of clay soil with under grain condition was not sufficient because surface soil shut out percolate to under drain tube.

Table 1 Plant height

Treatment	DAT 20		DAT 30		DAT 40		
	25	16	25	16	25	16	(Hill/m.^{2})
C	42.7	43.2	60.3	61.2	65.2	66.1	
D	43.8	42.2	57.9	58.4	63.4	63.0	
D & H	40.1	40.9	56.7	52.3	66.1	59.9	

DAT = Days After Transplanting

Table 2 Number of tiller and paniole/m.^{2}

Treatment	DAT 20				DAT 30				DAT 40				No.of paniole			
	25	16	mean	F	25	16	mean	F	25	16	mean	F	25	16	mean	F
C	282	211	247		479	413	446		454	397	426		258	237	248	
D	283	221	252	NS.	421	402	417	NS.	396	402	399	NS.	258	230	244	NS.
D & H	269	200	235		500	373	437		436	381	434		275	254	265	

Table 3 Leaf area

	Treatment	Dry matter/leaf area/stem (mg./cm.^{2})		L A I	
		25	16	25	16
DAT 40	C	12.4	12.2	2.7	3.1
	D	12.6	13.1	3.0	2.5
	D & H	12.7	14.3	2.8	2.2
Heading stage	C	20.0	19.9	5.0	4.5
	D	21.3	22.2	4.1	3.5
	D & H	20.0	22.4	4.4	3.2

Table 4 Yield kg./rai (kg./ha.)

Treatment	25	16	mean	F
C	1015 (6344)	1018 (6362)	1017 (6356)	
D	1057 (6606)	1059 (6619)	1058 (6613)	NS.
D & H	1062 (6638)	988 (6175)	1025 (6406)	
mean	1045 (6531)	1022 (6388)		
F	5%			

Table 5 Yield component

	Treatment	No.of paniole/m^2	No.of spikelet/pan.	No.of all grains/m^2	Percentage Ripening	1000grains weight
25	C	272	110	29753	75.0	27.4
	D	270	109	29429	76.0	27.3
	D & H	277	104	31468	78.9	27.4
16	C	239	120	28628	75.6	27.4
	D	256	115	29372	75.5	26.5
	D & H	246	120	29429	78.0	26.8

Exp. 2

Intensive cultivation Techniques for Increasing Rice Yield.

1 9 8 0 Wet

Mr. Vichien Sasiprapa
Mr. Pairai Duangpiboon
Dr. Tetsujiro Sugahara

Introduction

Rice is stable food and major crops growed by the farmers in Thailand. The annual production is about 16.5 million tons of paddy, 12.5 million tons are for local consumption and the rest is for exporting to other countries (about 1.8~2.0 million tons every year)

Even, Thailand is number one in exporting rice to world markets, but her average yield is very low (2.0 tons/ha) when comparing with neighboring countries like Japan, Taiwan and Korea (5.0~6.0 tons/ha) due to 80 percent of the rice cultivation area are under rainfed condition, which cause the farmers not to risk to improve their rice yield by inputting the new technologies such as applying chemical fertilizer, spraying insecticide or so on, The increasing of national production are mostly in irrigated area where water can be controlled and have a good chance for highly return inputs.

The second rice crops in dry - season which have abundance of solar energy can obtained a very high yield than the rainy or wet season but the acreage of rice cultivation is limited by amount of water reserved in all resevoir, so the ways and means to increase the rice yield in wet season is the most important thing to try to raise up the national average.

Objective

To apply the intensive rice cultivation technique by comparing

1. deep and shallow plowing
2. densities of planting
3. rates of chemical fertilizer
4. the correlation among the above factors.

Materials and Method

1. Rice variety — RD 7
2. Design — Strip - split 3 replications.
   Sub - plot = 4 x 6 sq.metre, 8 treatments
   (3 factors, 2 levels.)

3. Sowing 31 st July 1980.
Transplanting 20 th August 1980.
Harvest 3 rd December 1980.

4. Treatment

Factors

1) Plowing (Main I)

Shallow (S) 10 - 15 cm.

Deep (D) 20 - 25 cm.

2) Spacing (Main II)

Wide (16) 25 x 25 cm. = 16 hills/m²

Narrow (25) 20 x 20 cm. = 25 hills/m²

3) Fertiliser rate /rai

Low (L) 9 - 12 - 6.

High (H) 18 - 12 - 6.

Applying by

Day after transplanting	N Low	N High	P	K
7	2.5	5	12	6
20	2.5	5	-	-
40	4.0	8	-	-
Total	9.0	18	12	6

Result

From the Wet season of 1980, there were outbreak of brown plant-hopper in Sing-buri, Angthong, Suphan Buri and in the Rice Experiment Station.

This experiment also had been severely damaged by Ragged stunt so we couldn't find the clear answer but we got some interesting data in ragged stunt dispersal condition as follows :-

1. Plant height

The plant height is shown in table 1 and figure 1.

The plant height of different plowing depth and spacing was not different but plant height of high nitrogen level was higher than the low one.

The comparison of plant height elongation in 10 days between the ragged stunt dispersal condition field and normal condition field which was planted after the first 2 months was different. The normal condition plant was more elongate than the ragged stunt one.

2. Number of tiller per square metre

The number of tillers per wq.metre of different plowing was not different but in different spacing, the tillers of 25 hills/sq.metre plot were more developed than the 16 hills/sq.metre plot and also with nitrogen level plots, the tiller number of the high level one was more than the low level one. (Table 1)

The comparison of tiller number increasing in 10 days period between the ragged stunt dispersal condition field and normal condition field was not so much different. (Figure 2)

3. Yield

The yield of this experiment was very less by ragged stunt. There were average 297 Kg. per hectare. Those yield were only 5.9% of 500 kg. as normal field yield (400kg.)

The dispersal condition seemed to be effected by transplanting spaces. The dense plot was less damaged by ragged stunt than the loose plot. The difference was significant at 5 % level. (Table 3)

Table 1 Plant height and Number of tiller on growing time

Group treatment	Plant height			Number of tiller/m^2		
	20 DAT	30 DAT	40 DAT	20 DAT	30 DAT	40 DAT
Shallow	36.2	47.4	55.2	145	332	345
Deep	37.7	48.2	55.0	144	329	340
16 hills/m^2	37.1	47.6	54.8	115	285	305
25 hills/m^2	36.8	48.0	55.3	174	377	380
Low fertilizer	36.2	45.6	51.1	137	305	316
High fertilizer	37.7	50.0	59.1	152	357	369

DAT...Days after transplanting.

Table 2

Treatment yield Kg./hectare

Treatment (M_1	M_2	S)	Replication 1	2	3	Average
S	16	L	206	244	143	198
S	16	H	134	83	129	115
S	25	L	315	556	564	478
S	25	H	608	250	671	510
D	16	L	140	58	247	148
D	16	H	135	67	161	121
D	25	L	374	480	410	421
D	25	H	177	547	440	388

Grand mean 297

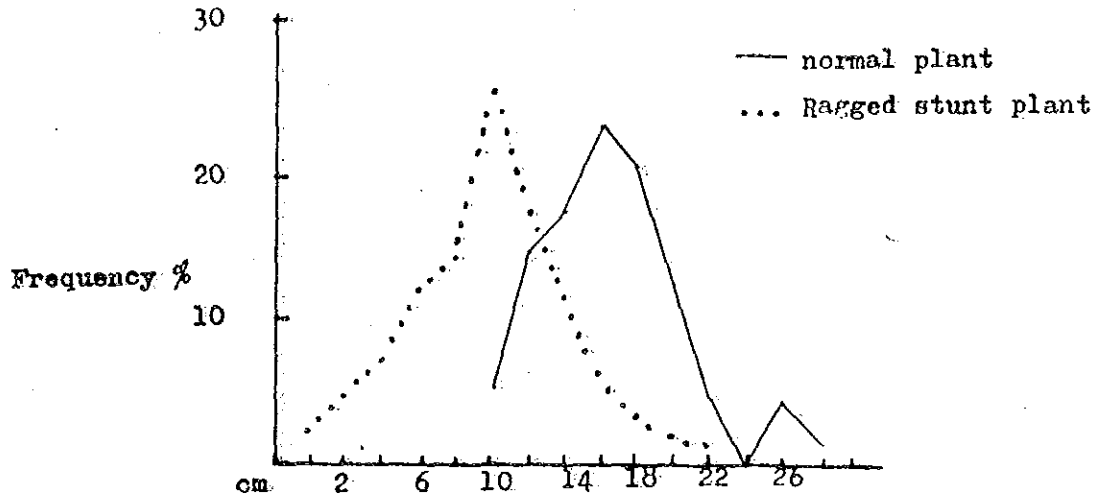
Table 3

Group treatment yield Kg./hectare

Treatment	Replication 1	2	3	Mean	Significant
Shallow plowing	316	283	377	325	N.S
Deep plowing	206	288	314	269	
16 hills/m^2	154	113	170	146	5 %
25 hills/m^2	368	458	531	449	
Low fertilizer	269	334	341	315	N.S
High fertilizer	263	337	350	283	

Effect of Ragged stunt for growing rice

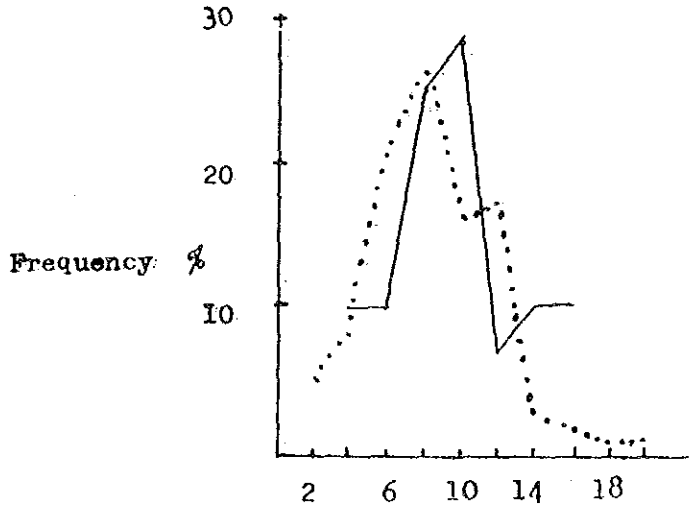
Figure 1 Extension of plant height for ten day



30 DAT - 20 DAT = plant height

DAT... day after transplanting

Figure 2 Number of tillers for ten day



30 DAT - 20 DAT = No. tillers

DAT... day after transplnting

1 9 8 1

(D R Y)

Exp. 1 Effect of seedling and split application of nitrogen for yield and yield components

Exp. 2 Effect of different nurseries and space for rice yield

Exp. 3 Different density pre - trial on rice

- General discussion of intensive cultivation techniques

- Recommendation of intensive cultivation techniques on transplanting rice

Exp. 4 Study on multiple cropping system for paddy field
Posibility of cultivation on upland upland crop on dry season

- Recommendation of intensive transplanting cultivation techniques of rice at Chao Phya and Mae Klong Pilot Project areas.

Exp. 1

Effect of seedling and split application of nitrogen for yield and yield components.

1 9 8 1 Dry

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Mr. Pairat Duangpiboon
Mr. Yoshiya Takashima
Dr. Tetsujiro Sugahara

This experiment was undertaken to find the relation between yield and yield components on different seedlings and split application of nitrogen.

The yield of rice can be expressed by the product of the number of panicles per unit area, the number of spikelets per panicle, the percentage of ripened grain and the weight of 1,000 grains.

Each yield components is determined by different growth stage of rice plant. As commonly known, nitrogen top dressing at active tillering will increase the number of panicles, panicle initiation stage dressing will increase the number of spikelets and heading stage dressing will promote the ripened percentage. And vigorous seedling has a beneficial effect on yield components also.

Accordingly, the effect was compared by nitrogen application at different growth stages and between seedling use.

Materials and method

1. Variety	R.D. 7	
2. Design and plot	Randomized complete block design, 3 replications. Plot = 4 m. × 5 m. = 20 sq.m., 8 treatments and 3 blocks.	
3. Sowing	24 February	1981.
Transplanting	14 March	1981.
Harvest	18~26 June	1981.
4. Spacing	20 cm. × 20 cm. = 25 hills/sq.m. and 3 seedlings/hold.	

5. Treatment

1) Nursery (Wet)

Mark	Treatment name	Seed rate gm./m²	Fertilizer gm./m² Basal			Top
			N	P	K	N
V	Vigorous seedling	40	7.5	7.5	7.5	-
G	General seedling	80	-	-	-	5.0

2) Yield components

Mark	Treatment name	Fertilizer Basal (4 DAT) N	P	K	Top N 1st (15 DAT)	2nd (PFS)	3rd (Heading)	Total N	P	K
P	Panicle	8	12	6	8	-	-	16	12	6
S	Spikelets	8	12	6	-	8	-	16	12	6
R	Ripened	8	12	6	-	4	4	16	12	6
C	Control	4	12	6	4	4	4	16	12	6

- Measure height, leaf age, tillering and dry weight of rice plant in each treatment by taking 50 seedlings/treatment.
- After transplanting, measure the height and tillering in 20, 30, 40 DAT and before harvesting by taking 10 hills/treatment.
- Measure plant height and panicle length by taking 10 hills/treatment.
- Number of panicle counting from 60 hills/treatment.
- Nitrogen analysis in leaf at 22 DAT and 7 days after heading in every treatment.

Result

1. Growth of rice seedling.

Plant height, number of tillers, top-dry weight and leaf age at transplanting time are given in Table-1.

It was found that vigorous seedling has tendency to give higher value in plant height, number of tillers, leaf age and top-dry weight than general seedling.

2. Growth of rice on main field.

Plant height, culm length, panicle length, number of tillers and panicles are given in Table-2.

Vigorous seedling plots were higher than general seedling plots, in plant height and culm but the former ones were less than the later ones in the number of tillers and panicles. It means that the number of tillers was developed by young aged seedlings of the general seedling more than by old aged seedlings of the vigorous seedling. See table-1.

Panicle plot was higher in plant height, culm length, the number of tillers and panicles but shorter in panicle length than the others. These particulars could be recognized in plant height and the number of tillers at 30 days after transplanting of Table-2.

These results seemed to have some relation with nitrogen application at active tillering stage. The fact appeared that there was more nitrogen content in rice plant at 22 days after transplanting in Table-3.

3. Yield

Yield of paddy is shown in Table-4.

The comparison of yield between seedling and among treatments were not significant by F test. But yield values have some suggestions as follows :

1) Between seedling, there was the tendency that vigorous seedling gave higher yield than general seedling.

2) Among treatments, rice yield in C plot was the highest one, the second was P plot, the third was S plot and the last one was R plot.

4. Yield components.

(1) Between seedlings

Yield components factor that was compared between different seedlings, the data were shown in Table-5 and 6.

(1) The number of panicles per square metre of vigorous seedling plots were less than general seedling plots but the number of spikelets per panicle of the former ones were higher than the later ones and both factors were statistic significance at 1 % level.

(2) The number of spikelets per square metre which showed product of both factors, vigorous seedling plots were better than general seedling plots at 5 % level significant.

(3) The other factors between different seedlings were percentage of ripened grain, weight of 1,000 grains and degree of ripening. They were not significant.

(2) Among treatments of nitrogen application.

For yield components factor that was compared among treatments, the data were shown in Table-5 and 7.

(1) The number of panicles per square metre of P plot was more than the others at 1 % level significant.

(2) The number of spikelets per panicle of S plot was better than the control one and P plot was the lowest at 1 % level significant.

(3) But the number of spikelets per square metre was not significant among treatments.

(4) The other components as percentage of ripened grains, weight of 1,000 grains and degree of ripening were 5 % level significant. Ripened percentage of S plot was lower than the others, 1,000 grains weight and ripening degree of P and C plots were better than S and R plots.

Discussion

1. General seedling gave more number of panicles but gave less yield and number of spikelets per unit area than vigorous seedling.

2. The yield was not significant but yield values were C>P>S>R. This result suggested as follows :

   1) Should experiment more replications of the same nitrogen quantity treatment to get the clear statistic result.

   2) Optimum nitrogen application time for yield increasing should be three times as basal, active tillering stage and panicle formation stage.

   3) In this experiment, nitrogen application at heading stage was not effect.

   4) If wanting to increase number of panicle/sq.m, should consider on nitrogen application in active tillering stage (15DAT).

   5) If wanting to increase number of spikelets per panicle, should consider on nitrogen application in panicle formation stage.

   6) If wanting to increase good grain percent, should consider on nitrogen application in appropriate period of rice growth.

   7) To increase weight of 1,000 grains, should apply in every appropriate period of rice growth. It can't be increased by applying only in some period.

   8) Number of panicle per unit area and number of spikelets per panicle are the components. They are rather free and easy to be increased or reduced.

   9) Good grain percent and 1,000 grains weight in the same variety are the components. And it is difficult to be increased or reduced because there are many co-factors in heredity, environment and other.

Table-1 Seedling characters when transplanting.

	Plant height	Number of tillers per seedling	Leaf age	Top-dry weight per seedling
	cm.			
Vigorous	30.5	1.58	5.59	128 mg.
General	23.1	1.00	4.89	64

Investigation by 50 seedlings.

Table 2 Average of plant height and the number of tillers per hill

Main	Sub	Plant height 20 DAT	30 DAT	40 DAT	Harvest ⁂ Culm length	Panicle length	Number of tillers 20 DAT	30 DAT	40 DAT	Harvest ⁂⁂ No. of panicles
V	P	38.4	57.2	69.4	115.6	25.0	13.6	23.0	20.0	12.0
	S	34.4	43.2	52.0	109.0	27.1	13.6	16.2	15.0	9.6
	R	35.1	40.7	48.6	108.5	26.3	12.6	15.6	14.7	9.8
	C	35.1	46.4	54.0	111.9	26.3	14.8	21.3	18.0	10.8
G	P	35.8	51.1	63.3	113.9	24.7	16.1	25.0	21.7	13.3
	S	33.5	40.6	49.6	105.8	27.0	14.1	15.9	15.2	10.0
	R	33.0	40.0	49.3	108.1	26.2	14.2	18.1	16.6	10.6
	C	32.2	40.0	47.2	108.3	26.4	11.6	15.9	15.3	10.3

DAT = Days after transplanting

20 DAT 40 DAT Sampling the same 10 hills per each plot.

⁂ Culm & panicle length Sampling 10 hills.

⁂⁂ Number of panicles Sampling 60 hills.

Table-3 Nitrogen percentage in plant leaf

Seed-ling	Treat-ment	N fertilizer Kg./rai Basal 4 DAT	Top 1 15 DAT	Top 2 P.I.S	Top 3 Heading	N % 22 DAT	7 days after heading
V	P	8	8	-	-	3.88	1.30
	S	8	-	8	-	2.99	1.96
	R	8	-	4	4	3.10	1.84
	C	4	4	4	4	3.60	1.82
G	P	8	8	-	-	4.19	1.35
	S	8	-	8	-	3.10	1.80
	R	8	-	4	4	3.38	2.05
	C	4	4	4	4	3.67	2.04

Table-4 Yield (14 % moisture) Kg./ha

Seedling	Treatment	Block I	II	III	Mean
Vigorous	P	5,180	5,629	5,497	5,435
	S	4,863	5,321	5,249	5,144
	R	4,958	4,629	5,529	5,039
	C	5,486	6,177	5,364	5,675
General	P	4,728	5,885	5,010	5,208
	S	4,857	5,822	5,425	5,368
	R	4,750	5,324	5,479	5,184
	C	5,030	5,448	5,657	5,378

Group comparison between seedlings.

Seedling	Mean	Remark
Vigorous	5,323	no significant.
General	5,285	

Group comparison among treatments.

Treatment	Mean	Remark
P	5,322	no significant.
S	5,256	
R	5,112	
C	5,527	

Yield was harvested from area 2 m. x 3 m. in center of each plot.

Table-5 Yield components

Seed-ling	Treat-ment	No. of panicles -/sq.m.	No. of spikelets -/panicle	R %	1,000 grains weight	No. of spikelets -/sq.m.	Ripened degree R %× 1,000 grains weight	Calcula-tion Yield-/sq.m.
						100		
V	P	307	84.7	76.4	27.8	260	21.2	551.7
	S	243	102.7	75.5	27.2	249	20.6	512.8
	R	249	100.2	75.4	27.4	250	20.7	515.7
	C	273	96.4	76.6	27.7	263	21.5	559.0
G	P	336	74.1	75.9	27.8	249	21.1	524.5
	S	258	100.5	72.9	27.6	260	20.1	522.2
	R	274	88.1	76.5	27.4	242	20.9	506.3
	C	263	80.0	76.3	27.4	209	20.9	437.5

Table-6 Group comparison of yield components between seedlings.

Seedling	No. of panicles -/sq.m.	No. of spikelets -/panicle	R %	1,000 grains weight	No. of spikelets -/sq.m.	Ripened degree R%× 1,000 grains weight
					100	
V	268	96.0	76.0	27.6	256	21.0
G	283	85.7	75.4	27.5	240	20.8
Significant	**	**	non	non	*	non

Table-7 Group comparison of yield components among treatments.

Treatment	No. of panicles -/sq.m.	No. of spikelets -/paniole	R %	1,000 grains weight	No. of spikelets -/sq.m.	Ripened degree R%× 1,000 grains weight
					100	
P	322 a	79.4 c	76.1 a	27.8 a	254	21.2 a
S	251 b	101.6 a	74.2 b	27.4 b	254	20.4 b
R	262 b	94.2 ab	75.9 a	27.4 b	246	20.8 ab
C	268 b	88.2 b	76.5 a	27.6 ab	239	21.2 a
Significant	**	**	*	*	non	*

** = 1 % , * = 5 % , non = not significant by F test.

Common letter (a, b, c) are not significant by Duncan's Multiple Range Test.

Yield components values are average of 180 hills as each plot = 60 hills × 3 blocks.

Table-8 Correlation coefficients among yield components.

	No. of panicles -/sq.m.	No. of spikelets -/panicle	Ripened %	1,000 grains weight
No. of spikelets/panicle	-0.805*	...		
Percentage of ripened	0.325	-0.481	...	
1,000 grains weight	0.812*	-0.483	0.066	...
Yield	0.313	0.282	-0.019	0.568

* = 5 % significant.

Exp. 2 Effect of different nurseries and space for rice yield.

1 9 8 1 Dry

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Mr. Pairat Duangpiboon
Mr. Yoshiya Takashima
Dr. Tetsujiro Sugahara

This experiment was carried on a series of the intensive cultivation techniques for rice yield increasing by comparing between

1. dry and wet nurseries
2. 20 cm. and 25 cm. spacing in field.

Materials and method

1. Location — Suphan Buri Experiment and Training Center.
2. Variety — R.D. 7.
3. Design — Randomized complete block design, 3 replications.
   Plot = 5 m. × 6 m. = 30 m^2, 4 treatments.
4. Sowing — 24 February 1981.
   Transplanting — 14 March 1981.
   Harvest — 23 June 1981.
5. Nursery
   Seed rate — 40 gm./m^2, Basal gm./m^2 N : 7.5, P : 7.5, K : 7.5
6. Main field

Fertilizer Kg./rai

Basal (4 DAT)			Top N			Total		
N	P	K	1st(15 DAT)	2nd(PFS)	3rd(Heading)	N	P	K
4	12	6	4	4	4	16	12	6

DAT : Days after transplanting.
PFS : Panicle formation stage.

7. Treatment

Space \ nursery	dry	wet
25 cm.	D - 25	W - 25
20 cm.	D - 20	W - 20

8. Investigation
   Yield sampling area = 2 m. × 4 m. = 8 sq.metre.
   Sampling hills for yield components = 20 hills × 2 place per plot.

Result

1. Yield

Yield data are given in Table-1.

Between dry and wet nursery treatment, yield was not significant.

Between different spaces, 20 cm. x 20 cm. spacing gave higher yield than 25 cm. x 25 cm. spacing at 5 % level significant.

2. Seedling and growth of rice

Character of transplanted seedling and rice plant on growing stage are given in Table-2 and 3.

Both nursery seedlings resembled in character.

The plant height of dry nursery seedling was higher than wet nursery seedling in main field. But wet nursery seedling got more tillers and average weight than dry nursery seedling.

Between different spacing, the number of tillers per hill of 25 cm. plot was more than 20 cm. plot and the number of panicles per hill of both plots when they were harvested, were in the same trend. The maximum tillering of both dry and wet nursery methods are not different at 30 DAT.

3. Yield components

Yield components data are shown in Table-4.

The yield components between dry and wet nursery seedlings were not significant except weight of 1,000 grains. 1,000 grains weight of dry nursery seedling was weightier than wet nursery seedling at 5 % significant.

The number of panicles per square metre of 20 cm. spacing was more than 25 cm. spacing but the number of spikelets per panicle of the former one was less than the later one at 1 % significant.

For the number of spikelets per square metre between spacing, was the product of panicles number per square metre and spikelets number per panicle, were not significant but the result value of 20 cm. spacing was more than 25 cm. spacing plot.

Discussion

This experiment result gave some suggestions as follows:

1) Different nursery seedling didn't give difference in yield and its yield components.

2) For different spacing, 20 cm. spacing with fertilizer rate 16-12-6, gave more yield than 25 cm. spacing. It was effected by the increment of panicles number per square metre.

Table-1 Yield Kg./ha

Treatment \ Block	I	II	III	Mean	Nursery average	Spacing average
D - 25	4,663	5,470	4,392	4,842	5,286	25 cm. = 5,015
D - 20	5,946	5,927	5,317	5,730		
W - 25	4,786	5,477	5,297	5,187	5,230	20 cm. = 5,502*
W - 20	5,101	5,371	5,349	5,274		

* 5% significant

Table-2 Character of seedling when transplanting

Treatment	Plant height	Number of tiller	Leaf age	Top dry weight/-seedling
	cm.			mg.
D	35.8	1.08	5.65	117
W	30.5	1.58	5.59	128

Table-3 Growth in rice plant

	Plant height			No. of tillers per hill			Culm length	Panicle length	No. of panicle -/hill
Treatment \ DAT	20	30	40	20	30	40	Harvest	Harvest	Harvest
D - 25	37.0	46.7	53.0	9.4	21.7	21.6	115.2 cm.	27.7 cm.	14.3
D - 20	37.3	48.1	53.4	6.7	18.8	18.1	113.4	26.1	11.1
W - 25	34.2	37.1	44.7	7.8	23.0	21.6	113.1	27.3	15.3
W - 20	33.9	45.0	44.7	9.0	21.0	19.6	111.4	26.5	11.6

Table-4 Group comparison in yield components

Treatment \ Components	No. of panicles -/sq.m.	No. of spikelets -/panicle	No. of spikelets per sq.m.	R %	1,000 grains weight	Ripened degree	Calculation yield
Dry	261.6	102.1	26,355	77.2	27.80*	21.45	5,658
Wet	263.8	101.2	26,594	76.5	27.54	21.05	5,600
25 cm.	238.9	107.6**	25,651	76.9	27.54	21.15	5,427
20	285.6**	95.7	27,297	76.8	27.79*	21.35	5,831

* 5 % level ** 1 % level significant.

Exp.3 Different density pre - trial on rice

1 9 8 1 Dry

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Dr. Tetsujiro Sugahara

This experiment was carried on a series of intensive cultivation techniques for increasing rice yield.

In the tropical countries, rice production per unit area is low when comparison with the other countries such as Korea, Taiwan and Japan.

From the reports of researchers in Thailand, it is found that the panicles number per unit area is less. If the number of panicles was increased by density, yield might be increased.

According to Mr. Akio Osada's experiment about spacing in Thailand (1968 ~ 1972), he concluded that the optimum density for new hybrids varieties should be within 12 to 16 hills per square metre, considering from costs of planting and seedling preparation.

However, he suggested it was possible to increase yield by increasing plant density.

Accordingly, pre-test was done for finding yield and yield components of different densities (16, 25, 32 and 50 hills per square metre)

Materials and method

1.	Location	Suphan Buri Experiment and Training Center.
2.	Variety	R.D.7
3.	Design	Randomized complete block design, 3 replications. Plot 5 x 2.5 m. = 12.5 sq.m., 4 treatments.
4.	Sowing	24 February 1981.
	Transplanting	16 March 1981.
	Harvesting	24 June 1981.
5.	Nursery	
	Seed rate	40 gm./m^2., Basal gm./m^2. N: 7.5, P : 7.5, K : 7.5.

6. Main field fertilizer Kg./rai.

Basal(2 DAT)			Top N			Total		
N	P	K	1st(15 DAT)	2nd(PFS)	3rd(Heading)	N	P	K
4	12	6	4	4	4	16	12	6

7. Treatment

Mark	Spacing	Density hills/m^2	
16	25 x 25 cm.	16	
25	20 x 20	25	2 seedlings/hill
32	25 x 12.5	32	
50	20 x 10	50	

8. Investigation

Sampling yield : Each plot was taken 140 hills except plot 16 that was taken only 90 hills.

Sampling yield components : Each plot was taken 20 hills x 2 places.

Result

The grain yield and analysis of variance of yield are shown in Table-1 and 2.

Among different densities, yield was slightly significant at 10 % level because of less replication number.

Yield values were 50 > 32 = 25 > 16 hills per square metre.

Yield components are given in Table-3

In the number of panicles per square metre, 50 hills plot was the highest but among the other plots, they were not significant at 5 % level.

16 and 25 hills plots had more number of spikelets per panicle than 32 and 50 hills plots.

Among different densities, there was not significance in ripened percentage and 1,000 grains weight.

About the number of spikelets per square metre that closely related with yield, 50 hills plot was the highest but 32,25 and 16 hills plots were not significant at 5 % level.

This experiment gave some suggestions as follows:

If the number of panicles per square metre was high, yield would be high too.

If the number of spikelets per panicle was high, yield wouldn't be so high.

So, if wanting to increase yield, to increase number of panicles per unit area is better than increase to number of spikelets per panicle.

Table-1 Yield Kg./ha

	I	II	III	Mean
16	5,062	4,932	4,363	4,786
25	5,510	5,394	4,732	5,212
32	5,413	5,387	4,762	5,187
50	5,266	6,570	5,618	5,818

Table-2 Analysis of variance on yield

Variation	Degree of freedom	Sum of squares	Mean squares	F	Tabular F 10 %	Tabular F 5 %
Block	2	1,008,672	-			
Treatment	3	1,630,795	543,598	4.07+	3.29	4.76
Error	6	801,985	133,664			
Total	11	3,441,452	-			

+ 10 % level significant.

Table-3 Yield components

Components / Treatment	No. of panicles -/sq.m.	No. of spikelets -/panicle	R %	1,000 grains weight	No. of spikelets -/sq.m.
					100
16	221 b	102.3 a	75.0	27.4	225 b
25	247 b	103.0 a	77.4	27.5	254 ab
32	259 b	94.2 b	74.8	27.5	243 b
50	335 a	88.1 b	75.7	27.4	294 a
Significant	*	**	non	non	*

* 5 % ** 1 % level significant.

non = not significant.

Common letters (a, b) are not significant.

General discussion of Intensive cultivation techniques

In intensive cultivation techniques experiments which had been done at Suphan Buri Training Center in Dry season 1981, there were relation in yield and yield components trial, nursery and space trial and densities trial of rice plant which gave the same quantities of fertilizer in main field. (Those experimental materials and methods were discussed in Exp.1, Exp.2 and Exp.3 papers.)

Some suggestions from those results of experiments combination result are as follows ;

Result and discussion

1. Correlation coefficient of yield and yield components

Data of yield and yield components are shown in Table-1 and the correlation coefficients are given in Table-2.

The relation between yield and the number of spikelets per unit area, it was the most positive, next was the relation between yield and the number of panicles per unit area. Although the percentage of ripened grain and weigh of 1,000 grains related with yield were slightly positive, the number of spike per panicle was not related with yield. Namely, to increase the number of spikelets per unit area, it would increase yield directly.

If wanting to increase the number of spikelets per unit area, to increase the number of panicles per unit area was better than to increase the number of spikelets per panicle because there was positive relation betwee the number of spikelets per unit area and the number of panicles per unit area but there was no relation between the number of spikelets per unit area and the number of spikelets per panicle.

Moreover, there were positive relations between the number of panicles per unit area and weight of 1,000 grains or percentage of ripened grain. It means to increase the number of panicle per unit area would give better effect to yield.

If increasing the number of spikelets per panicle, it will give negati effect to weight of 1,000 grains and percentage of ripened grain.

2. Relationship between the number of spikelets and panicles.

Figure-1 shows the linear regression between the number of panicles per square metre and the number of spikelets per panicle from vigorous seedling, general seedling and density trial of three experiments data.

Numerals beside the regression in figure are calculated by $X_1 \times \hat{Y}_1$ which is the estimation of the number of spikelets per square metre. X_1 is the minimum and maximum value of the number of panicles per square metre in each experiment. In addition to this, 300 panicles were set as the common value.

1) For comparison of regression slopes as b coefficient, there is similarity between vigorous and general regression lines but density regression line sloped down more slowly than vigorous and general lines. It means the proportion between decrement of spikelets number and panicles number of density line is less than vigorous and general lines.

The suggestion from this result is as follow;

To increase the number of spikelets per unit area, it is better to increase number of panicles by density method or in a good comnination than fertilizer application method only.

2) Comparison of elevation as a coefficient. Between vigorous and general elevation, vigorous is better than general in spikelets number increasing per unit area.

3) If comparing between 300 panicles per square metre and estimation of spikelets number per square metre, density trial is the highest, next is vigorous seedling and the last one is general seedling because in each 300 panicles, density method builds only panicles at lower node but general seedling method constructs panicles at low and higher node.

Table-1 Data of yield and yield components

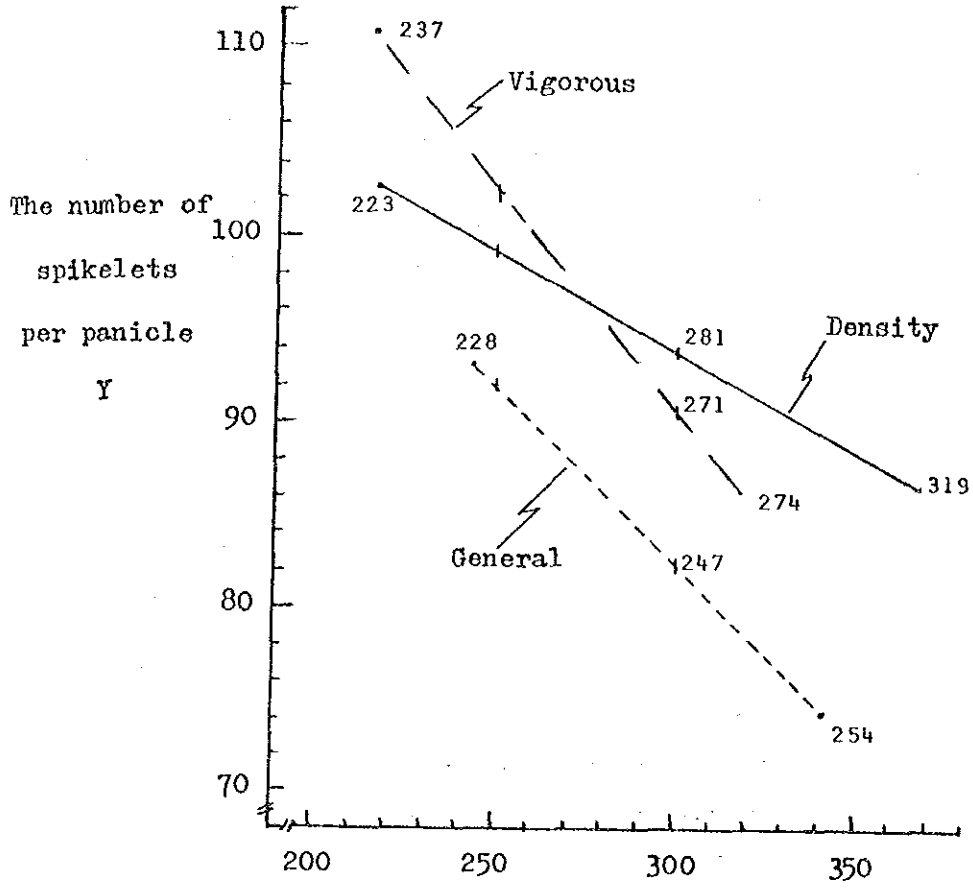
Treat-ment	No. of panicles /sq.m.	No. of spikelets /panicle	R %	1,000 grains weight	No. of spikelets /sq.m.	Ripened degree	Yield /sq.m.
					100		
VP	307	84.7	76.4	27.8	260	21.2	551.7
VS	243	102.7	75.5	27.2	249	20.6	512.8
VR	249	100.2	75.4	27.4	250	20.7	515.7
VC	273	96.4	76.6	27.7	263	21.5	519.0
GP	336	74.1	75.9	27.8	249	21.1	524.5
GS	258	100.5	72.9	27.6	260	20.1	522.2
GR	274	88.1	76.5	27.4	242	20.9	506.3
GC	263	80.0	76.3	27.4	209	20.9	437.5
D 25	233	110.4	77.2	27.6	257	21.3	548.5
D 20	288	93.7	77.1	28.0	270	21.6	583.0
W 25	244	104.8	76.3	27.5	256	21.0	536.8
W 20	283	97.6	76.6	27.6	276	21.1	583.1
16	221	102.3	75.0	27.4	225	20.5	462.0
25	247	103.0	77.4	27.5	254	21.3	541.1
32	259	94.2	74.8	27.5	243	20.6	500.0
50	335	88.1	75.7	27.4	294	20.7	609.6
Mean	269.6	95.05	75.98	27.55	253.6	20.94	530.86

Table-2 Correlation coefficient among yield components

	No. of panicles -/sq.m.	No. of spikelets -/panicle	R %	1,000 grains weight	No. of spikelets /sq.m.	Ripened degree	Yield
No. panicles/m²	...	-0.781**	0.105	0.458	0.497*	0.233	0.510*
No. spikelets/panicle	-0.781**	...	-0.028	-0.275	0.143	-0.095	0.111
R %	0.105	-0.028	...	0.272	0.123	0.901**	0.324
Weight of 1,000 grains	0.458	-0.275	0.272	...	0.343	0.615	0.454
No. spikelets/m²	0.497*	0.143	0.123	0.343	...	0.240	0.975**
Degree of ripened	0.233	-0.095	0.901**	0.615*	0.240	...	0.455
Yield	0.510*	0.111	0.324	0.454	0.975**	0.455	...

Figure-1

Regression and estimate of the number of spikelets per square metre.



Density trial	r = -0.722	$\hat{Y}_i = 125.445 - 0.106X_i$
Vigorous seedling	r = -0.827	$\hat{Y}_i = 161.878 - 0.238X_i$
General seedling	r = -0.652	$\hat{Y}_i = 140.241 - 0.193X_i$

Numeral in Figure = $X_i * \hat{Y}_i$ (number of spikelets/m^2 : unit 100)

X

Recommendation of intensive cultivation techniques on transplanting rice

February, 1982.

Suphan Buri Training Center.

Variety — R.D. 7 and R.D. 23.

Nursery — Seed rate 50 gm./m^2.
Fertilizer gm./m^2 Basal N : P : K = 3.5 : 3.5 : 3.5.
Duration 20 days.

Main field — Density 25 ~ 50 hills/m^2. (Do many densities as possible is better but avoid 16 hills/m^2.).
Space and seedling are 20 x 20 cm.(3 seedlings), 25 x 15 cm.(2 seedlings) and 20 x 10 cm.(2 seedlings).

Fertilizer

Total			Basal			Top 1	Top 2
N	P	K	N	P	K	N	N
18	12	6	6	6	6	6	6

Basal applying : 0 ~ 1 day before transplanting by mixing with soil.
Top 1 applying : 15 days after transplanting.
Top 2 applying : Panicle formation stage (40 ~ 45 days after transplanting).

Exp. 4

Study on Multiple Cropping System for Paddy Field
-- Possibility of Cultivation on Upland Crop on Dry Season---

Dry Season: 1981

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Mr. Pairat Duangpibul
Mr. Yoshiya Takashima
Dr. Tetsujiro Sugahara

Purpose

In order to propel the multiple cropping on paddy field and the integrated farming for the irrigated agricultural area as paddy farming in the dry season, this experiment was carried out to collect the fundamental upland crop data.

Materials and methods

1) Design Randomize Completed Block 4 replications
2) Kind, varieties and seedling time
   - Soy bean SJ - 4 26th Jan.1981
   - Mung bean SPR - 1 20th Jan.1981
   - Sweet corn Super Sweet 20th Jan.1981
3) Size of plot and space of planting
   - Size of plot 6m. x 5m.
   - Space of planting
     - Soy bean 75cm. x 20cm. 2 stem planting
     - Mung bean 75cm. x 20cm. 2 " "
     - Sweet corn 75cm. x 20cm. 2 " "

4) Fertilizer (kg/rai)

Kind	Total			Basal			Top
	N	P	K	N	P	K	N
Soy bean	3	9	6	3	9	6	-
Mung bean	3	9	6	3	9	6	-
Sweet corn	18	12	6	9	12	6	9

Result

1. Planting

For the works of plouging and soil preparation, when the soil dried applied the big style tractor (75 HP) by rotary tilling. Since the soil of that field was heavy clay, the works of soil breaking were quite difficult and the size of soil on the time of planting was 1 - 5 cm. of gravel style.

The seed of soy bean, mung bean and sweet corn were sowed on 20th Jan. but the sprout of soy bean were bad, so it had to be planted again.

Soon after sowing irrigated to the plants by method of furrow irrigation.

2. Irrigating

The water irrigating was made according to sprinkling time of that field (once a week) by method of furrow irrigation, so the water irrigating in once a week was over quality for the crop at the former part of growth period (PF 2.0 - 2.2)

In the later part of growth, for the surface soil (depth of 10cm.), the water capacity of soil, one week after irrigating was PF 2.5 - 2.7 which was suitable irrigation. But since the mung bean near ground surface were much flourishing,

the stems on the edge of soil surfaced fungus disease by Fusarium after irrigation and appeared missing hills. As countermeasure, the fungicide "Captan" was sprayed.

3. State of growth

(1) Soy bean

The growth of whole part were not good, especially, the lower leaves which showed wither and on account of that the soil was excessive wet.

(2) Mung bean

The growth was good and the plants quite flourished but, on the later part of growth period the plants were suffused by disease as shown in the picture and the withered hills appeared remarkably (rate of hills affected 3%) By the result of spraying of chemicals, the affection was checked thereafter.

(3) Sweet corn

Owing to the number of plants that they grew too much and the fertilizer was insufficient, the growth was quite bad. The crop was harvested in fresh corn. As shown in the Fig.-1, the most part were in size of 60 g. and those over 100 g. are able to be made as article of commerce were quite few.

Discussion

In the purpose to make multiple cropping system on paddy field and integated agricultural area, we have made test of introducing the upland crop into the paddy farming in dry season.

According to the Agricultural Statistics yield of Thailand as specified in Table - 9 for comparison; our yield soy bean was two times higher and the yield of mung bean was 3 times. All these are owing to the effect of irrigation and fertilization that were they great.

For reference down in Table - 10 as the cost of cultivation specified in the Agricultural Statistics of Thailand as basis comparing with the yield of this test of pilot farming and calculated the profit.

Table - 1

	Seeding time	Germination time	Germination %	Missing hills %
Soy bean	Jan. 26	Jan. 30	87	0.1
Mung bean	Jan. 20	Jan. 23	90	1.1
Sweet corn	Jan. 20	Jan. 24	74	0.5

Table - 2 Soy bean

	Plant height	Stem length	Number of node	Number of branch
I	80.3	47.4	12.4	4.2
II	83.2	47.6	12.2	3.6
III	79.5	48.8	11.6	3.4
IV	76.4	43.8	11.6	3.5
average	79.9	46.9	12.0	3.7

Table - 3 Mung bean

	Stem length	No.of leaf	No.of node	No.of branch
I	82.1	9.2	11.4	6.6
II	79.7	9.6	10.7	6.4
III	77.9	10.1	10.8	7.1
IV	72.6	9.7	9.7	6.4
average	78.1	9.7	10.7	6.6

Table - 4 Sweet corn

	45 days after seeding		Stem length	No.of leaf	No.of Paniole/hill
	Plant height	No.of leaf			
I	125.8	9.2	151.5	11.4	2
II	136.8	9.6	157.1	10.9	2
III	145.0	10.1	157.7	11.7	2
IV	140.1	9.7	162.4	11.6	2
average	136.9	9.7	157.2	11.4	2

Table - 5 Soy bean yield component

	No.of/hill pods	No.of/m^2 pods	No.of/m^2 seeds	No.of/pod seeds	Normal ratio seed to total seed	100 seeds weight normal	100 seeds weight injured
I	107	713	1190	1.7	92.3	15.5	10.4
II	127	844	1355	1.6	90.9	15.4	10.7
III	116	776	1290	1.7	95.4	16.0	9.8
IV	114	861	1250	1.5	88.4	15.7	11.2
mean	116	799	1200	1.6	91.7	15.9	10.5

Table - 6 Soy bean yield kg./ha. (kg./rai)

	Normal seed	Injured seed	Total seed
I	1598 (256)	133 (21)	1731 (277)
II	2169 (347)	216 (35)	2385 (382)
III	1929 (309)	93 (15)	2022 (324)
IV	1807 (289)	236 (38)	2043 (327)
mean	1876 (300)	170 (27)	2046 (327)

Table - 7 Mung bean yield component

	No.of/hill pods	No.of/m. pods	No.of/m. seeds	No.of/pod seeds	Normal ratio seed to total seed	100 seeds weight normal	100 seeds weight injured
I	37.4	249	2440	9.8	98.0	71.5	40.6
II	34.8	232	2390	10.3	98.6	72.0	41.6
III	35.7	238	2142	9.0	97.0	72.3	42.6
IV	38.9	259	2486	9.6	98.2	71.0	41.6
mean	36.8	245	2365	9.7	98.0	71.7	41.6

Table - 8 Mung bean yield kg./ha (kg./rai)

	Normal seed	Injured seed	Total seed
I	1740 (278)	36 (6)	1776 (284)
II	1713 (274)	24 (4)	1737 (278)
III	1538 (246)	48 (8)	1586 (254)
IV	1784 (285)	33 (5)	1817 (290)
mean	1694 (271)	35 (6)	1729 (277)

Table - 9 Agricultural Statistic Yield 1978/79 (kg./ha.)

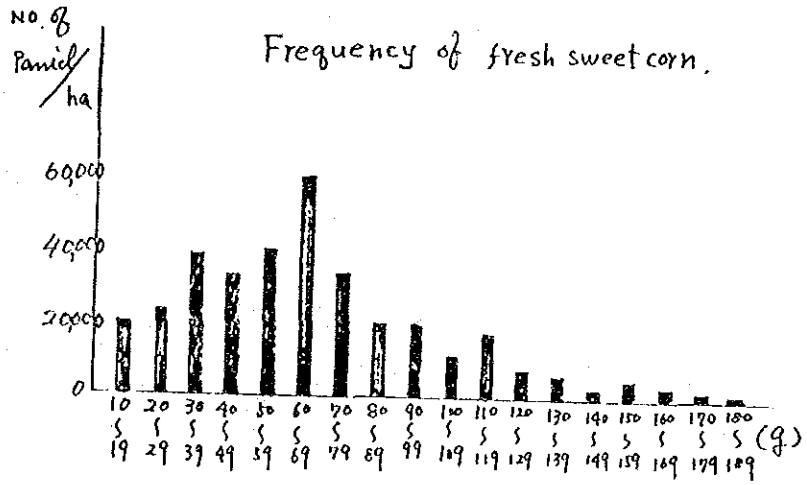
	Whole kingdom	Central plain	Suphan buri plain
Soy bean	983	945	625
Mung bean	613	572	556

Table - 10 Trial balance of farms net income

	Farm price Yield(kg./rai)	#/ Price/kg (฿)	฿ Farm price	#/ Cost (฿)	Net income (฿)
Rice	700	2.24	1568	870	698
Soy bean	300	4.77	1431	574	857
Mung bean	271	5.26	1425	500	925

#/ Agricultural Statistics of Thailand
Crop year 1979/80 (central plain)

Figure - 1



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(W E T)

Exp. 1 Effect of potassium fertilizer and fertilizer application time on germinated direct broadcasted rice

Exp. 2 Effect of seedling densities and nitrogenous fertilizer rate on the growth and yield of transplanted rice

Exp. 3 Different rates and split application of nitrogen fertilizer on the yield of transplanted rice

Exp. 4 The comparison of rice yield on rates and times of nitrogen fertilizer which refers to different cultivation methods

Exp. 1

Effect of Potassium Fertilizer and Fertilizer application Time on Germinated Direct Broadcasted Rice

Wet Season 1981

Mr. Vichien Sasiprapa
Mr. Pairat Duangpibul
Mr. Yoshiya Takashima
Dr. Tetsujiro Sugahara

Introduction

On the social demand, the germinated direct broadcasting of rice has spreaded rapidly in the recent year. However, the technique in cultivation for this method may be quite different. It depends on the condition of location and condition of sowing.

According to cultivation on the irrigated agricultural area, the technical system of cultivation has almost been built up but the various questions about the details still remained for study.

Among these matters in detail, we have performed test about the basal fertilizer application time and effect of application of potassium fertilizer on germination direct broadcasting rice.

Materials and methods

1.	Variety	RD-25
2.	Design	Factorial experiment arrange in RCBD 5 replications.
3.	Plot size	3.3m. x 6m. - $20m^2$ Block $80m^2$ Total $400m^2$
4.	Sowing	13th Aug.1981.
5.	Harvesting	11th Nov.1981.

6. Treatment

Treatment	T	F
	Basal application time	K fertilizer
T_1 F_1	1 - DBS.	0
F_2		6
T_2 F_1	20 - DAS.	0
F_2		6

(1) Fertilizer application time

mark	Basal	Top dressing
T_1	1 day before broadcasting	Panicle initiation stage
T_2	20 days before broadcasting	*

(2) Fertilizer (kg./ral)

mark	Basal	T Top	Total	P	K
T_1	4.8	7.2	12.0	6	0
T_2	4.8	7.2	12.0	6	6

* Top dressing 18th September (36 days after sowing)

Result

From the stage of the paddy, at the beginning T_1 appeared well growth as shown in the Fig.1 but when it got into the later part of growth period, the growth was restained owing to insufficiency of fertilizer.

On the other hand, the growth of the T_2 District showed badness at the beginning part but the rice recovered by fertilizing 20 days after sowing and the tillering, increased at the later part of growth period.

With regard to the effect of basal application time for yield, as shown in Table - 1, the T_1 yield 422 kg./rai (2.64 ton/ha.) and T_2 403 kg./rai (2.52 ton/ha.) in average, at the time of applying basal fertilizer and it showed no significant difference.

According to the effect of applying potassium, the applied F_2 yield of 442 kg./rai (2.76 ton/ha.) and unapplied F_2 yield of 383 kg./rai (2.39 ton/ha.) were regarded as having significant difference of 5 %.

The central plain of Thailand, the soil contains plenty of potassium thus the application of potassium is considered as being a question. But it has been recognized that there was effect for applying potassium fertilizer by the test on the plantation of germinated direct broadcasting rice.

However, on observing the state of growth of rice, the effect of N fertilizer was great and the effect of K fertilizer has not yet been as certained. So, the test on this point shall be continued in the future.

For short age variety like R.D. 25, basal fertilizer application should be done before 20 DAS because 20 DAS is very close to panicle initiation period of this variety (only 16 days different).

About yield components, the number of spikelets per panicle is very low so yield should be increased by increasing the number of spikelets per panicle with appropriate fertilizer rate. The other components are not so inappropriate and different.

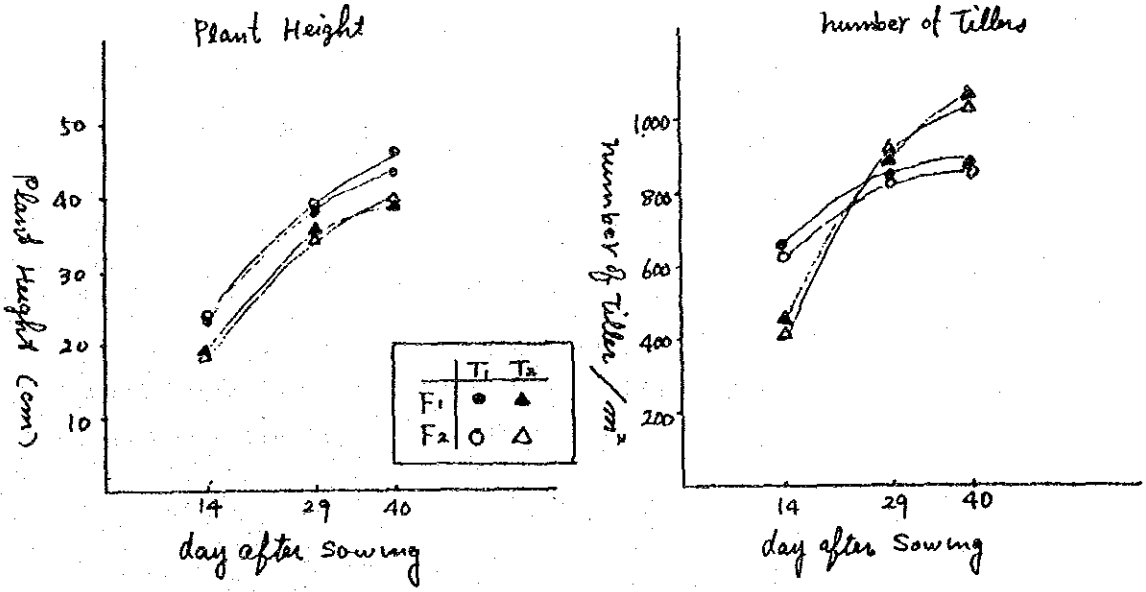
Table - 1 Yield Kg./rai

Main 1	Main 2 \ Block	I	II	III	IV	V	Mean	Main 1 mean	Main 2 mean
T_1	F_1	432	320	444	329	425	390	422	F_1 383
	F_2	520	436	468	409	434	453		
T_2	F_1	394	355	337	411	384	376	403	F_2 442*
	F_2	435	485	450	375	406	430		

Analysis of variance on yield

Variation	d.f	S.S	M.S	F	Tabular F 5 %	1 %
Block	4	9,588.7	-	-		
T (Main 1)	1	1,711.25	1,711.25	0.898^{ns}	4.75	9.33
F (Main 2)	1	17,228.45	17,228.45	9.043*	4.75	9.33
T x F	1	110.45	110.45	0.058^{ns}	4.75	9.33
Error	12	22,862.1	1,905.175			
Total	19					

Fig. - 1



Exp. 2

Effect of Seedling Densities and Nitrogenous Fertilizer Rate on The Growth and Yield of Transplanted Rice

Wet 1981

Mr. Vichien Sasiprapa
Mr. Pairat Duangpibul
Mr. Yoshiya Takashima
Dr. Tetsujiro Sugahara

Introduction

In the tropic countries, rice can be grown vigerously due to abundant of sunshine (solar energy) but the yield is still quite low comparing with some sub-tropic countries. The reason is that even number of tillers per unit area is rather high but the productive tiller is less while producing panicle. From the previous experiments, they are clearly found that the yield of paddy has closed correlation to number of panicle per unit area than the other components. Increasing of plant populations with reference of using different spacings and nitrogenous fertilizer rates, it may be one of the technique in increasing rice yield, so the experiments on those factors are performed in wet season 1981 at Suphan Buri Rice Experiment Station.

Materials and methods

1. Variety RD - 23
2. Nursery
   - Sowing 13th July 1981.
   - Seed rate 50 gm./m^2
   - Fertilizer Basal N = 3.5,P = 3.5,K = 3.5 gm./m^2
   - Top dressing (9DAS) N = 2.0 gm./m^2

3. Transplanting 29th July 1981

4. Design 2 x 4 factorial in Randomize Completed Block design 3 replications
Plot = 20m.^{2} Block = 160m.^{2}

5. Treatments

(kg/rai)

	H					M				
Main 1 fertilizer	N 24			P 12	K 6	N 12			P 12	K 6
	Basal	Top 1	Top 2			Basal	Top 1	Top 2		
	8	8	8			4	4	4		
Main 2 density/m.^{2}	16	25	32	50		16	25	32	50	

Periods of nitrogen application

Basal = DBT 1
Top 1 = DAT 15 (13th Aug.)
Top 2 = PIS (8th Sep.)

DBT - Day Before Transplanting
DAT - Day After Transplanting
PIS - Panicle Initiation Stage

Result

1. Vegetation period

Throughout the growth period, plant height in the plot of heavy application of N fertilizer are higher than those in the less fertilizer; the difference was about 10 cm. (as Fig.-1) at 24 days after transplanting. Furthermore, there are no difference in planting densities.

According to the increasing in number of tillers per hill classified by period as shown in Fig.-2, the number of tillers in the plot of heavy N fertilizer was more than the less fertilization as mentioned that the increase pattern depends on the planting density. The most densed spacing (50 hills/m^2) were already ceased to increase reaching the maximum tillering stage within 25 days after transplanting. The 32 hills/m^2 were also increasing in very small number thereafter. Furthermore, the 25 hills/m^2 and 16 hills/m^2 were continuing to increase until the time of 45 days after transplanting.

To observe the increase by the tiller per m., they are shown in the Fig-3. The plant of dense spacing plot with heavy fertilization would already reach the limit of growth for 25 days after transplanting and it was regarded as not increasing thereafter. However, those in the wide spacing plot will not reach such limit and continue to increase the tiller up to 45 days after transplanting.

Those in the plots of less fertilization also showed the same tendency. It is known that less of N fertilization will make the rice slowly grow and have the tendency of increasing of tiller until late time but it will not reach growth of community limit and have a week individual tiller.

2. Yield and yield components

The yield is as shown in the table-1. It was regarded as there is significant difference of 1% for application of N fertilization level and 5% for planting density.

For observing of planting density, in the heavy N fertilization plots, the rice planting in much number of hills would increase the yield as 16 hills 25 hills 50 hills. On the other hand, in the less N fertilization plot, rice planting in much number of hills would increase the yield to the upmost of 32 hills/sq.m. but the yield would drop down as from 50 hills as the formular 16 hills 25 hills and 50 hills 32 hills.

In observing the yield, classified by yield component, for the number of panicle per hill, it was regarded that there is significant difference of 1% for both of N fertilization level and planting density. For the number of panicle per square metre, it was regarded that there is significant difference of 1% for N fertilization level and 5% for planting density.

For the number of spikelets per panicle, it was regarded that there is significant difference of 1% between the N fertilization level and planting density respectively and apparently. It was known that both have closed relation.

For number of spikelets per m^2, it was regarded that there is significant difference of 1% for N fertilization level but no difference among the planting densities.

According to percentage of ripened grains, it was recognized that there was no difference between N fertilization and planting density but, in the thousand grain weight, it was regarded that there is significant at 1% between the fertilization levels.

Conclusion

1. Rice yield in the tropic countries can be increased by increasing number of panicle per square metre.
2. Nitrogen fertilizer plays a very important role in increasing of number and vigorousness of tiller per unit area.
3. When increasing plant population with colsed transplanting, optimal amount of fertilizer should be put into consideration otherwise it will bring to the poor growth of rice plant and cover of decreasing in yield.
4. Transplant yield increasing can be done by space adjusting and appropriate seedling per hold.

Table - 1 Yield in kilogram per rai

Main 1	Main 2	Block			Mean			
		1	2	3	Treatment	Main 1	Main 2	
H	16	797	787	709	764	797.8	DMRT	
	25	750	744	819	771		16 650.3	b
	32	713	819	867	800		25 679.3	ab
	50	846	852	871	856		32 732.0	a
M	16	572	545	492	536	597.6	50 729.2	a
	25	620	520	623	587			
	32	602	656	735	664			
	50	604	600	602	602			
F Test						5%	1%	

Table - 2 Number of panicle per hill

Main 1	Main 2	Block			Mean			
		1	2	3	Treatment	Main 1	Main 2	
H	16	15.1	14.0	12.3	13.80	9.05	DMRT	
	25	9.8	9.8	10.2	9.93		16 12.11	a
	32	7.6	6.5	8.2	7.43		25 8.78	b
	50	5.2	5.5	4.4	5.03		32 7.00	c
M	16	10.9	9.9	10.5	10.43	7.21	50 4.63	d
	25	8.6	6.7	7.6	7.63			
	32	6.0	7.1	6.6	6.56			
	50	4.1	4.3	4.3	4.23			
F Test						1%	1%	

Table - 3 Number of panicle per square meter

Main 1	Main 2	Block 1	Block 2	Block 3	Mean Treatment	Mean Main 1	Mean Main 2
H	16	241.0	223.5	196.5	220.3	237.8	
	25	243.5	244.0	255.5	247.7		
	32	224.5	206.5	261.5	230.8		
	50	261.0	277.0	219.5	252.5		
M	16	174.5	157.5	167.0	166.3	190.9	
	25	187.0	165.5	190.5	181.0		
	32	191.0	227.5	202.0	206.8		
	50	203.5	213.5	211.5	209.5		
F Test						1%	5%

DMRT

16	193.3	b
25	214.3	ab
32	218.8	a
50	231.0	a

Table - 4 Number of spikelet per panicle

Main 1	Main 2	Block 1	Block 2	Block 3	Mean Treatment	Mean Main 1	Mean Main 2
H	16	123.5	113.5	115.2	117.4	108.6	
	25	112.8	100.8	109.0	107.5		
	32	107.7	111.4	111.1	110.1		
	50	97.2	102.6	98.9	99.6		
M	16	107.8	102.5	96.2	102.2	99.6	
	25	104.1	99.0	105.1	102.7		
	32	97.4	98.5	110.0	102.0		
	50	94.7	86.5	93.0	91.4		
F Test						1%	1%

DMRT

16	109.8	a
25	105.1	a
32	106.0	a
50	95.5	b

Table - 5 Number of spikelet per square meter

(x 100)

Main 1	Main 2	Block			Mean			
		1	2	3	Treatment	Main 1	Main 2	
H	16	297	255	226	259	258		
	25	275	241	278	264			
	32	243	230	290	254			
	50	254	285	217	252		16	215
M	16	188	162	160	170	190	25	226
	25	195	165	200	187		32	233
	32	186	224	222	211		50	222
	50	192	184	197	191			
F Test						1%		ns

Table - 6 Weight of 1,000 grains

Main 1	Main 2	Block			Mean			
		1	2	3	Treatment	Main 1	Main 2	
H	16	26.5	27.9	27.0	27.1	27.6		
	25	26.7	28.3	27.5	27.5			
	32	27.7	27.3	28.4	27.8			
	50	28.0	27.3	28.4	27.9		16	26.7
M	16	26.8	26.6	25.6	26.3	26.6	25	26.9
	25	25.9	26.4	26.7	26.3		32	27.4
	32	27.6	27.0	26.6	27.1		50	27.3
	50	26.3	26.9	26.7	26.6			
F Test						1%		ns

Exp. 3 Different rates and split application of nitrogen fertilizer on the yield of transplanted rice.

Wet season 1981

Mr. Vichien Sasiprapa
Mr. Pairat Duangpiboon
Dr. Tetsujiro Sugahara

This experiment is carried out to find the economical cultivation of different nitrogen rates and split application of transplanted rice.

Method and materials

1. Variety — RD 23.
2. Design — Factorial in randomized complete block design. 3 replications. Plot = 20 m^2, block = 180 m^2 and total area = 540 m^2.
3. Nursery — Sowing 13 July 1981. Seed rate = 50 gm./m^2. Fertilizer basal N:P:K each is 3.5 gm./m^2.
4. Transplanting — 29 July 1981. 25 cm. x 20 cm. —— 20 hills/m^2, 3 seedlings/hill.
5. Treatment

Kg./rai		N				P	K
Rate \ Split		Basal	Top 1	Top 2	Top 3	Basal	Basal
12	T1	6	-	6	-	12	6
	T2	4	4	4	-	12	6
	T3	3	3	3	3	12	6
18	T1	9	-	9	-	12	6
	T2	6	6	6	-	12	6
	T3	4.5	4.5	4.5	4.5	12	6
24	T1	12	-	12	-	12	6
	T2	8	8	8	-	12	6
	T3	6	6	6	6	12	6

Basal 1 day before transplanting. Top 1 15 days after transplanting.
Top 2 Panicle initiation stage. Top 3 Heading stage.

1. Yield

Among nitrogen rate treatments, the highest yield was obtained from 18 kg/rai plot. Even the 24 kg/rai plot had the same number of spikelets per square metre as 18 kg/rai plot but the yield of 24 kg per rai plot was less because 24 kg/rai plot was lodged at 25 days after heading.

Among split nitrogen treatments, there was significant difference at 10% level. The differences among yields were not so clear. (Table 1) But the tendencies showed that the highest yield can be obtained from 3 times of nitrogen application in low and medium nitrogen rate and 4 times in high rate.

2. Yield components

Yield components were calculated from only 2 blocks.

Among nitrogen rate treatments, there was significance in the number of panicles per square metre and the number of spikelets per square metre. And among split nitrogen treatments, there was significance only the number of spikelets per panicle but there was none for the other yield components.

1) The number of panicles per square metre

Among nitrogen rate treatments, there was significance at 5% level. The number of panicles per square metre of 18 and 24 kg/rai plots were higher than 12 kg/rai plot.

Among split nitrogen treatments, there was not significance (Table 3)

2) The number of spikelets per panicle

Among nitrogen rate treatments, there was not significance. And among split nitrogen treatments, there was 1% level significance and T3 plot was higher than T1 and T2 plots.

3) The number of spikelets per square metre

For the number of spikelets per square metre, there was 5% level significance among nitrogen rate treatments (Table 2). 18 and 24 kg/rai plots were higher than 12 kg/rai plot (Table 5)

Among application times, there was not significance (Table 2,5)

4) Percentage of ripening and weight of 1,000 grains

There was not significance in both components among different nitrogen rate treatments and split times of application.

3. Discussion

This experiment had some suggestions as :

1) In wet season, the optimal rate of nitrogen supply was 18 kg/rai, 12 kg/rai rate which gave less yield and 24 kg/rai was too much at this experimental field because rice plant was early lodged before harvest that, dued to the field, it was cultivated green manuring crop as preceeding crop in dry season as the result of soil analysis in Table 6. But at present, 12 kg/rai is enough rate when considering about cost and gain from yield.

2) The best split nitrogen applications seemed to be 3 times at basal, active tillering and panicle initiation stage on transplanting method because rice plant would produce much number of panicles and spikelets per unit area. If using high nitrogen rate, it should be applied by increasing the application time to avoid the disadvantage of too much nitrogen fertilizer for rice plant.

Table 1 Yield Kg./ha

Fertilizer	N split time \ Block	1	2	3	MEAN	Fertilizer mean	N Split time mean
	T1	5027	5352	5340	5240		
12	T2	5327	5147	5420	5298	5071 (b)	
	T3	4390	4572	5061	4674		T1 4906
	T1	5296	5378	5014	5229		T2 5264
18	T2	5713	5729	5623	5688	5465 (a)	T3 5171
	T3	5710	5586	5147	5478		
	T1	4735	4025	3991	4250		
24	T2	5287	4742	4388	4806	4806 (b)	
	T3	5558	5582	4942	5361		

F test : Fertilizer 1 % significant : Split time 10 % significant.
⁂ significant 5 % level by D.M.R.T.

Table 2 Yield components (Total mean)

		No. of panicles per sq.m.	No. of spikelets -/panicle	R%	1000 grains weight	No. of spikelets per sq.m.	+ Ripened degree	Calculation yield gm./m²
	T1	193.5	118.75	75.6	27.5	22976	20.8	477.5
12	T2	203.5	117.85	75.8	27.9	23945	21.2	505.9
	T3	196.0	120.50	77.7	28.0	23592	21.7	510.9
	T1	210.0	126.10	74.7	27.6	26482	20.7	545.1
18	T2	230.0	117.65	70.9	28.0	27027	19.9	537.9
	T3	215.5	123.85	74.9	27.8	26679	20.8	555.3
	T1	223.5	114.15	72.5	27.8	25524	20.1	512.3
24	T2	232.0	119.55	68.9	28.4	27739	19.5	537.9
	T3	203.5	130.30	74.2	28.2	26524	20.9	553.2
F test	Fertilizer	*	ns	ns	ns	*	ns	ns
	N.split time	ns	**	ns	ns	ns	ns	ns

* 5 % significant, ** 1 % significant, ns no significant.
+ Ripened degree = 1000 grains weight x R% ÷ 100

Table 3 Number of panicles per square metre

Fertilizer	N. split time \ Block	1	2	MEAN	Fertilizer mean	N.split time mean	
12	T1	196	191	193.5	197.7 (b)		
	T2	205	202	203.5			
	T3	185	207	196.0		T1	209.0
18	T1	209	211	210.0	218.5 (a)	T2	221.8
	T2	244	216	230.0		T3	205.0
	T3	223	208	215.0			
24	T1	205	242	223.5	219.7 (a)		
	T2	226	238	232.0			
	T3	203	204	203.5			
F test					*		ns

* significant 5 % level by D.M.R.T

Table 4 Number of spikelets per panicle

Fertilizer	N. split time \ Block	1	2	MEAN	Fertilizer mean	N.split time mean	
12	T1	118.0	119.5	118.75	119.03		**
	T2	112.7	123.0	117.85		T1	119.66 (b)
	T3	120.3	120.7	120.50			
18	T1	123.0	129.2	126.10	122.53	T2	118.35 (b)
	T2	117.1	128.2	117.65		T3	124.88 (a)
	T3	122.0	125.7	123.85			
24	T1	111.9	116.4	114.15	121.33		
	T2	115.2	123.9	119.55			
	T3	128.0	132.6	130.30			
F test					ns		**

** significant 1 % level by D.M.R.T.

Table 5 Number of spikelets per square metre

Fertilizer	N. split time / Block	1	2	MEAN	Fertilizer mean	N.split time mean	
12	T1	23121	22831	22976	23504 (b)		
	T2	23047	24842	23944			
	T3	22193	24991	23592		T1	24994
18	T1	25710	27254	26482	26729 (a)	T2	26237
	T2	28572	25482	27027		T3	25598
	T3	27210	26147	26679			
24	T1	22942	28105	25524	26595 (a)		
	T2	26042	29436	27739			
	T3	25989	27058	26524			
F test					*	ns	

* significant 5 % level by D.M.R.T.

Table 6 Soil facilities after harvest

No. of Exp.	Pre orop	Organic matter (%)	P (p.p.m)	Total N(%)
Exp. 3	Green manure	1.7343	3.0730	0.0866
Exp. 2	Rice	1.0327	4.7292	0.0517
Exp. 3/Exp. 2		1.68	0.650	1.68

Exp. 4 The comparison of rice yield on rates and times of nitrogen fertilizer which refers to different cultivation methods.

Wet season 1981

Mr. Vichien Sasiprapa
Mr. Pairat Duangpiboon
Dr. Tetsujiro Sugahara

This experiment was carried out for clarifying among transplanting by hand, transplanting by machine and direct broadcasting methods for yield under different rates and times of nitrogen fertilizer.

Method and materials

1. Variety — RD 23.

2. Design — Split plot design, 3 replications.
Sub plot = 60 m^2, main plot = 180 m^2,
block = 380 m^2 and total area = 1080 m^2.

3. Sowing

Hand transplanting — Sowing 13 July 1981, seed rate = 50 gm./m^2.
Fertilizer basal N:P:K each is 3.5 gm./m^2.

Machine transplanting — Sowing 13 July 1981.
Seed box nursery, basal ammonium phosphate = 3 gm./box and seed rate = 140 gm./box.

Direct broadcasting — Sowing 24 July 1981.
1 night soaking and 1 night covering.

4. Transplanting

Hand — 30 July 1981. (seedling age 20 days)
20 cm. x 20 cm. and 3 seedlings/hill.

Machine — 30 July 1981. (seedling age 15 days)
30 cm. x 14 cm. and 3 seedlings/hold

5. Treatment

		N			P	K
Sub \ Main	Total -	1 st (6 Aug.)	2 nd (21 Aug.)	3 rd (P.I.S)	1 st (6 Aug.)	1 st (6 Aug.)
Direct	12	6	-	6	6	6
	18	6	6	6	6	6
Hand	12	6	-	6	6	6
	18	6	6	6	6	6
Machine	12	6	-	6	6	6
	18	6	6	6	6	6

Result

1. Yield

Yield sampling area was 10 square metre out in each plot but 18 kg/rai plot under direct sowing at block 3, which had a lot of rat damage, was adjusted by statistic mehtod.

1) Different nitrogen rates as main factor

The plot that fertilizer rate was 18 kg/rai was effected by lodging at 10 days after heading so it gave less yield than 12 kg/rai plot. (Table 1) (High nitrogen rate causes lodging)

2) Different cultivation methods as sub factor

Among cultivation methods, the yield of machine transplanting plot was the highest one. The next was the yield of hand transplanting plot and the last one was the yield of direct sowing plot.

The yield of direct sowing plot was the lowest one because of early lodging effect in 18 kg/rai plot.

The statistic significance is 1%

2. Yield components

Yield components sampling was one square metre in each plot.

1) Comparison of nitrogen rate as main factor

Between 12 and 18 kg/rai plots, the number of panicles per unit area of 12 kg/rai plot was higher than 18 kg/rai plot. The reason was that direct sowing plots gave different numbers of panicles per unit area. So, 12 kg/rai plot gave more panicles than 18 kg/rai plot. This fact was doubted so it was needed to clarify in the future repeated trial.

2) Comparison of cultivation method as sub factor

Direct sowing method gave more number of panicles than other methods but the number of spikelets per panicle was the lowest.

The number of spikelets per unit area of machine transplanting plot was the highest one. (The number of spikelets per unit area is closely related with yield.)

Conclusion

1. In high feritlity soil, 12 kg/rai of nitrogen rate is enough for rice plant. (This area was nourished by mung bean planting before the expe experiment.)

2. In direct sowing cultivation, the appropriate fertilizer rate should be considered. If not, there will be lodging which effected rice yield because the plant is too high by too much fertilizer.

3. From this experiment, if applying appropriate fertilizer rate and good managing, the received yield won't be different from the yield of transplanting rice cultivation such as in case of 12 kg/rai of nitrogen rate in this experiment.

Table 1 Yield Kg./ha

Main	Sub \ Block	1	2	3	MEAN	Main mean	Sub mean	
12	Direct	4564	3944	5042	4517	4853*		
	Hand	4886	4765	4637	4763			
	Machine	5337	5100	5406	5281		Direct	4012 (c)
18	Direct	3351	3161	(3231)	3256	4403	Hand	4691 (b)
	Hand	5035	4284	4536	4618		Machine	5117 (a)
	Machine	5320	4536	5002	4953			
F test						*	**	

The common letters are not significant by D.M.R.T.

Table 2 Yield components

Main (N fertilizer)	Sub (method)	No. of panicles -/sq.m.	No. of spikelets -/panicle	R%	1000 grains weight	No. of spikelets per sq.m.	+ Ripened degree	Calculation yield gm./m²
12	Direct	414	63.3	72.5	28.6	26155	20.7	536
	Hand	231	93.4	80.7	27.9	21508	22.5	483
	Machine	311	99.1	72.1	26.4	30720	19.0	585
18	Direct	270	76.1	66.2	28.1	20069	18.7	364
	Hand	223	108.4	76.4	28.0	24160	21.4	517
	Machine	329	97.1	70.8	26.9	31854	19.1	608

+ Ripened degree = 1000 grains weight × R% ÷ 100

Table 3 Main and sub means on yield components

Factor	Item	No. of panicles -/sq.m.	No. of spikelets -/panicle	R%	1000 grains weight	No. of spikelets per sq.m.	+ Ripened degree	Calculation yield
Main	12	319	82.3	75.1	27.6	26128	20.8	535
	18	274	96.1	71.8	27.6	26023	19.9	513
F test		*	ns	ns	ns	ns	ns	*
Sub	Direct	356 (a)	68.4 (b)	70.0 (b)	28.4 (a)	23721 (b)	19.9 (b)	467 (b)
	Hand	227 (b)	100.9 (a)	78.6 (a)	28.0 (a)	22834 (b)	22.0 (a)	500 (b)
	Machine	320 (a)	98.1 (a)	71.5 (b)	26.7 (b)	31287 (a)	19.1 (b)	597 (a)
F test		**	**	*	**	**	*	**

The common letters are not significant by D.M.R.T.

1 9 8 2 D R Y

1. Effect of different transplanting to rice yield 1981
2. Density and nitrogen rate trial on transplanting rice
3. Fundamental test for germinated direct broadcasted rice
4. General discussion of density and nitrogen rate and recommendation of intensive cultivation technique of transplanting rice
5. Recommendation of intensive transplanting cultivation technique of rice
6. Recommendation of intensive transplanting cultivation technique of rice at Chao Phya and Mae Klong Pilot Project areas

Exp. 1

Effect of different transplanting to rice yield

1 9 8 1

Mr. Vichien Sasiprapa
Mr. Pairat Duangpiboon
Mr. Yoshiya Takashima
Dr. Tetsujiro Sugahara

This experiment was carried out to clarify yield of rice on different transplanting time.

Method and material

1. Variety — New varieties those resist brown planthopper, R.D. 21 and R.D. 23, R.D. 7 and R.D. 9 as the control varieties

2. Sowing-transplanting

Season	Variety	Sowing	Transplanting	Spacing	Seedling -/hill
Dry	R.D. 7	24 Feb. 1981	16 Mar. 1981	25x25	3
Early Wet	R.D. 7, 9,21,23	26 May 1981	16 June 1981	25x12.5	2
Wet	R.D. 7, R.D. 23	12 Aug. 1981	1 Sep. 1981	30x15	3
Early Dry	R.D. 7, R.D. 23	11 Nov. 1981	1 Dec. 1981	30x15	3

3. Nursery fertilizer

Basal gm./m^2 N = 3.5 ; P = 3.5 ; K = 3.5

Seed rate 50 gm./m^2

4. Main field

Fertilizer	N	P	K	Note
Total	24	12	6	
Basal	10	12	6	- Before transplanting
Top 1	8	-	-	- 15 days after transplanting
Top 2	6	-	-	- P.I.S (45~50 D.A.T)

Result and discussion

1. Yield

Table 1 and Table 2 showed yield of different transplanting times of RD 7 and RD 23. There was not significance among yield of different season in RD 7. But in RD 23, there was 1% significance between yield of different season that June transplanted yield was higher than December transplanted yield.

Table 3 showed four varieties yield which were transplanted in June. This result was not significant among four varieties.

But these results couldn't be concluded because they came from the only one time trial.

2. Yield components

Table 4 and 5 showed data of yield components of June and September transplanted rice.

Among four varieties comparison, the number of panicles per square metre of RD 23 was more than RD 7 in 2 times test results and the number of spikelets per square metre got the same trend also.

3. Plant height

At the harvest time, RD 21 was the highest one in culm length and plant height and the shortest one was RD 9.

4. The number of tillers

Table 7 showed the number of development tillers.

The maximum tillering stage seemed to be between 25 35 days after transplanting.

Table 1. Yield of different transplanting times of R.D. 7 (Kg./ha)

R.D. 7

TR*	HR*	I	II	III	IV	Mean	
16/3	20/8	4,211	5,030	4,386	3,979	4,402	
16/6	22/9	4,290	4,367	4,812	5,102	4,643	
1/9	1/12	4,620	4,375	4,814	4,883	4,673	ns
1/12	9/4	5,081	4,381	4,975	4,684	4,780	

Table 2. Yield of different transplanting times of R.D. 23 (Kg./ha)

Variety	TR*	HR*	I	II	III	IV	Mean	1 % significant
	16/6	22/9	5753	6098	5103	5373	5582	a
R.D. 23	1/9	1/12	5186	4712	5273	5159	5083	ab
	1/12	9/4	4141	4333	4458	4250	4296	b

Table 3. Yield of four varieties (Kg./ha)

Transplanting on 16 th June

Variety	Harvest	I	II	III	IV	Mean	
R.D. 7	22/9	4,290	4,367	4,812	5,102	4,643	
R.D. 9	22/9	5,555	5,522	5,250	5,070	5,349	ns
R.D. 21	25/9	4,208	5,945	5,373	4,452	4,995	
R.D. 23	22/9	5,753	6,098	5,103	5,373	5,582	

* TR = Transplanting

* HR = Harvest

Table 4. Yield components of 16 th June transplanted rice

Variety \ Components	Panicles/-sq.m.	Spikelets/-panicle	R%	1000 grains weight	Spikelets/-sq.m.	※ R-D	Yield (gm/m²)
R.D. 7	189.6	108.0	71.5	29.8	20,477	21.3	437.0
R.D. 9	257.6	102.3	65.6	29.4	26,359	19.3	508.8
R.D. 21	233.2	123.3	72.0	28.7	28,765	20.7	596.4
R.D. 23	272.8	104.5	77.2	27.2	28,521	21.0	600.0

※ Ripened degree = (R% × 1000 grains weight) ÷ 100

These yield components are calculated from 80 hills sample.

Table 5. Yield components of 1 st September transplanted rice

Variety \ Components	Panicles/-sq.m.	Spikelets/-panicle	R%	1000 grains weight	Spikelets/-sq.m.	R-D	Yield (gm/m²)
R.D. 7	209.5	116.1	75.4	27.7	24,338	20.9	508.7
R.D. 23	235.3	123.9	72.9	26.8	29,176	19.6	571.9

These yield components are calculated from 80 hills sample.

Table 6. Plant height cm. (16 June transplanting)

Variety / *D.A.T	R.D. 7	R.D. 9	R.D. 21	R.D. 23
15	37.9	36.8	42.5	37.1
25	52.5	52.1	59.2	49.1
35	61.7	66.5	73.0	61.5
Harvest length culm	90.5	83.5	102.1	94.2
Harvest length panicle	28.6	24.7	27.9	29.2
Harvest plant height	119.1	108.2	130.0	123.4

10 hills sampling, measure plant height in each hill

*D.A.T = Days after transplanting

Table 7. Number of tillers per hill (16 June transplanting)

Variety / D.A.T	R.D. 7	R.D. 9	R.D. 21	R.D. 23
15	8.8	8.9	8.1	8.6
25	15.8	18.1	16.1	18.5
35	15.0	18.1	15.7	18.1

The samples are 10 hills.

Exp. 2

Density and nitrogen rate trial on transplanting rice

1 9 8 2 Dry

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Mr. Pairat Duangpiboon
Dr. Tetsujiro Sugahara

This experiment was carried on a series of density trial from 1981 Dry season for rice yield increasing.

Accordingly, this trial was done for finding yield and yield components of different densities (16, 32 and 50 hills per sq.m.) and different nitrogen rate (12, 18 and 24 Kg per rai).

Material and method

1. Variety R.D. 23
2. Design Randomized complete block design
   - Main 1 Density 3 levels
   - Main 2 Nitrogen rate 3 levels
3. Plot size 4 m. x 5 m. = 20 m^2., block = 180 m^2. and total = 540 m^2.
4. Sowing 18 th March 1982
   - Seed rate 50 gm./sq.m.
   - Fertilizer gm./m^2 3.5 - 3.5 - 3.5
   - Transplanting 3 rd April 1982
   - Harvest 8 th July 1982
5. Treatment

5-1 Density

Density	Spacing	No. of seedling/hill
16	25 x 25	3
32	25 x 12.5	2
50	20 x 10	2

5-2 Fertilizer

Nitrogen Kg/rai	Basal			Top 1	Top 2	Total		
	N	P	K	N	N	N	P	K
12	4	12	6	4	4	12	12	6
18	6	12	6	6	6	18	12	6
24	8	12	6	8	8	24	12	6

Basal = 1 day before transplanting
Top 1 = 15 days after transplanting
Top 2 = paniole initiation stage

Result

1. Plant height and culm length at harvesting time

About culm length and plant height, heavy nitrogen plot (18,24 kg/rai) were higher than 12 kg/rai nitrogen plot. But the panicle length was not much different among treatment plots.

At different densities, there wasn't any clear different on culm length, panicle length and also plant height.

2. Yield

The grain yield and analysis of variance of yield were shown in Table 2-1, 2-2 and 2-3.

For among main effect on densities, the highest yield obtained from the 32 hills/sq.m. plot which was 7,301 kg/ha. The lower and higher denses (16 and 50 hills/sq.m.) weren't shown any difference in yield (6,642 and 6,449 kg/ha respectively.)

In comparison on nitrogen rates, the maximum yield was obtained from the 18 kg.n/rai plot (7,158 kg/ha) but showed not significant difference with 24 kg.n/rai plot (6,705 kg/ha). The lower rate of nitrogen 12 kg/rai, yield of rough rice was the lowest (6,528 kg/ha) and showed highly significant difference in statistic analysis with the yield of 18 kg.n/rai plot.

For individual comparison of treatment yield of rough rice in Table 2-3, the highest yield was 32 hills/sq.m. with 18 kg.n/rai plot (7,950 kg/ha), the lowest yield was obtained from the wider density with low rate of nitrogen application plot (6,222 kg/ha).

3. Yield components

Yield components data and analysis of significance were shown in Table 3-1 and 3-2

Table 3-1 showed that the density effect on number of panicle per sq.m. seemed to be the same trend of increasing indensity of plant per unit area that more number of panicle could be obtained. For number of spikelets/panicle and number of spikelets/sq.m., it showed the opposite tendency, the least yield components which were ripening percentage and 1,000 grains weight showed non-significant differnce among densities treatments.

Table 3-2 showed nitrogen rates effect which were non-significant different on number of panicle/sq.m., number of spikelets/panicle and ripening percentage but for differences in 1,000 grains weight, the more nitrogen application could obtain the higher in grain weight.

Conclusion

From this experimental result, differences between crop cutting area for yield and calculated yield (yield components) occured due to the sample area taken for yield components analysis, it was less and less lodging than crop cutting area for yield. But many interesting points can be obtained for considering and conclusion as follows :

1. When increasing the number of hills per square metre and nitrogen rate of application of transplanting rice cultivation, lodging effect should be put into consideration and awareness.
2. Lower in density have opportunity to apply higher nitrogen fertilizer rate, at the same time if using higher in density of planting, lower nitrogen rate was necessity.
3. Higher yield can be obtained which optimal planting density (32 hills per sq.m.) and applied nitrogen at 18 kg/rai in the case of transplanting rice for Dry season in the Central plain area as the result of this trial.

Table 1 Culm and panicle length and plant height at harvest time of density and nitrogen trial on transplanting rice.

Treatment Density	Nitrogen	Culm length	Panical length	Plant height
16	12	103.9	25.0	128.9
	18	109.6	26.4	136.0
	24	109.7	26.0	135.7
32	12	102.7	25.2	127.9
	18	104.3	25.3	129.6
	24	112.5	25.2	137.7
50	12	100.5	25.0	125.5
	18	107.4	25.5	132.9
	24	106.0	25.4	131.4

Plant height samples were taken from the highest plant in each hill of 10 hills which were harvested from each plot of 3 blocks.

Table 2-1 Yield (Kg./ha) of density and nitrogen rate trial

Density hill/m^2	Nitrogen Kg./rai	I	II	III	Mean	
16	12	6141	6128	6398	6222	6642
	18	6428	6867	6975	6757	
	24	6844	7056	6939	6947	
32	12	6687	6716	7852	7085	7301
	18	7112	8583	8181	7959	
	24	6943	6827	6806(L)	6859	
50	12	6118	6488	6224	6277	6449
	18	6924	6836	6519	6760	
	24	6273(L)	6579	6076(L)	6309	

(L) = Lodging on after heading

Table 2-2 Yield comparison among main effect of density and nitrogen rate

Density		Yield	$\dot{X}$ 1%	Nitrogen		Yield	$\dot{X}$ 1%
16	hill/m^2	6,642	b	12	Kg./rai	6,528	b
32	"	7,301	a	18	"	7,158	a
50	"	6,449	b	24	"	6,705	ab

$\dot{X}$ Significant levels of DMRT are followed to F test

Table 2-3 Individual comparison of treatment yield

	Treatment name Density		Nitrogen	Yield	$\dot{X}$ Significant 5%
1.	32	-	18	7,959	a
2.	32	-	12	7,085	b
3.	16	-	24	6,947	bc
4.	32	-	24	6,859	bcd
5.	50	-	18	6,760	bcd
6.	16	-	18	6,756	bcd
7.	50	-	24	6,309	cd
8.	50	-	12	6,277	cd
9.	16	-	12	6,222	d

$\dot{X}$ Any two means having a common letter are not significantly different at 5 % level

Table 3-1 Yield components of density and nitrogen rate by hand transplanting

Treat-ment		No. of paniole -/sq.m.	No. of spikelet -/paniole	R%	1,000 grains weight	Yield gm/m^2	No. of spikelet -/sq.m.	Ripening degree
16	12	225.1	112.7	82.6	25.7	535.0	25,187.3	21.2
	18	242.1	126.1	83.1	26.5	671.4	30,502.0	22.0
	24	261.1	125.1	81.5	26.3	697.3	32,623.3	21.5
32	12	252.8	109.3	84.9	25.9	607.9	27,547.3	22.0
	18	261.3	116.7	84.0	26.7	680.0	30,361.3	22.5
	24	292.8	114.2	80.0	27.3	731.3	33,446.0	21.8
50	12	315.8	108.4	82.6	26.3	742.1	34,212.7	21.7
	18	319.2	109.1	82.0	27.0	769.8	34,819.0	22.1
	24	347.5	113.8	80.6	26.8	845.6	39,244.0	21.6

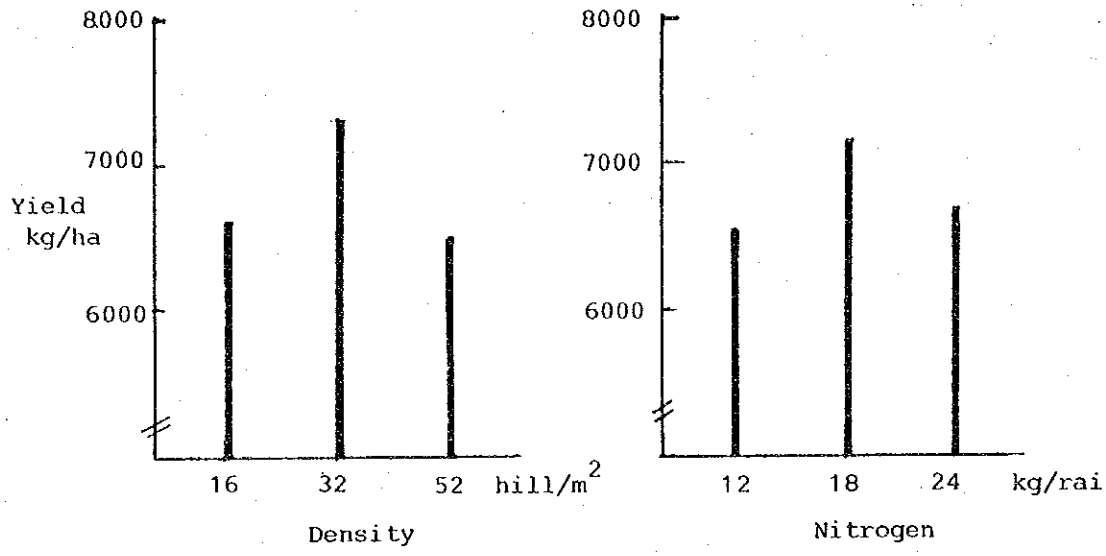
Table 3-2 Treatment mean and ~~significant~~ significance of yield components

Components / Treat-ment	Significant	Pa/m^2	Sp/pa	R%	1000GW	Yield gm/m^2	Sp(100) -/sq.m.	R-D
		1%	1%	ns	ns	1%	1%	ns
Density (hill/m^2)	16	243 b	121 a	82.4	26.2	634.6 b	294 b	21.6
	32	269 b	113 ab	83.0	26.6	673.0 b	305 b	22.1
	50	328 a	110 b	81.7	26.7	785.9 a	361 a	21.8
Significant		ns	ns	ns	5%	1%	1%	ns
Nitrogen rate (Kg/rai)	12	265	110	83.3	26.0 b	628.3 b	290 b	21.6
	18	274	117	83.0	26.7 a	707.1 ab	319 ab	22.2
	24	300	118	80.7	26.8 a	758.1 a	351 a	21.6

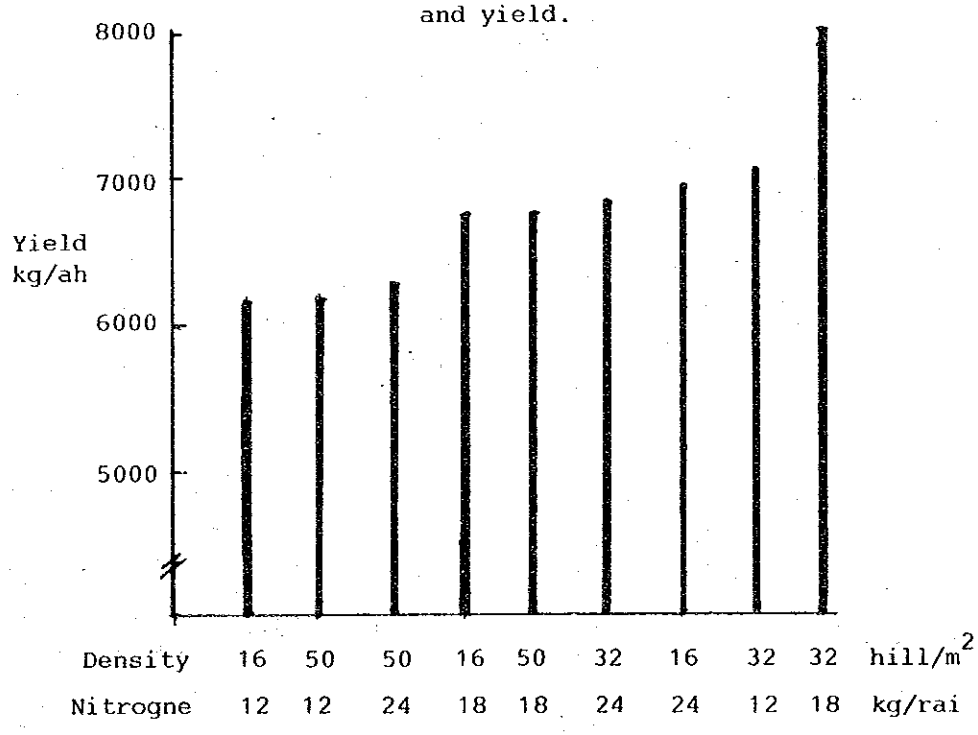
Significant level as F test and DMRT

Yield components samples were taken 20 hills in each plot of 3 blocks

Fig. 1 Yield and density



Combination density, nitrogen and yield.



Exp. 3

Fundamental test for germinated direct broadcasted rice

1 9 8 2 Dry

Mr. Vichien Sasiprapa
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This experiment was carried on to obtain basic data of germinated direct broadcasted rice. Accordingly, this trial was done for finding yield and yield components of four nitrogen (6, 12, 18 and 24 Kg./rai) and seed rate (8, 16, 24 and 32 Kg./rai).

Material and method

1. Variety R.D. 23
2. Design Split - plot, 3 replications
   Main Nitrogen
   Sub Seed rate
3. Plot size Sub plot 28 m^2., Main 112 m^2., Block 448 m^2. and Total 1,344 m^2.
4. Sowing 2 nd April 1982
   Harvest 22 nd July 1982
5. Treatment

	Total				Basal				Top 1			
	F1	F2	F3	F4	F1	F2	F3	F4	F1	F2	F3	F4
Main = Nitrogen Kg/rai	6	12	18	24	3	6	9	12	3	6	9	12
P	6	6	6	6	6	6	6	6	-	-	-	-
K	6	6	6	6	6	6	6	6	-	-	-	-

Sub = Seed rate Kg./rai 8, 16, 24, 32

Basal 15 days after sowing
Top 1 panicle formation stage

Result and discussion

1. Plant height, culm and panicle length

Plant height, culm and panicle lenght were trended to be longer in less seed rate plot than in more seed rate plot, but in heavy fertilizer factor, the differences of length among seed rate plots weren't clear.

2. Yield

Yield data was shown in Table 2-1 and comparison of yield among main and sub effect was shown in Table 2-2.

In nitrogen rate factor, yield of 6, 12 and 18 kg/rai were higher than 24 kg/rai. In seed rate case, yield of less seed rate plots were higher than others.

These results were dued to those heavy nitrogen and seed rates plots were lodged at early heading stage.

Individual comparison of treatment yields was shown in Table 2-3 and Figure 1.

The results were very clearly different, the yields which come from less nitrogen and seed rate plots belong to significant (a) group. On the other hand, yields of heavy nitrogen and seed rate plots belong to (c) group which were the lowest yield of all.

This result suggested that the better condition should be 8 kg/rai of seed rate and 12 - 18 kg/rai of nitrogen rate. If choosing nitrogen rate 6 kg/rai, seed rate should be increased to be 16 - 24 kg/rai but avoid the rate 32 kg/rai.

In general, there is no need to apply nitrogen in rate 24 kg/rai because too much fertilizer is the cause of lodging.

3. Yield components

Yield components data and significant check were shown in Table 3.

1) Among nitrogen rate plots, there were significance on number of panicles per square metre, ripening percentage, number of spikelets per square metre, ripening degree and yield.

In number of panicles per square metre, there were trend to have more panicles in less nitroten plots than heavy nitrogen plots.

Less nitrogen plots were clearly higher in ripening percentage than the heavy nitrogen ones and about the ripening degrees were the same also.

Number of spikelets per square metre and yield were the same trend. Less nitrogen rate plots gave higher yield than heavy nitrogen rate plots because heavy nitrogen rate plots were lodging at early maturing stage.

In commonly, the more nitrogen applying, the more panicles getting, so this result was a doubt because the plots those received heavy nitrogen gave less panicles than the less ones by not having the appropriate reason. But the ripening percentage had no problem because lodging that caused by heavy nitrogen could reduce ripening percentage.

So, don't apply heavy fertilizer in direct sowing rice cultivation because it is the cause of lodging that will reduce the yield.

Among seed rate plots, there were significance on number of spikelets per panicle, number of spikelets per square metre and yield.

In number of spikelets per panicle, 8 kg/rai of seed rate plot had more spikelets than the other seed rate plots while their panicle number were nearly the same.

This result could be explained that there would be more competition in growing stage of heavy seed rate plots than in less seed rate plot, but this was the doubtful reason, so there should be some further investigation trial on this reason again.

There were many interesting results those should be clarified again because there was no reasonable phenomenon to explain them.

Table 1 Culm and panicle length and plant height at harvesting time of nitrogen and seed rate on direct broadcasted rice.

Treatment Nitrogen	Seed	Culm length	Panicle length	Plant height
6	8	92.9	23.0	115.9
	16	85.4	21.2	106.6
	24	88.3	21.3	109.6
	32	83.2	19.4	102.6
12	8	99.4	21.9	121.3
	16	95.6	21.4	117.0
	24	92.4	22.2	114.6
	32	95.5	20.4	115.9
18	8	100.0	23.6	123.6
	16	98.6	22.8	121.4
	24	95.3	22.3	117.6
	32	90.3	21.8	112.1
24	8	105.0	23.9	128.9
	16	101.8	22.8	123.8
	24	99.6	23.9	123.5
	32	98.2	23.0	121.2

Plant height samples were taken 10 plants in each plot of 3 blocks.

Table 2-1 Yield (Kg./ha) of germinated direct sowing

Nitrogen Kg./rai	Seed rate Kg./rai	I	II	III	Mean
6	8	6,527	6,103	5,949	6,193
	16	5,696	5,557	6,164	5,806
	24	6,395	5,901	5,428	5,908
	32	5,501	6,129	5,533	5,721
12	8	6,872	6,704	6,448	6,675
	16	5,605(L)	5,742	6,069	5,805
	24	6,385	4,766(L)	5,513	5,555
	32	5,996(L)	5,304(L)	5,546	5,615
18	8	6,030	7,548	5,618	6,399
	16	3,333(L)	5,611(L)	5,676	4,873
	24	3,781(L)	4,796(L)	3,107	3,895
	32	4,823(L)	4,170(L)	4,589	4,527
24	8	4,900	3,377(L)	4,776(L)	4,351
	16	3,724(L)	3,577(L)	2,937	3,413
	24	4,178(L)	2,694(L)	3,626(L)	3,499
	32	2,971(L)	3,710(L)	3,205(L)	3,295

(L) = Lodging on after heading

Table 2-2 Yield comparison among main effect of nitrogen and sub effect of seed rate

Main = nitrogen	Yield	$\dot{X}_{.1\%}$	Sub = seed rate	Yield	$\dot{X}_{.1\%}$
6	5,907	a	8	5,904	a
12	5,913	a	16	4,974	b
18	4,924	a	24	4,714	b
24	3,640	b	32	4,790	b

$\dot{X}_{\alpha}$ Significant level of DMRT and F test

Table 2-3 Individual comparison of treatment yield

	Lodging	Nitrogen - Seed rate	Yield	Significant 1%
1.		12 - 8	6,675	a
2.		18 - 8	6,399	a
3.		6 - 8	6,193	a
4.		6 - 24	5,908	a b
5.		6 - 16	5,806	a b
6.	L	12 - 16	5,805	a b
7.		6 - 32	5,721	a b
8.	2L	12 - 32	5,615	a b
9.	L	12 - 24	5,555	a b
10.	2L	18 - 16	4,873	b c
11.	2L	18 - 32	4,527	b c
12.	2L	24 - 8	4,350	b c
13.	2L	18 - 24	3,895	c
14.	3L	24 - 24	3,499	c
15.	2L	24 - 16	3,413	c
16.	3L	24 - 32	3,295	c

* L = one plot only lodging, 2L = 2 plots lodging, 3L = 3 plots lodging
** Significant level of F test and DMRT

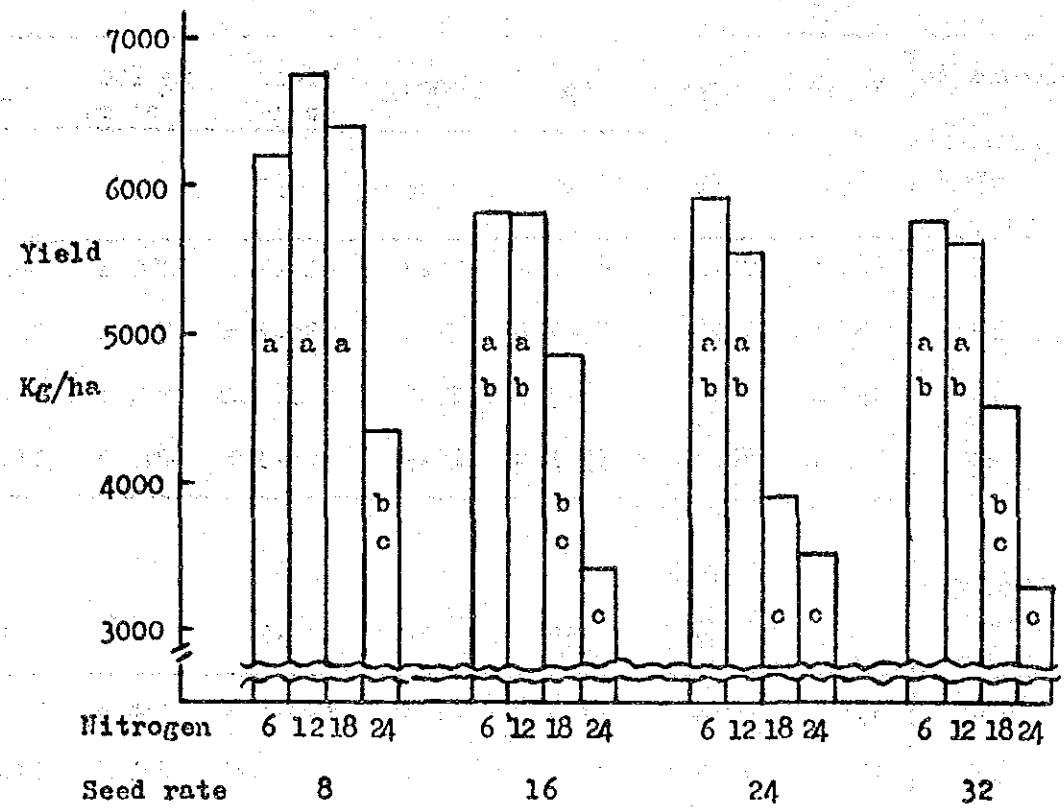
Table 3 Yield components mean and significant of nitrogen and seed rate on direct sowing

Components / Treatment		Pa/m^2	Sp/pa	R%	1000GW	Yield gm/m^2	Sp(100) -/sq.m.	R-D
Significant	Main	1%	ns	1%	ns	1%	5%	1%
Nitrogen rate (Kg/rai)	6	400 a	72.1	84.7 a	26.7	632.7 a	280 a	22.6 a
	12	385 a	77.0	77.7 b	27.4	636.2 a	297 a	21.3 b
	18	334 ab	84.0	68.7 c	27.2	513.0 ab	274 a	18.7 c
	24	258 b	78.7	59.1 d	26.9	326.3 b	201 b	15.9 d
Significant	Sub	ns	1%	ns	ns	1%	1%	ns
Seed rate (Kg/rai)	8	333	90.4 a	74.3	27.2	605.5 a	298 a	20.2
	16	356	76.7 b	73.4	27.1	552.8 ab	271 ab	19.9
	24	340	75.1 b	70.8	27.0	497.1 bc	253 bc	19.1
	32	348	69.5 b	71.8	26.8	452.9 c	229 c	19.3

Significant level is DMRT and F test

Yield components samples were taken 1 square metre in each plot of blocks

Figure 1 Comparison of each treatment yield



4. General discussion of density and nitrogen rate and recommendation of intensive cultivation technique of transplanting rice.

1. Density and spacing

Density and spacing experiments had been done four times trials those were in Dry season 1981, Wet season 1981 and Dry season 1982 so this is the summary of those experimental results. (See Table-1 to Table-4)

Yield of 16 hills per square metre was lower than yield of 25, 32 and 50 hills densities.

Yield of 50 hills per square metre was some case higher than yield of 25 and 32 hills densities but lower than yield of 25 and 32 hills densities when lodging was occured.

Not only density but also nitrogen quantity and soil fertility those effected rice yield.

But in general, these results suggest the good density should be 25 ~ 32 hills per square metre and should avoid 16 and 50 hills densities.

2. Nitrogen rate

Experimental results of different nitrogen rates (12, 18 and 24 Kg. per rai) were shown in Table-3, 4 and 5.

Those results suggest the 12 Kg./rai of nitrogen is too less and the 24 Kg./rai of nitrogen is over application.

The optimum nitrogen rate for getting more yield seems to be 18 Kg. per rai

Table-1 Different nurseries and spaces 1981 Dry

Field = 5-2 : Variety R.D. 7 : Nitrogen = 16 Kg./rai

Density \ Nursery	Dry	Wet	Density mean
16 hills/m²	4,842	5,187	5,015
25	5,730	5,274	5,502 *
Nursery mean	5,286	5,230	
Significant	ns		

Table-2 Density pre trial 1981 Dry

Field = 5-2 : Variety R.D. 7 : Nitrogen = 16 Kg./rai

Density	Mean	Significant
16	4,786	
25	5,212	
32	5,187	ns
50	5,818	

Table-3 Density and nitrogen rate 1981 Wet

Field = 5-2 : Variety R.D. 23

Density \ Nitrogen Kg./rai	12 X	24 X	Density mean XX
16 hills/m²	3,350 c	4,775 a	4,064 B
25	3,669 bc	4,819 a	4,246 AB *
32	4,150 b	5,000 a	4,575 A
50	3,763 bc	5,350 a	4,558 A
Nitrogen mean	3,735	4,896 **	

Table-4 Density and nitrogen rate 1982 Dry

Field = 7-5 : Variety R.D. 23

Density \ Nitrogen Kg./rai	12		18		24		Density mean	
16	6,222	d	6,756	bcd	6,947	bc	6,642	B
32 hills/m²	7,085	b	7,959	a	6,859	bcd	7,301	A **
50	6,277	cd	6,760	bcd	6,309	cd	6,449	B
Nitrogen mean	6,528	B	7,158	A	6,705	AB	**	

Table-5 Nitrogen and split application 1981 Wet

Field = 2-5 : Variety R.D. 23

Nitrogen \ Split time	2		3		4		Nitrogen mean	
12	5,240	abc	5,229	abc	4,250	cd	5,071	AB
18 Kg./rai	5,298	abc	5,688	a	4,806	cd	5,465	A **
24	4,674	cd	5,481	ab	5,361	abc	4,806	B
Time mean	4,906		5,264		5,172	ns		

Individual comparing by DMRT
Group comparing by DMRT
} Common letter is not significant

F test = ** 1% level, * 5% level and ns = no significant

5. Recommendation of intensive transplanting cultivation technique of rice

This cultivation method was based on the experiment carried on at Suphan buri Rice Experiment Station field which the soil fertility is medium and heavy clay texture.

Intensive method

1) Variety — R.D. 7 and R.D. 23
(R.D. 23 is the ragged stunt resistant variety)

2) Seed selection — The best method is salt solution selection or at least doing by water selection.

3) Nursery
Seed rate 50 gm./m^2
Fertilizer gm./m^2
Basal N = 3.5 P = 3.5 K = 3.5
Duration 20 days

4) Main field
Density 25 and 32 hills/m^2
25 hills spacing 20cm×20cm 3 seedlings/hill
32 hills spacing 25cm×12.5cm 2 seedlings/hill

Fertilizer

Total			Basal			Top 1	Top 2	
N	P	K	N	P	K	N	N	
18	12	6	6	12	6	6	6	
18	6	0	6	6	0	6	6	P,K abundant field

Basal : before transplanting by mixing with soil
Top 1 : 15 ~ 20 days after transplanting (Activity tillering growth stage)
Top 2 : 40 ~ 45 days after transplanting (Panicle initiation growth stage)

5) Weedicide — Saturn G 5 Kg./rai at 7 days after transplanting

6) Plant protection — Applying Furadan at least 2 times
1 st : 10 days after transplanting
2 nd : 40 days after transplanting

7) Water management — Soil should always submerge under water 5 ~ 10 cm. especially in period of 40 days after transplanting to 20 days after flowering.

6. Recommendation of intensive transplanting cultivation technique of rice at Chao Phya and Mae Klong Pilot Projects areas

I.A.D.P

This cultivation method was based on the experiment carried on at Chao Phya, Mae Klong Pilot Projects and Suphan Buri Training Center.

Intensive method

1) Variety — R.D. 21 and R.D. 23 (ragged stunt resistant varieties)
R.D. 7 (non-resistant variety to ragged stunt)

2) Seed selection — The best method is salt solution selection (Specific gravity = 1.10) or at least doing by water selection.

3) Nursery
- Seed rate — 50 gm./m^2
- Fertilizer — gm./m^2
  Basal N=3.5 : P=3.5 : K=3.5
  If rice growth isn't good, supply top dressing N=0.5 gm./m^2 at 5 days before transplanting.
- Duration — 20 days

4) Main field
- Density — 25 and 32 hills/m^2
  25 hills : spacing 20x20 cm. 3 seedlings/hill
  32 hills spacing 25x12.5 cm. 2 seedlings/hill
- Fertilizer (Kg./rai)

	Target yield	Total N	Total P	Total K	Basal N	Basal P	Basal K	Top 1 N	Top 2 N
R.D. varieties	6~5 t/ha	18	12	6	6	12	6	6	6
	4 t/ha	12	6	0	6	6	0	-	6
Local varieties	3 t/ha	8	6	0	4	6	0	-	4

Basal : Transplanting time (incorporate to soil if possible)
Top 1 : Active tillering stage (R.D. varieties are 15~20 days after transplanting.)
Top 2 : Panicle initiation stage (R.D. varieties are 40~45 days after transplanting)

5) Weedicide — Saturn G 5 Kg./rai at 7 days after transplanting

6) Plant protection Apply Furadan at least 2 times (5 Kg./rai at once)
1 st : 10 days after transplanting
2 nd : 40 days after transplanting

7) Water management Soil should always submerge condition about 5~10 cm. deep especially in period of 40 days after transplanting to 20 days after transplanting

8) Estimation of farmers' income per rai at Chao Phya and Mae Klong Pilot Projects areas

Transplanting method

฿/rai

Item \ Target yield	4 t	5.5 t
Chemical	300	300
Fertilizer	278	524
Fuel	74	74
Machine rental	129	129
Maintenance	8	8
Wages	550	700
Total	1,339	1,735
Field rental	200	200
Agriculture expenditure	1,539	1,935
Production (Kg./rai) 3.3฿/Kg.	640	880
Gross income	2,112	2,904
Net income	573	969

Exp. 1 Organic manure, nitrogen rate and density trial of transplanting rice

1 9 8 2 Wet

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This experiment was carried out to clarify effect of organic manure, nitrogen rate and density on transplanting rice yield

Method and material

Sesbania had been cultivated as pre-crop in Dry season

1. Variety: R.D. 23
2. Design: Randomized Complete Block, 3 replications
   - Main 1: Organic manure 3 levels (Sesbania, compost and non)
   - Main 2: Nitrogen rate 2 levels (6 and 12 Kg./rai)
   - Main 3: Density 2 levels (16 and 32 hills/m^2)
3. Field and area: Field No. 5-2
   - Plot: Block 1 and 2 4x5 = 20 m^2 Block 240 m^2; Block 3 3x6 = 18 m^2 Block 216 m^2 } Total 696 m^2
4. Nursery
   - Sowing: 29 th July 1982
   - Seed rate (dry): 50 gm./m^2
   - Fertilizer: Basal Ammophos 30 gm./m^2 (N:P:K = 4.8:6.0:0)
   - Seed bed area: 40 m^2
5. Flowering: 16~20 th October 1982
   Harvest: 15 th November 1982
6. Treatment

Main 1 Organic manure	Main 2 Nitrogenous Kg./rai	Main 3 Density
G = 5,000 gm./m^2 (Fresh sesbania)	6	16 hills * 3 seedlings/m^2
C = 1,000 gm./m^2 (Compost)	12	32 hills * 2 seedlings/m^2
P = Non		

7. Fertilizer

Mark	Basal N : P : K	Top 1	Total N : P : K
6	3 : 9 : 6	3 : 0 : 0	6 : 9 : 6
12	6 : 9 : 6	6 : 0 : 0	12 : 9 : 6
Time	1 DBT	P.I.S	

8. Investigation

Yield and yield components

Result of yield and yield components

Yield and yield components were shown in Table 1 and 2.

1. Yield among organic manure and non plots were not significant, only 1,000 grains weight of organic manure plots were higher than non plot at 1% significance.

2. Yield between different nitrogen rates were 1% significant, 12 kg(n)/rai plots had higher yield than 6 kg(n)/rai plots. In yield components, there were significance in ripening characters (R% and 1,000 grains weight) the high nitrogen rate plots had higher ripening chracters than the low nitrogen rate plots.

3. Yield between different densities were 5% significant, the more density plots had higher yield than the less density plots because more density would increase the number of panicle and the number of spikelets per unit area.

Table 1.

Yield

Manure	Nitrogen Kg./rai	Density hills/m² \ Yield Kg./ha	1	2	3	Mean
Green manure	6	16	4,370	3,266	3,793	3,810
		32	4,223	3,639	5,230	4,364
	12	16	3,958	4,715	4,345	4,339
		32	4,307	4,249	4,259	4,271
Compost	6	16	3,408	3,689	3,069	3,388
		32	4,523	4,006	3,925	4,151
	12	16	3,849	4,356	4,787	4,331
		32	5,125	4,689	6,122	5,312
Non	6	16	3,779	3,152	3,963	3,631
		32	4,327	3,809	3,527	3,888
	12	16	4,144	4,052	4,245	4,147
		32	4,058	4,190	4,124	4,124

Mean of yield Kg./ha

Organic manure		Nitrogen	Kg./rai	Density	hills/m²
Green manure	4,196	6	3,872	16	3,941
Compost	4,295	12	4,421**	32	4,351*
Non	3,947				
F test	ns		1%		5%

Table 2.

Yield components'means

Treatment name		No. of panicle -/sq.m.	No. of spikelets -/panicle	R%	1,000 grains weight	No. of spikelet -/sq.m.	R-D
Manure	Green manure	184	106	81.3	26.5	19,417	21.6
	Compost	178	110	81.0	26.0	19,508	21.1
	Non	184	102	79.5	25.6	18,551	20.4
F test		ns	ns	ns	1%	ns	1%
Nitrogen	6 Kg./rai	178	104	79.4	25.6	18,410	20.3
	12 Kg./rai	186	108	81.8**	26.5**	19,907	21.7**
F test		ns	ns	1%	1%	ns	1%
Density	16 hills/m^2	166	110**	80.5	25.9	18,274	20.9
	32 hills/m^2	199**	101	81.5	26.2	20,043*	21.2
F test		1%	1%	ns	ns	5%	ns

R% = Ripening percentage R-D = Ripening degree

Exp. 2 Experiment of lodging avoidance on germinated direct sowing rice

1 9 8 2 Wet

Mr. vichien Sasiprapa
Mr. Pairat Duangpiboon
Dr. Tetsujiro Sugahara

This experiment is carried out to avoid lodging on direct sowing by applying different nitrogen rate and taking off seedlings to make lines by interculture after germinating, etc.

Method and material

1. Variety — RD 23
2. Design — Randomized Complete Block, 3 replications
3. Field and area
   - Field — No. 5-2
   - Area — Plot 30 m^2, Block 240 m^2 and Total 720 m^2
4. Sowing
   - Date — 17th August 1982
   - Seed rate (dry) — 16 kg/rai (10 gm/m^2)
5. Heading — 25~30 th October 1982
   Harvest — 26~29 th November 1982
6. Treatment

No	Mark	Main 1 (Fertilizer) N	P	K	Main 2 (Treatment)	Basal N	P	K	Top N	Treatment
1	12 C	12	9	0	Control	6	9	0	6	Non
2	12 L	12	9	0	Line	6	9	0	6	15 DAS making line
3	12 D	12	9	0	Drainage	6	9	0		Middle stage, one week drainage
4	12 2,4-D	12	9	0	2,4-D	6	9	0	6	Middle stage, supply 2,4-D
5	18 C	18	9	0	Control	9	9	0	9	Non
6	18 L	18	9	0	Line	9	9	0	9	15 DAS making line
7	18 D	18	9	0	Drainage	9	9	0	9	Middle stage, one week draingae
8	12 2,4-D	18	9	0	2,4-D	9	9	0	9	Middle stage, supply 2,4-D
						15 DAS			P.I.S	

7. Weeding

Plot 1, 3, 5, 7	Saturn G 5 Kg./rai
Plot 4, 8	Saturn G and 2,4-D
Plot 2, 6	Interculture

8. Investigation

Yield and yield components

Result

The result of this experiment wan not cleared in this Wet season due to the rainfall was less than normal year (700 mm. out of 1,200mm.)

The effect of yield was lost by lodging of the rice plant in each treatment becoming negligible. But the effect of high application rate of nitrogen fertilizer still showed some lodging at grain ripening stage, 20 days after flowering.

Yield

1) Among treatments, yield were nearly the same except the line plots of 18 N plots. (Table 1)

2) Yield comparison of nitrogen fertilizer between 12 kg and 18 kg wasn't significant. (Table 2)

3) Yield comparison of methods treatments was at 5% significant. The lined plots were higher than control and drain plots and between lined and 2,4-D plots, there was not significance by DMRT. (Table 2)

The line plots showed good effect of increased rice yield.

Yield components

1) About yield components between nitrogen plots, there were significance only 1,000 grains weight and ripening degree but they didn't effect much on yield.

2) The yield components among methods, treatments were significant. In lined plots, the hill number was less because some seedlings were taken off when making lines but the number of spikelets per panicle and per square metre were more than the other plots. This components showed very closed correlation to increase yield than the other components. Even the lined plots had less 1,000 grains weight and low ripening degree but they effected yield a little.

1983 DRY

1. Effect of seed rate and nitrogen fertilizer on yield of germinated direct broadcasting rice.
2. Effect of seedling take off for space-line on yield and its yield components for germinated direct broadcasting rice.
3. Different quantities of Calper coating on rice seed for germinated direct broadcasting rice under submerged condition field.
4. Different quantities of Calper coating on rice seed for germinated direct broadcasting rice under general condition field.
5. Effect of weed control and seedling take-off on the Calper dust seed coating and non coated seed for germinated direct broadcasting rice.

Table 1 - Yield Kg./ha

Nitrogen Kg./rai	Treatment \ Block	1	2	3	Mean	DMRT
12	Control	5,576	5,307	5,073	5,319	b
	Line	5,998	5,230	5,099	5,442	b
	Drain	5,534	5,146	4,229	4,970	b
	2,4-D	5,435	6,137	5,280	5,617	b
18	Control	5,264	6,091 L	4,504	5,286	b
	Line	6,615	6,101	6,404	6,373	a
	Drain	5,811	5,462	4,787	5,353	b
	2,4-D	5,024	5,589 L	5,381 L	5,331	b

L = Lodging 20 days after heading. Individual comparison each treatment by DMRT

Table 2 - Mean of yield and F test

Nitrogen Kg./rai	Yield
12	5,337
18	5,586
F test	ns

Treatment	Yield	DMRT(5%)
Control	5,302	b
Line	5,908	a
Drain	5,161	b
2,4-D	5,474	a b
F test	5%	

Table 3 - Yield components

Treatment \ Components		Hills -/m²	Panicle -/m²	Spikelet -/panicle	R%	1000GW.	Spikelet -/m²	R-D
Nitrogen Kg./rai	12	118	285	93.8	84.1	25.0	26,187	21.0
	18	131	275	94.3	85.3	25.8**	25,795	22.1**
F test		ns	ns	ns	ns	1%	ns	1%
Method	Control	141 a	278	93.4 ab	83.9	25.5 a	25,906 b	21.4 a
	Line	92 b	262	111.2 a	83.8	24.8 b	28,978 a	20.8 b
	Drain	125 a	297	80.4 b	85.8	25.6 a	23,615 b	22.0 a
	2,4-D	139 a	282	91.3 b	85.1	25.8 a	25,467 b	21.9 a
F test		5%	ns	1%	ns	1%	5%	5%

Note Common letter is no significant by DMRT

R% = Ripening percentage

R-D = Ripening degree

Exp. 1

Effect of seed rate and nitrogen fertilizer on yield of germinated direct broadcasting rice.

(1983 Dry)

Mr. Vichien Sasiprapa
Mr. Opart Chantasuk
Dr. Tetsujiro Sugahara

This experiment was carried out to clarify the effect on yield from different seed rate (8 and 16 kg/rai), basal nitrogen fertilizer (6 and 8 kg/rai), top dressing nitrogen at panicle iniation stage and booting stage (0 and 4 kg/rai).

Material and method

1. Variety RD 23
2. Design L 16 factorial design
3. Plot size 4x8 = 32 m^2 total 32x16 = 512 m^2
4. (1) Sowing Apr 7, 1983
   (2) P.I.S. May 30, 1983
   (3) Booting Jun 17, 1983
   (4) Heading Jun 21, 1983
   (5) Harvest Jul 26, 1983
5. Treatment (kg/rai)

Repeat	Plot No.	Seed rate A	Basal N B	P.I.S. N C	Booting N D
1	1	8	6	0	0
	2	8	6	4	4
	3	8	8	0	4
	4	8	8	4	0
	5	16	6	0	4
	6	16	6	4	0
	7	16	8	0	0
	8	16	8	4	4
2	9	8	6	0	4
	10	8	6	4	0
	11	8	8	0	0
	12	8	8	4	4
	13	16	6	0	0
	14	16	6	4	4
	15	16	8	0	4
	16	16	8	4	0

(1) Basal 19 days after sowing N and P 6 kg/rai.
(2) P.I.S. Panicle initiation was 53 days after sowing.
(3) Booting stage was 71 days after sowing.

6. Management
   Saturn G 5 kg/rai 8 days after sowing
   Furadan 5 kg/rai 11 days after sowing
   Furadan 5 kg/rai P.I.S.

Result

1. Growth

(1) Number of tillers

Number of tillers was investigated at one week interval and panicles at harvesting time was given in table 1 and figure 1.

It was found that maximum number of tiller stage was 5 weeks after sowing for most all plots and the effective tillering percentage was 42.6% for 8 kg/rai seed rate and 39.0% for 16 kg/rai seed rate.

But on harvesting time the number of panicles were nearly the same in spite of a great difference in number of tillers at maximum tillering stage.

On figure 1, shown that the number of tillers of all plots reached to final effective panicle number line about 3 weeks and the number of active tillers were promoted within 3-4 weeks after basal dressing.

(2) Plant height

Plant height as one week interval and on harvested culm, panicle length were given in table 2 and figure 2.

Actived elongation of plant height was between 3 and 4 weeks after basal dressing and after that the extension of plant height was slow, again rapidly elongate was developed after panicle initiation stage to heading stage.

Plant height in this year experiment at harvest was less than last year total plant height was less than 100 cm.

2. Yield

Table 3,4 and 5 shown yield analysis table and treatment mean as sample from 8 square metres.

By these result, yield on seed rate and nitrogen basal quantity were 5% significant, that is yield of seed rate 8 kg/rai plot gave higher yield than 16 kg/rai plots and 8 kg basal higher yield than 6 kg basal. Yield of given 4 kg/rai nitrogen on panicle initiation stage and booting stage were more than no given nitrogen plots at each of two stages by 1% significant.

3. Yield component

Yield component on each treatment are given in table 6.

(1) Grand mean in table 6 on number of panicle per square metre was 451, number of spikelets per panicle was 65.5, ripening percentage was 71.6%, thousand grain weight was 27.6 gm, yield from above multiple factor was 580.8 gm, ratio of yield : straw was 1:0.8 and number of spikelets per square metre was 29,489 grains. These yield components were investigated from 50x50 cm sample area.

(2) Those yield components had been calculated and analysed by F-test. Among treatments, significant factors were only number of spikelets per panicle and thousand grains weight.

4. Number of spikelets per panicle

Table 7,8 and 9 shown analysis on number of spikelets per panicle.

(1) By table 8 of F-test value and table 9 shown the significant difference between seed rate (A) at 5% level that is seed rate of 8 kg/rai plot was higher in number of spikelets per panicle than 16 kg/rai seed rate plot. For nitrogen application shown high significant difference at 1% level of top dressing at P.I.S plot than the other top dressing plots and the interaction of nitrogen topdressing time at P.I.S. and booting stage (CD) was also significant at 5% level.

(2) Analysis of interaction for P.I.S. and booting stage nitrogen application.

Table 10, 11 and figure 3 shown interaction. (table 10 was calculated of interaction from table 7)

C_1D_1	number spikelets	62.0
C_2D_1	number spikelets	64.8
C_1D_2	number spikelets	59.6
C_2D_2	Number spikelets	75.8

L.S.D. = 7.077

Remark

C_1	P.I.S.	not give nitrogen	D_1	Booting stage	not give nitrogen
C_2	P.I.S.	give 4 kg notrogen	D_2	Booting stage	give 4 kg nitrogen

Among C_1D_1, C_1D_2 were not significant but significant was for C_1D_2.

Figure 3 shown the relation of nitrogen times and rate of applications at P.I.S. and booting stage, C_2D_2 give nitrogen at P.I.S. and booting stage at the rate of 4 kgN/rai was the highest in number of spikelets per panicle than the others.

5. Thousand grain weight

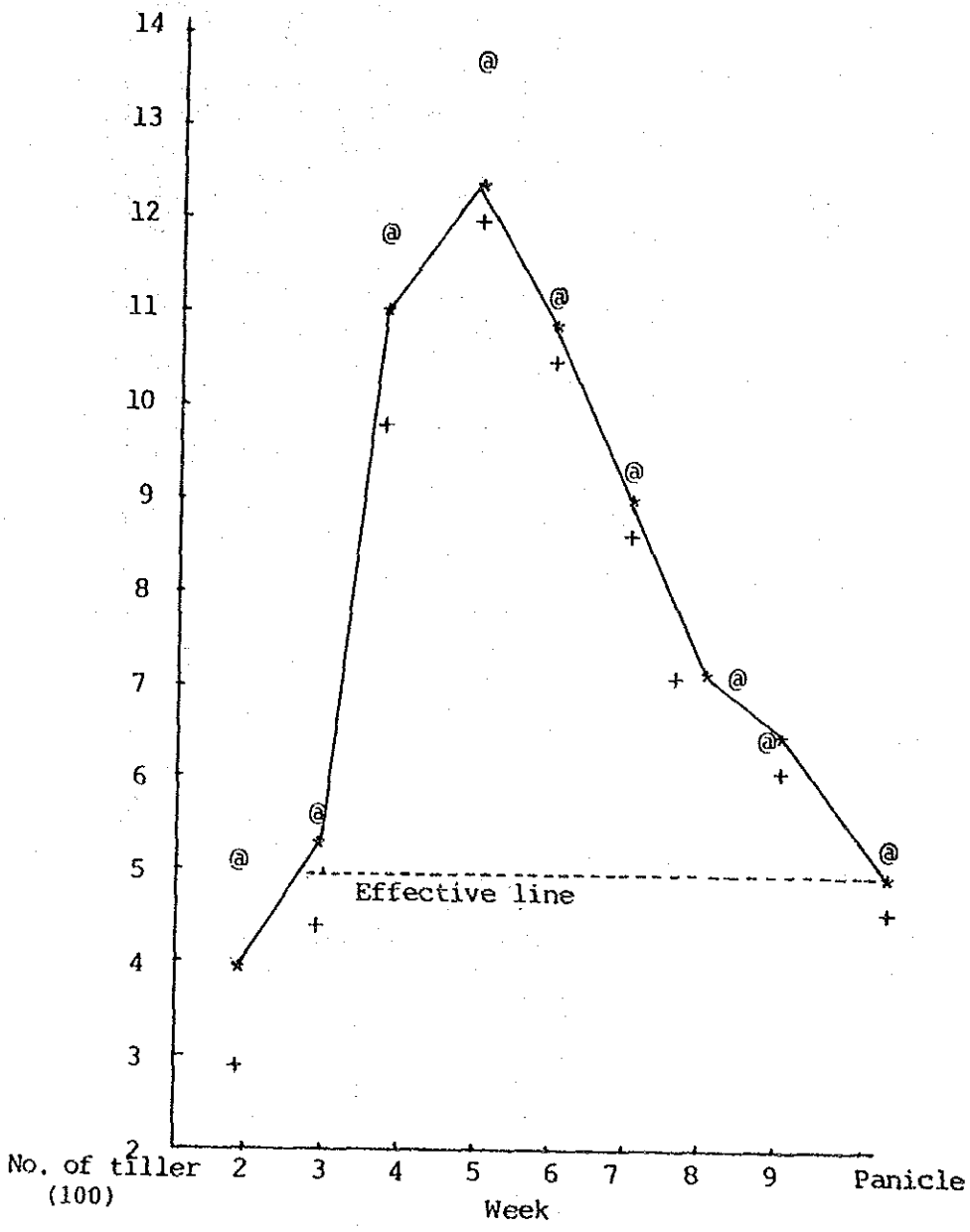
Table 12 and 13 shown analysis of thousand grain weight among treatment, basal nitrogen (B) was significant at 5% that is basal of 8 kgN/rai plots were higher than basal of 6 kgN/rai plots but difference of nitrogen basal quantity effected on 1,000 grain is not clear in the reason.

Table 1 Number tiller per square meter

No.	Treatment	19/4	27/4	4/5	12/5	18/5	25/5	1/6	8/6	Panicle	Max tiller%
1	8-600	247	293	793	913	960	880	813	640	473	49
2	8-644	313	340	920	1033	1060	1027	773	720	540	50
3	8-804	360	520	1127	1367	1133	1053	773	700	480	35
4	8-840	267	540	1100	1353	1153	847	740	673	500	37
5	16-604	473	593	1067	1307	1080	1027	853	767	553	42
6	16-640	567	593	1160	1360	1100	933	767	760	553	40
7	16-800	420	433	933	1067	933	840	560	560	433	40
8	16-844	567	673	1280	1460	1247	1087	753	713	547	37
9	8-604	267	393	873	1054	907	753	700	593	467	44
10	8-640	220	460	787	940	840	640	613	600	467	49
11	8-800	453	853	1407	1600	1353	893	767	707	573	35
12	8-844	140	313	813	947	860	727	573	533	427	45
13	16-600	473	540	1113	1260	993	793	680	607	473	37
14	16-644	453	653	1453	1427	1067	953	767	667	527	36
15	16-804	500	547	1100	1273	1027	867	807	613	493	38
16	16-840	560	620	1400	1447	1113	773	667	667	567	39
	Mean	392	522	1082	1238	1051	881	725	657	504	41

Seed rate	19/4	27/4	4/5	12/5	18/5	25/5	1/6	8/6	Panicle
8-	283	464	977	1150	1033	852	719	645	490
16-	501	582	1188	1325	1070	909	731	669	518

Figure 1. Number tiller per square meter



Remark Seed rate

@ 16 kg/rai
* average
+ 8 kg/rai

Table 2 Plant height Length

No.	Treatment	27/4	4/5	12/5	18/5	25/5	1/6	8/6	Culm	Panicle	Height
1	8-600	26.1	41.5	44.4	45.6	54.2	60.7	64.4	62.9	22.9	85.8
2	8-644	25.6	40.6	42.3	44.6	50.2	58.1	65.2	65.1	23.4	88.5
3	8-804	27.0	43.9	44.7	48.5	55.7	60.3	68.7	69.8	23.1	92.9
4	8-840	27.3	44.7	45.0	48.8	54.3	62.2	68.8	71.8	23.1	94.9
5	16-604	27.0	41.1	42.7	44.1	48.7	56.6	60.3	66.6	21.5	88.1
6	16-640	24.9	41.6	41.1	45.9	52.2	56.1	63.8	65.2	22.0	87.2
7	16-800	25.4	40.0	40.8	44.4	50.5	55.3	58.3	59.4	21.1	80.5
8	16-644	27.8	43.1	47.4	53.5	61.1	68.1	75.1	74.8	23.3	98.1
9	8-604	26.9	42.1	43.4	46.1	52.4	59.1	65.1	66.8	21.4	88.2
10	8-640	27.5	40.7	42.2	44.8	50.4	54.2	64.9	70.4	23.4	93.8
11	8-800	27.7	43.8	45.8	52.2	60.1	63.8	70.0	68.7	20.8	89.5
12	8-844	27.7	44.8	45.8	46.3	52.5	60.7	69.3	74.3	24.2	98.5
13	16-600	25.8	42.4	43.7	50.5	54.6	62.1	66.7	65.3	20.7	86.0
14	16-644	30.0	42.7	47.2	53.7	62.3	68.9	75.4	75.2	23.7	98.9
15	16-804	25.7	39.3	40.4	44.0	48.0	55.1	62.0	63.7	21.7	85.4
16	16-840	25.1	43.7	46.7	53.1	58.9	65.4	72.2	67.1	22.0	89.1
Mean		26.7	42.2	43.9	47.8	54.1	60.4	66.8	67.9	22.3	90.4

Seed rate	27/4	4/5	12/5	18/5	25/5	1/6	8/6	Height
8-	27.0	42.8	44.2	47.1	53.7	59.9	67.1	91.5
16-	26.5	41.7	43.8	48.7	54.5	61.0	66.7	89.2

Table 3 Yield (Sample = 8 m^2)

No.	Treatment	kg/ha	kg/rai
1	8-600	5140	822
2	8-644	6409	1025
3	8-804	6098	976
4	8-840	6790	1086
5	16-604	5770	923
6	16-640	5692	911
7	16-800	5128	820
8	16-844	6823	1092
9	8-604	5817	931
10	8-640	6198	992
11	8-800	5874	940
12	8-844	7021	1123
13	16-600	5261	842
14	16-644	6213	994
15	16-804	6144	983
16	16-840	5804	929
Mean		6011	962

Table 4 Yield per hectare

No.	Data	Yate-4	Effect	V	Fact
1	5140	96182.0	6011.4	578186070	CT
2	6409	-5718.0	-357.4	2043470	C
3	6098	-3182.0	-198.9	632820	B
4	6790	670.0	41.9	28056	BC
5	5770	2512.0	157.0	394384	A
6	5692	-1260.0	-78.8	99225	AC
7	5128	-1256.0	-78.5	98596	AB
8	6823	-292.0	-18.3	5329	e
9	5817	-482.0	-30.1	14520	R
10	6198	-1438.0	-89.9	129240	e
11	5874	-474.0	-29.6	14042	e
12	7021	1722.0	107.6	185330	AD
13	5261	-464.0	-29.0	13456	e
14	6213	572.0	35.8	20449	BD
15	6144	-444.0	-27.8	12321	CD
16	5804	-4408.0	-275.5	1214404	D

Table 5 Analysis table of yield

Varia	DF	SS	MS	F	
Total	15	4905643.75			
BL	1	14520.25	14520.25	0.36	ns
A	1	394384.00	394384.00	9.73	*
B	1	632820.25	632820.25	15.62	*
C	1	2043470.25	2043470.25	50.44	**
D	1	1214404.00	1214404.00	29.97	**
AB	1	98596.00	98596.00	2.43	ns
AC	1	99225.00	99225.00	2.45	ns
AD	1	185330.25	185330.25	4.57	ns
BC	1	28056.25	28056.25	0.69	ns
BD	1	20449.00	20449.00	0.50	ns
CD	1	12321.00	12312.00	0.30	ns
Error	4	162067.50	40516.88		

F(1,4;.05) = 7.71 F(1,4;.01) = 21.2

Treatment	Rate	Mean	Rate	Mean
Seed rate	8	6168.4	16	5854.4
Basal N	6	5812.5	8	6210.3
P.I.S. N	0	5654.0	4	6368.8
Booting N	0	5735.9	4	6286.9

Table 6 Yield components

No.	Treatment	PA	SP/PA	R%	1000g	Yield	Y:ST
1	8-600	415.0	68.4	66.5	26.3	486.8	0.6
2	8-644	476.0	79.9	66.9	26.3	669.6	0.8
3	8-804	444.0	66.1	71.0	28.0	583.7	0.7
4	8-840	480.0	70.7	71.9	27.8	678.9	0.8
5	16-604	461.0	56.1	77.9	27.7	558.0	0.7
6	16-640	541.0	59.2	67.4	26.9	581.0	0.7
7	16-800	385.0	61.5	68.4	27.3	441.8	0.7
8	16-644	456.0	69.6	70.5	28.0	626.5	0.7
9	8-604	434.0	61.5	77.9	27.7	575.3	0.8
10	8-640	410.0	68.7	70.2	27.2	537.6	0.8
11	8-800	469.0	60.3	76.7	27.6	598.5	0.8
12	8-844	406.0	80.5	71.3	28.4	661.2	0.8
13	16-600	441.0	57.6	77.8	27.8	549.3	0.8
14	16-644	452.0	73.0	71.5	27.9	657.8	0.8
15	16-804	493.0	54.8	72.8	28.4	559.0	0.7
16	16-840	456.0	60.5	67.2	27.9	516.9	0.8
	Mean	451.1	65.5	71.6	27.5	580.1	0.7

PA = Panicle per square meter
SP/PA = Number spikelets per panicle
R% = Number good grains divide all number grains
1000g = 1000 grains weight
Yield/m^2 = Yield per square meter
Y:ST = Ratio of yield : straw

Table 7 Number of spikelets per panicle

No.	Data	Yate-4	Effect	V	Fact
1	68.40	1048.4	65.5	68696.4	CT
2	79.90	-75.8	-4.7	359.1	C
3	66.10	0.4	0.0	0.0	B
4	70.70	1.4	0.1	0.1	BC
5	56.10	63.8	4.0	254.4	A
6	59.20	-11.2	-0.7	7.8	AC
7	61.50	1.4	0.1	0.1	AB
8	69.60	10.8	0.7	7.3	e
9	61.50	14.6	0.9	13.3	R
10	68.70	21.2	1.3	28.1	e
11	60.30	-9.0	-0.6	5.1	e
12	80.50	-5.2	-0.3	1.7	AD
13	57.60	13.6	0.9	11.6	e
14	73.00	1.4	0.1	0.1	BD
15	54.80	53.2	3.3	176.9	CD
16	60.50	-34.6	-2.2	74.8	D

Table 8 Analysis table of number of spikelets per panicle

varia	DF	SS	MS	F	
Total	15	940.45			
BL	1	13.32	13.32	1.02	ns
A	1	254.40	254.40	19.57	*
B	1	0.01	0.01	0.00	ns
C	1	359.10	359.10	27.62	**
D	1	74.82	74.82	5.76	ns
AB	1	0.12	0.12	0.01	ns
AC	1	7.84	7.84	0.60	ns
AD	1	1.69	1.69	0.13	ns
BC	1	0.12	0.12	0.01	ns
BD	1	0.12	0.12	0.01	ns
CD	1	176.89	176.89	13.61	*
Error	4	52.00	13.00		

F(1,4;.05) =7.71 F(1,4;.01) = 21.2

Table 9 Treatment mean of number spikelets per panicle

Treatment	Rate	Mean	Rate	Mean
Seed rate	8	69.5	16	61.5
Basal N	6	65.6	8	65.5
P.I.S. N	0	60.8	4	70.3
Booting N	0	63.4	4	67.7

Table 10 Yate table

Mark	Data	Row (R)	R/16	Combination
T	1048.4	991.2	62.0	C1D1
C	-75.8	1036.4	64.8	C2D1
D	-34.6	954.0	59.6	C1D2
CD	53.2	1212.0	75.8	C2D2

Table 11 2-Way table

	D1	D2	Mean
C1	62.0	59.6	60.8
C2	64.8	75.8	70.3
Mean	63.4	67.7	(65.5)

$$L.S.D. = t(4;0.05)\sqrt{2(\text{error MS})/4}$$
$$= 2.776\sqrt{13.00/2} = 7.077$$

Fig 3 Interaction of spikelets per panicle

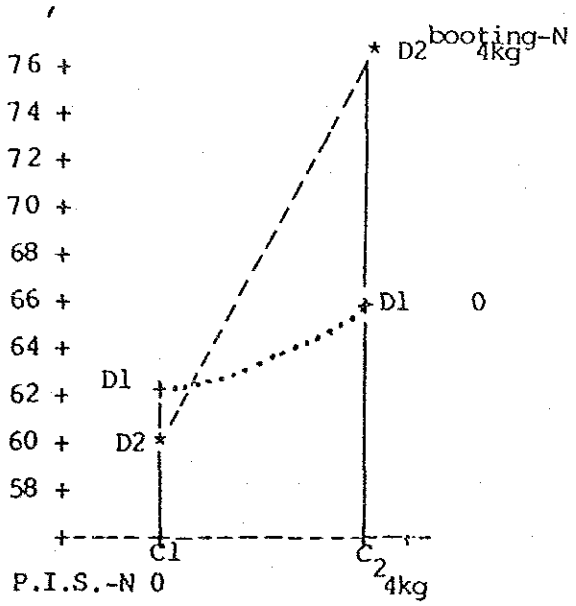


Table 12 Analysis table of spikelets per square meter

Varia	DF	SS	MS	F	
Total	15	14309115547.8			
BL	1	11909401.0	11909401.0	1.65	ns
A	1	21785556.3	21785556.3	3.02	ns
B	1	467172.3	467172.3	0.06	ns
C	1	115992900.0	115992900.0	16.07	*
D	1	19005240.3	19005240.3	2.63	ns
AB	1	6024570.3	6024570.3	0.83	ns
AC	1	176400.0	176400.0	0.02	ns
AD	1	11556.3	11556.3	0.00	ns
BC	1	3876961.0	3876961.0	0.54	ns
BD	1	489300.3	489300.3	0.07	ns
CD	1	6165289.0	6165289.0	0.85	ns
Error	4	28878661.3	7219665.3		

F(1,4;.05) = 7.71 F(1,4;.01) = 21.2

Table 13 Treatment mean of spikelets per square meter

Treatment	Rate	Mean	Rate	Mean
Seed rate	8	30620	16	28286
Basal N	6	29624	8	29282
P.I.S. N	0	26760	4	32145
Booting N	0	28363	4	30543

Table 14 Analysis table of 1000 grain weight

Varia	DF	SS	MS	F	
Total	15	5.99			
BL	1	1.32	1.32	16.66	*
A	1	0.42	0.42	5.32	ns
B	1	1.96	1.96	24.69	**
C	1	0.01	0.01	0.13	ns
D	1	0.81	0.81	10.20	*
AB	1	0.56	0.56	7.09	ns
AC	1	0.02	0.02	0.28	ns
AD	1	0.02	0.02	0.28	ns
BC	1	0.25	0.25	3.15	ns
BD	1	0.04	0.04	0.50	ns
CD	1	0.25	0.25	3.15	ns
Error	4	0.32	0.08		

F(1,4;.05) = 7.71 F(1,4;.01) = 21.2

Table 15 Treatment mean of 1000 grain weight

Treatment	Rate	Mean	Rate	Mean
Seed rate	8	27.4	16	27.7
Basal N	6	27.2	8	27.9
P.I.S. N	0	27.6	4	27.6
Booting N	0	27.4	4	27.8