IR-2053	1	8/6	12/6	20/6	14/7	66 .2	25.1	13.8	108.7	69.0	63.5	25.4	20.2	5.1
	2	8/6	12/6	20/6	12/7	59.8	24.5	13.7	105.4	81.9	77.7	13.9	20.7	6.2
	3	8/6	12/6	20/6		56.8	25.6	13.8	122.7	83.7	68.2	18.9	21.9	6.8
IR-1514	1	14/6	20/6	28/6	14/7	42.7	24.2	18.1	105.9	61.8	58.4	30.7	15.1	4.5
	2	14/6	20/6	28/6	12/7	48.0	24.1	18.7	119.5	73.1	61.1	27.9	17.2	6.3
	3	14/6	20/6	28/6		40.4	24.6	21.7	101.4	63.7	62.8	20.3	17 .3	6.4
IR-1561	1	3/5	12/5	17/5	7/7	44.8	22.5	17.6	86.9	69.1	79.5	15.0	18.7	6.1
	2					43.8	21.6	17.7	91.8	82.2	89.5	6.5	20.4	7.9
	3					44.8	21.9	16.9	80.9	67.9	84.0	7.8	19.6	6.0
IR-127	1	16/5	20/5	27/5	26/6	61.4	21.5	7.4	204.4	86.0	42.1	38.6	17.6	3.0
	2	16/5	20/5	27/5	26/6	65.3	21.7	7.0	226.5	102.5	45.2	40.0	17.1	3.3
	3	16/5	20/5	29/5	26/6	61.8	20.8	7.9	204.2	107.0	52.4	29.4	20.2	4.6
IR-2153	1	5/6	9/6	13/6		58.3	21.2	19.6	71.0	51.5	72.5	21.2	21.2	5.7
	2					52.6	21.1	18.9	94.7	64.6	68.2	22.9	20.6	6.7
	3					59.2	22.4	16.0	86.0	63.7	74.1	14.4	22.0	6.0
TOS 103	1	21/5	27/5	31/5	16/6	45.1	24.2	13.4	75.9	54.4	71.7	18.8	24.5	4.8
	2	21/5	27/5	31/5	16/6	45.5	22.8	14.1	95.2	65.7	69.1	22.9	23.6	5.8
	3	21/5	29/5	31/5	16/6	46.3	23.2	13.4	98.7	64.6	67.1	20.0	24.3	5.8
C-6	1	29/5	9/6	15/6	12/7	52.6	23.3	12.5	122.9	69.3	56.4	30.6	25.3	5.9
	2					50.2	23.5	14.6	107.5	69.1	64.3	22.7	23.9	6.4
	3					54.5	23.6	13.1	117.7	86.2	73.3	18.6	26.5	8.0

C-11	1	7/5	12/5	19/5	26/6	49.5	22.1	13.6	96.4	74.0	76.8	15.0	21.5	5.8
	2	7/5	12/5	23/5	26/6	49.4	20.9	14.1	90.0	67.1	74.6	11.3	22.3	5.6
	3	7/5	12/5	21/5	26/6	51.6	21.0	12.6	108.5	97.0	89.3	2.8	22.4	7.3
C-15	1	5/6	16/6	28/6	7/7	55.7	22.2	16.5	101.8	77.9	76.6	12.7	20.4	7.0
	2	5/6	16/6	28/6		53.0	24.1	14.8	116.9	65.7	56.2	22.1	20.0	5.2
	3	5/6	16/6	28/6		61.0	24.3	13.7	130.9	95.5	72.9	18.5	22.1	7.7
BG 34-8	1	2/5	6/5	20/5	15/6	52.6	20.3	12.5	107.6	83.2	73.3	13.4	20.5	5.7
	2	2/5	6/5	20/5	15/6	51.7	21.8	14.6	107.9	78.2	72.5	19.4	19.3	6.0
	3	2/5	6/5	20/5	15/6	56.4	22.5	13.6	113.3	78.4	69.2	21.2	20.9	5.9
BG 90-2	1	19/5		29/5	25/6	46.8	22.5	13.7	101	68.4	67.9	22.2	23.4	5.8
	2					45.8	24.4	15.3	105	80.7	76.8	14.9	23.4	7.7
	3					46.7	23.0	11.8	97.4	76.2	78.2	14.4	23.4	5.6
BG 11-	1	16/6	20/6	28/6	11/7	72.9	36.1	11.3	78.6	51.5	65.5	22.0	18.4	2.9
11	2	16/6	20/6	28/6	11/7	79.6	37.6	13.4	132.0	50.4	38.2	38.3	19.5	3.5
	3	16/6	20/6	28/6	11/7	74.5	26.7	14.2	134.9	71.6	53.1	31.7	20.6	5. 6
TAICHU-	1	2/5	8/5	20/5	25/6	61.2	19.9	10.3	61.0	37.2	61.0	16.8		3.0
NG 65	2	2/5	8/5	27/5	25/6	68.8	19.4	11.1	66.2	43.2	65.2	11.8	25.1	3.2
	3	2/5	8/5	27/5	25/6	72.7	20.9	12.9	84.1	59.8	71.0	13.6	25.6	5.3
TAICHU-	1	5/5	16/5	27/5	25/6	49.3	19.1	12.6	105.1	67.2	63.9	18.4	20.6	4.7
NG IKU	2	5/5	16/5	27/5	25/6	49.9	21.2	15.6	94.4	59.0	62.5	20.5	24.0	5.9
KYU	3	5/5	16/5	27/5	25/6	50.8	20.4	15.1	101.5	60.3	59.5	15.9	24.3	5.9

Takao	1	8/5	16/5	21/5	24/6	60.2	19.9	12.3	84.6	67.9	80.3	6.8	22.7	5.1
21	2	8/5	16/5	27/5	24/6	77.4	19.6	14.1	95.4	71.9	75.4	9.9	23.7	6.4
	3	8/5	16/5	27/5	24/6	71.5	19.7	12.5	99.8	66.6	66.8	10.7	23.7	5.3
Hsinchu	1	16/5	20/5	29/5	27/6	66.0	20.1	11.2	76.6	41.2	53.8	16.1	23.0	2.8
56	2	16/5	20/5	29/5	27/6	80.2	17.9	14.1	102.8	56.7	55.1	19.1	24.7	5.3
	3	16/5	20/5	29/5	27/6	72.8	18.3	13.2	91.9	50.5	55.0	20.8	21.4	3.8
Toitsu	1	16/5	20/5	28/5	19/6	49.3	19.4	12.6	90.5	50.4	55.7	21.8	23.2	3.9
	2	16/5	20/5	28/5	19/6	52.6	20.8	13.8	115.2	67.1	58.2	25.5	24.6	6.1
	3	16/5	20/5	28/5	19/6	48.9	20.3	12.9	114.1	69.4	60.8	26.3	22.8	5.4
Ishin	1	17/5	22/5	29/5	16/6	48.1	21.2	14.4	88.7	54.1	61.0	29.1	23.3	4.8
	2	17/5	22/5	29/5	16/6	60.6	23.3	15.4	108.3	74.1	68.4	17.4	26.1	7.9
	3	17/5	22/5	29/5	16/6	55.2	22.4	15.2	106.2	62.6	59.0	26.7	22.2	5.6
Hino	1	19/5	24/5	29/5	30/6	80.4	24.0	5.3	59.2	9.6	16.3	67.3	21.6	0.3
	2	19/5	24/5	29/5	30/6	87.1	23.3	5.8	40.8	10.3	25.4	56.1	27.2	0.4
	3	19/5	24/5	29/5	30/6	76.1	24.7	5.7	79.5	10.1	12.7	70.5	18.5	0.3
Asomi-	1	8/4	12/4	28/4	15/5	34.9	12.0	30.8	24.7	13.3	54.0	33.0	24.5	2.7
nori	2	8/4	12/4	28/4	15/5	37.6	13.6	33.7	25.6	16.8	65.5	24.2	29.0	4.4
	3	8/4	12/4	28/4	15/5	40.3	14.7	28.3	24.0	14.5	60.3	30.7	24.7	2.7
Kogane	1	8/4	12/4	1/5	15/5	44.9	14.0	29.8	23.4	8.1	34.6	53.2	28.1	1.8
nishi	2	8/4	12/4	1/5	15/5	46.0	15.7	38.9	28.2	8.3	29.4	55.8	21.9	1.9
ki	3	8/4	12/4	1/5	15/5	45.7	13.7	30.3	37.9	7.3	19.3	64.1	26.8	1.6

Reimei	1	18/4	24/4	3/5	20/5	36.7	14.2	18.1	27.7	16.3	58.8	32.2	24.3	1.9
	2	18/4	24/4	3/5	20/5	46.0	17.5	30.9	29.2	16.0	55.0	30.o	25.1	3.3
	3	18/4	24/4	3/5	20/5	42.3	15.8	20.7	28.8	14.8	51.5	30.0	24.2	2.0
Toyo	1	18/4	24/4	1/5	20/5	37.5	14.1	24.9	36.2	12.0	33.1	45.3	20.6	1.6
nishiki	2	18/4	24/4	1/5	20/5	46.6	15.7	39.2	31.8	18.8	59.1	26.8	24.1	4.7
	3	18/4	24/4	1/5	20/5	42.4	14.6	36.1	26 .8	15.1	56.5	32.7	21.6	3.1
Norin	1	5/4	9/4	28/4	18/5	35.0	12.4	26.0	27.0	6.3	23.2	62.9		0.6
No.17	2	5/4	9/4	28/4	18/5	41.2	13.2	38.7	26.5	4.9	18.5	66.1	22.1	1.1
	3	5/4	9/4	28/4	18/5	38.9	12.6	31.6	24.9	3.2	12.7	70.9	23.7	0.6
Dawn	1	20/5	26/5	30/5	25/6	48.9	20.6	17.5	80.7	69.6	86.2	10.1	21.5	7.0
	2	16/5	20/5	27/5	25/6	47.9	22.4	19.6	85.6	67.0	78.3	16.5	21.6	7.6
	3	20/5	26/5	30/5	25/6	48.3	19.2	15.2	82.9	50.5	60.9	13.9	20.4	4.2
Blue	1	27/5	29/5	9/6	25/6	93.1	19.4	7.5	73.4	37.2	50.6	36.2	20.5	1.5
Bonnet	2	27/5	29/5	9/6	25/6	92.2	22.2	6.8	55.8	33.6	60.1	25.0	21.8	1.3
	3	27/5	29/5	9/6	25/6	84.6	20.9	6.7	63.9	36.1	56.4	28.6	20.7	1.3
Cowad	1													
mali	2													
	3													
SML-18	1	29/5	2/6	5/6	24/6	69.4	25.7	11.1	62.7	41.0	65.3	18.0	28.3	3.4
	2	29/5	2/6	5/6	24/6	66.o	23.9	10.6	55.0	29.8	54.3	18.5	31.5	2.7
	3	3/6	5/6	7/6	24/6	66.1	23.3	10.7	47.1	10.3	21.8	42.4	31.8	0.9

Tab. II-2 FERTILIZER ELEMENT TEST (FEBRUARY)

Variety...Tos 103 Sowing date...1st,Feb. Transplanting..8,Mar. Spacing...25cm X 15cm

Treat-ment	Rep. No.	Heading Start	40%	90%	Matu-rity date	Culm Length (cm)	Ear Length (cm)	No.of Panicle per Hill	No.of Grain per Panicle	No.of ripened Grain per Panicle	Percen-tage of ripened Grain (%)	Percen-tage of un-fer-tilized Grain(%)	1,000 Grain Weight (g)	Yield (t/ha)
N-0	1	18/5	25/5	2/6	16/6	43.1	21.4	11.9	78.8	62.2	78.9	14.2	23.2	4.6
	2	18/5	25/5	2/6	16/6	36.8	21.5	8.4	72.2	59.2	81.9	13.6	22.4	3.0
	3	18/5	25/5	2/6	16/6	39.0	21.6	8.3	59.1	47.5	80.4	14.1	24.0	2.5
P-0	1	23/5	2/6	7/6	23/6	41.8	21.4	13.8	101.7	81.5	80.2	8.5	20.2	6.1
	2	23/5	2/6	7/6	23/6	44.5	24.0	15.6	83.1	53.9	64.9	21.1	22.0	4.9
	3	23/5	2/6	7/6	23/6	45.8	22.6	15.3	81.8	66.9	81.8	9.9	25.2	6.9
K-0	1	21/5	27/5	5/6	18/6	43.4	22.2	14.4	89.0	76.2	85.6	10.5	23.1	6.8
	2	20/5	27/5	5/6	18/6	43.2	22.7	17.7	85.5	62.4	73.0	15.5	20.8	6.1
	3	20/5	27/5	5/6	18/6	42.0	25.0	13.3	80.7	67.0	83.0	10.5	22.4	5.3
S-0	1	22/5	28/5	8/6	20/6	45.4	20.5	16.0	97.9	74.4	76.0	14.3	23.1	7.3
	2	22/5	28/5	8/6	20/6	41.2	21.3	15.8	85.9	61.9	72.0	18.7	22.4	5.8
	3	22/5	28/5	8/6	20/6	44.7	23.6	13.8	88.4	66.0	74.6	16.4	22.7	5.5
NPKS-0	1	12/5	20/5	28/5	18/6	35.5	19.8	8.0	64.4	45.7	71.0	20.6	22.7	2.2
	2	12/5	20/5	28/5	18/6	35.5	20.1	7.9	59.2	46.2	78.1	15.6	23.0	2.2
	3	12/5	20/5	28/5	18/6	35.7	19.3	7.8	47.5	28.9	60.8	16.5	22.5	1.4
STANDARD	1	25/5	31/5	8/6	23/6	43.2	22.4	15.2	96.6	84.9	87.9	7.1	24.3	8.4
	2	25/5	31/5	8/6	23/6	42.4	21.9	16.4	82.3	62.9	76.5	13.4	22.6	6.2
	3	25/5	31/5	8/6	23/6	45.3	23.7	14.6	83.5	64.3	77.0	10.5	24.1	6.0

Tab. II-3 NITROGEN TEST (FEBRUARY)

Variety...Tos 103 Sowing date...1st,Feb. Transplanting date...13,Mar. Spacing..25cm X 15cm

Treatment	Rep. No.	Heading Start	Heading 40%	Heading 90%	Maturity date	Culm Length (cm)	Ear Length (cm)	No. of Panicle per Hill	No. of Grain per Panicle	No. of ripened Grain per Panicle	Percentage of ripened Grain (%)	Percentage of un-fertilized Grain(%)	1,000 Grain Weight (g)	Yield (t/ha)
Cont-	1	19/5	25/5	30/5	15/6	44.4	22.3	11.7	76.6	51.4	67.1	22.0	23.1	3.7
rol	2					36.6	20.4	11.2	59.3	41.1	69.4	18.5	24.1	3.0
	3					39.8	20.4	10.7	65.L	37.0	56.9	33.1	21.7	2.3
50-0-	1					42.6	20.8	12.9	74.8	54.4	72.7	17 .6	23.1	4.3
0-0	2					42.8	22.5	15.4	89.3	62.1	69.6	20.3	23.2	5.9
	3					39.5	21.0	12.3	94.8	52.0	54.9	26.9	21.1	3.6
20-10-	1					44.8	22.7	11.6	67.7	58.8	86.8	8.6	23.8	4.3
10-10	2					40.8	20.4	12.3	61.5	47.6	77.3	14.4	22.9	3.6
	3					38.6	20.6	11.3	70.5	55.9	79.3	13.9	22.2	3.7
30-0-	1					45.2	22.5	15.0	105.6	53.7	50.9	31.9	22.3	4.8
20-0	2					42.2	22.5	10.9	75.6	51.9	68.6	15.9	23.0	3.8
	3					41.7	22.0	10.7	87.9	58.3	66.3	20.4	22.5	3.7
20-0-	1					46.4	22.6	14.3	90.8	58.8	64.8	16.3	23.3	5.2
20-10	2					38.6	21.6	11.1	67.9	52.6	77.4	11.4	23.3	3.6
	3					43.4	22.0	12.5	83.9	52.3	62.3	22.2	23.5	3.4

100-0-	1	42.5	21.0	13.4	75.7	49.1	64.9	16.7	23.2	4.1
0-0	2	43.0	22.2	13.5	80.0	45.9	57.3	24.2	23.9	3.9
	3	44.0	23.0	13.1	87.5	50.5	57.7	23.2	23.6	4.2
30-30-	1	45.7	22.6	14.6	87.5	61.5	70.2	19.1	23.7	5.7
20-20	2	41.0	21.3	12.5	69.3	44.4	64.1	17.5	21.5	3.2
	3	46.8	26.8	16.4	83.3	47.0	56.5	19.6	23.1	4.8
60-0-	1	43.7	22.4	13.8	71.5	53.6	74.9	16.1	23.5	4.6
40-0	2	42.5	22.5	14.1	75.2	52.6	70.0	19.4	23.0	4.6
	3	44.1	22.0	12.0	82.3	60.0	72.9	18.1	22.7	4.4
40-0-	1	42.1	21.5	14.1	87.7	57.1	65.1	24.2	22.6	4.9
40-20	2	42.5	22.2	12.8	72.0	53.3	74.1	17.3	23.0	4.8
	3	43.7	21.2	14.4	93.0	56.4	60.7	25.4	21.7	4.7
150-0-	1	49.3	23.5	14.9	88.6	61.3	69.2	18.5	23.6	5.7
0-0	2	45.5	22.7	16.3	78.9	35.1	44.4	30.8	21.4	3.3
	3	42.5	22.1	13.9	84.1	42.0	50.0	24.4	22.7	3.5
50-30-	1	46.6	22.7	14.5	100.5	63.0	62.7	20.9	24.3	5.9
40-30	2	42.6	21.2	14.7	71.7	55.8	77.8	10.9	23.2	5.1
	3	36.9	21.9					21.7	23.4	
80-0-	1	49.5	24.6	17.0	99.4	62.1	62.5	25.3	24.2	6.8
70-0	2	44.6	22.0	16.7	121.8	66.1	54.3	33.5	23.3	6.9
	3	43.6	21.5	14.1	84.3	53.6	63.6	21.6	24.2	4.9

70-0-60-20	1	45.7	22.5	14.5	79.7	64.1	80.4	11.0	23.7	5.9
	2	44.6	21.9	14.2	68.8	58.2	84.6	22.7	24.0	5.3
	3	41.7	21.6	12.8	75.5	52.3	69.3	21.0	24.3	4.3
200-0-0-0	1	49.2	23.4	17.5	95.6	58.9	61.6	27.2	24.5	6.7
	2	46.4	22.6	16.7	100.2	42.0	42.0	35.1	22.6	4.2
	3	45.5	21.7	15.4	90.3	51.1	56.6	29.5	22.3	4.7
80-60-60-50	1	43.7	22.4	15.2	99.6	65.4	65.7	20.9	23.5	6.2
	2	40.0	21.0	15.5	79.7	56.2	70.6	18.4	23.1	5.4
	3	44.0	21.9	15.6	101.2	67.8	67.0	14.9	24.1	6.8
120-0-80-0	1	48.4	22.7	16.2	98.8	61.1	61.9	26.3	23.3	6.2
	2	46.5	23.2	15.7	93.1	61.7	66.3	20.1	22.8	5.9
	3	46.1	22.6	16.9	108.3	58.0	53.6	31.1	21.0	5.5

Ref. Four number in treatment are Nitrogen amount in kg and timing: Basal, 20 days after transplanting, premordia stage and heading stage, respectively.

Tab. II-4 CULTIVATION METHOD TEST (FEBRUARY)

Variety...Tos 103 Sowing date...1st,Feb. Transplanting date...11,12,Mar.

Treatment (Trans-planting) (cm)	Rep. No.	Heading Start	Heading 40%	Heading 90%	Maturity date	Culm Length (cm)	Ear Length (cm)	No.of Panicle per Hill	No.of Grain per Panicle	No.of ripened Grain per Panicle	Percentage of ripened Grain (%)	Percentage of un-fertilized Grain(%)	1,000 Grain Weight (g)	Yield (t/ha)
15 X 15	1	28/5	5/6	10/6	30/6	46.4	23.7	11.6	102.0	88.0	86.0	8.7	23.0	10.4
	2	27/5	31/5	4/6	30/6	47.1	22.3	11.7	73.8	65.4	88.6	7.5	25.1	8.5
	3	25/5	29/5	3/6	30/6	45.2	22.7	14.1	61.2	54.8	89.5	7.5	24.3	8.3
25 X 10	1	28/5	5/6	12/6	30/6	45.1	22.6	14.0	72.5	61.8	85.2	8.5	23.4	8.1
	2	28/5	3/6	8/6	30/6	43.2	22.1	12.4	78.8	69.2	81.8	6.4	24.7	8.5
	3	26/5	29/5	3/6	30/6	43.8	21.9	14.0	71.6	60.9	85.1	10.5	23.6	8.1
25 X 15	1	28/5	5/6	10/6	3/7	45.6	21.0	14.5	75.9	65.7	86.6	9.5	23.0	5.8
	2	28/5	1/6	10/6	3/7	50.5	24.4	12.4	88.9	78.5	88.3	7.8	23.5	6.1
	3	28/5	31/5	3/6	3/7	44.9	23.0	16.7	92.9	80.1	86.2	9.8	23.6	8.4
25 X 25	1	27/5	1/6	8/6	27/6	45.4	23.3	23.3	87.5	73.1	83.5	10.7	23.9	6.5
	2	28/5	5/6	10/6	27/6	49.7	24.5	22.7	81.2	73.8	90.9	6.3	22.8	6.1
	3	28/5	3/6	8/6	27/6	43.8	22.3	19.4	116	94.7	81.6	11.5	23.8	7.0
30 X 10	1	28/5	4/6	10/6	27/6	47.7	21.5	15.3	87.0	80.0	92.0	5.2	23.0	9.4
	2	25/5	31/5	4/6	27/6	46.9	23.4	17.0	87.4	74.2	84.9	9.9	22.6	9.5
	3	25/5	30/5	5/6	27/6	45.9	23.0	15.7	83.1	70.6	85.0	9.8	22.3	8.2

30 X 15	1	27/5	29/5	4/6	25/6	43.8	21.9	16.0	60.7	56.4	92.9	13.5	23.0	4.6
	2	28/5	5/6	12/6	25/6	43.5	23.2	16.8	91.4	82.5	90.3	7.2	23.2	7.2
	3	28/5	3/6	8/6	25/6			19.6	76.8	64.6	84.1	9.5	23.1	6.5
30 X25	1	27/5	31/5	7/6	26/6	43.8	22.6	17.9	96.5	65.1	67.5	17.8	22.7	4.4
	2	28/5	5/6	12/6	26/6	46.2	23.1	19.3	102	80.4	78.8	12.6	22.3	5.8
	3	27/5	31/5	3/6	26/6	46.1	22.5	21.2	89.0	75.2	84.5	10.5	22.5	6.0
30 X 30	1	28/5	1/6	8/6	30/6	45.0	24.0	21.0	88.3	77.3	87.5	9.1	22.0	4.0
	2	28/5	3/6	10/6	30/6	45.4	22.9	27.6	71.5	58.4	81.7	14.0	23.5	4.2
	3	28/5	3/6	8/6	30/6	46.1	23.7	23.2	81.7	62.5	76.5	14.8	23.6	3.8
17 hills	1	25/5	29/5	3/6	28/6	43.0	19.8	24.0	54.6	41.4	75.8	15.5	22.6	3.8
/ m^2 ∠1	2	4/6	8/6	14/6	26/6	51.0	23.4	29.6	65.9	51.6	78.3	12.5	22.7	5.9
	3	28/5	3/6	8/6	28/6	44.6	23.5	18.5	81.6	70.0	85.8	8.8	23.8	5.2
22 hills	1	25/5	31/5	8/6	27/6	47.2	22.1	19.0	85.4	72.1	84.4	8.1	22.0	6.6
/ m^2	2	27/5	31/5	4/6	27/6	47.0	22.5	19.2	70.1	54.7	78.0	12.7	23.1	5.3
	3	30/5	4/6	8/6	27/6	42.4	19.9	21.7	68.1	53.7	78.9	13.9	21.3	5.5
40 hills	1	28/5	31/5	8/6	30/6	44.7	20.9	18.4	66.1	47.7	72.7	18.9	23.8	8.4
/ m^2	2	28/5	5/6	12/6	30/6	47.2	22.6	17.6	87.4	68.4	78.3	14.1	23.6	11.4
	3	27/5	31/5	5/6	30/6	47.5	22.9	15.5	63.8	49.5	77.6	16.4	23.1	7.1
30 X 15	1	4/6	8/6	12/6	27/6	48.2	23.5	19.4	87.7	75.0	85.2	8.9	22.6	7.3
∠2	2	28/5	3/6	8/6	27/6	47.3	22.8	17.7	73.8	63.7	86.3	8.6	22.6	5.7
	3	26/5	1/6	8/6	30/6	47.0	22.5	20.0	94.5	69.0	73.0	16.4	23.1	7.1

∠1...B roadcast-transplanting ∠2...Transplant of broadcastable seedling

(Direct Seeding)

(a) Upland without puddling

Treatment	Rep. No.	Heading Start	40%	90%	Maturity date	Culm Length (cm)	Ear Length (cm)	No.of Panicle in 30cm X 10cm	No.of Grain per m^2	Percentage of ripened Grain	Percentage of un-fertilized Grain(%)	1,000 Grain Weight (g)	Yield (t/ha)
50 kg/ha		11/5	17/5	27/5	25/6	44.1	18.7	26.8	35900	68.1	19.8	23.7	5.8
75 kg/ha		20/5	26/5	30/5	25/6	36.5	18.3	25.7	48900	78.5	10.8	25.8	9.9
100 kg/ha		20/5	26/5	30/5	25/6	41.8	18.7	30.8	47400	62.0	16.8	24.3	7.1
(b) Submerged after puddling													
50 kg/ha		17/5	27/5	4/6	25/6	35.8	18.5	31.1	46500	65.2	22.0	20.8	6.3
75 kg/ha		11/5	17/5	27/5	25/6	38.9	18.2	29.0	34200	71.5	20.6	25.4	6.2
100 kg/ha		12/5	17/5	27/5	25/6	38.9	18.3	27.8	50500	60.8	22.7	20.9	6.4

Tab. II-5 Herbicide Test in Off-Season (February)

Variety...IR-8 Sowing Date...1st,Feb. Spacing...80 g seed / m^2

Treatment	Rep No.	Heading start	Heading 50%	Heading 90%	Maturity Date	Culm Length (cm)	Ear Length (cm)	Grass Amount 1	Grass Amount 2	Yield (t/h)
Direct Sowing										
DCPA	1	11/5	19/5	26/5	18/7			4	1	1.7
	2	12/5	20/5	27/5	18/7			3	3	3.9
	3	14/5	19/5	28/5	18/7			2	2	0.92
Saturn	1	20/5	26/5	6/6	18/7			2	2	2.0
(emu.)	2	21/5	26/5	4/6	18/7			3	3	5.1
	3	20/5	27/5	6/6	18/7			2	1	1.3
Saturn	1	20/5	26/5	6/6	18/7			5	1	0.74
(gra.)	2	22/5	27/5	6/6	18/7			4	5	2.6
	3	21/5	26/5	6/6	18/7			2	3	0.46
Ronster	1	25/5	31/5	9/6	14/7			1	1	1.0
(emu.)	2	24/5	31/5	9/6	14/7			3	3	0.92
	3	26/5	4/6	9/6	14/7			2	1	0.6
Basagran	1	25/5	4/6	9/6	14/7			1	1	2.2
	2	14/5	20/5	31/5	14/7			4	3	3.6
	3	15/5	20/5	28/5	14/7			2	2	1.7

Mixture	1	14/5	19/5	27/5	14/7	1	1	1.8
(Bas +	2	13/5	19/5	27/5	14/7	4	3	5.1
Pro.)	3	14/5	19/5	29/5	14/7	2	2	0.86
Propanil	1	14/5	20/5	28/5	14/7	2	3	1.7
	2	13/5	20/5	28/5	14/7	2	4	0.92
	3	13/5	19/5	28/5	14/7	3	1	2.4
Control	1	11/5	16/5	24/5	13/7	5	2	1.7
	2	11/5	16/5	24/5	13/7	2	2	3.2
	3	14/5	19/5	28/5	13/7	3	3	0.46
Transplanting								
Saturn	1	5/5	11/5	14/5	17/7	2	2	2.9
(emu.)	2	5/5	11/5	14/5	17/7	2	3	3.8
	3	6/5	15/5	18/5	17/7	2	1	4.7
Saturn	1	6/5	14/5	16/5	17/7	1	2	4.4
(gra.)	2	3/5	9/5	14/5	17/7	1	1	3.9
	3	5/5	11/5	14/5	17/7	1	2	4.4
X-5-2	1	3/5	9/5	17/5	17/7	1	2	3.4
	2	5/5	8/5	16/5	17/7	2	3	4.9
	3	3/5	9/5	14/5	17/7	1	2	4.5
MO	1	3/5	9/5	13/5	14/7	2	2	4.5
	2	3/5	9/5	17/5	14/7	2	4	4.9
	3	29/4	9/5	17/5	14/7	2	3	5.0

Basagran	1	3/5	11/5	15/5	14/7	2	3	3.9
	2	3/5	11/5	15/5	14/7	5	5	5.4
	3	3/5	10/5	15/5	14/7	2	3	3.8
Propanil	1	28/4	8/5	14/5	14/7	2	3	4.2
	2	28/4	7/5	17/5	14/7	4	3	5.2
	3	28/4	9/5	17/5	14/7	1	3	5.6
Mixture	1	3/5	9/5	17/5	14/7	1	2	4.4
(Bas.+	2	3/5	9/5	17/5	14/7	1	2	4.8
Pro.)	3	3/5	9/5	17/5	14/7	4	2	5.5
Control	1	4/5	9/5	17/5	14/7	2	4	3.3
	2	4/5	9/5	17/5	14/7	5	5	5.1
	3	4/5	9/5	18/5	14/7	4	3	4.4

Ref. Grass amount are judged by eye-estimation expressed by 1 to 5, each number being 1....Nothing, 2....Little, 3....Medium, 4....Many, 5....Quite many,.
Grass amount 1 and 2 are Cyperus nodule and other grass, respectively.
Judgement has been done 10th, Mar. on direct seeding, and 18th, Apr. on transplanting respectively.

III. Experiment on Germination Stand in Different Treatment for Direct Sowing Rice Cultivation under Submerged Condition

Experiment on Germination Stand in Different Treatment for Direct-Sowing Rice Cultivation under Submerged Condition

By : HIKARU NIKI /1
MOHAMED FAUZI /2

1. Introduction

The Government of the Sudan is going to establish a rice development project of 15,600 ha in Abu Gasaba Basin along the west bank of the White Nile, in the White Nile Province.

In this project, the government is intending to apply full mechanized irrigation farming, and the direct-sowing method seems to be the most practical cultivation method comparing with transplanting one from the economical and labor-saving point of view.

There are several problems to be solved for employing that method, and one of the most important one is how to obtain the best stand of seedlings after seed is sown to the field.

2. Object of Experiment

The object of this experiment is to find out the best treatment of seed, the best timing of seeding after puddling and the optimum submerging duration after sowing under the submerged field condition.

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Ministry of Agriculture, Food and Natural Resources, Sudan.

3. Design of Experiment and Materials to be Used

As the representative high-yielding varieties, IR-8, IR-20, C-6, C-11 and TOS-103 are used with the following treatments ;

(a) The degrees of incubation of seed are (1) three-day soaking only and (2) two-day pre-germination after three-day soaking,

(b) Timing of sowing are (1) just after puddling and (2) one day after puddling,

(c) Duration of submerging after sowing are (1) one day, (2) three days and (3) seven days.

Twelve combinations of treatment with four replications for each variety are practiced. One square meter (1m X 1m) of plot for each, and 10 grammes of seed (at the rate of 100kg/ha) for it are adopted. The total number of plot is 240.

To evaluate the degree of stand of seedling, eye-estimation with four grades, i.e. very good, good, ordinary and bad giving marks of three, two, one and zero, respectively, are adopted.

A standard germination test is carried out to know the germination ability of seed of each variety to be used. One hundred seeds of each variety soaked for three days are set on a moistened clean cotton bed in plastic plate, and examined potential germination ability of each variety.

Seed of each variety was soaked into water on 20th, January, and sown to the plot of just after puddling or of one day after puddling for the treatment of three-day soaking, for the plot of treatment for two-day incubation after three-day soaking, two-day incubated seed was sown on 25th, January to the plot of just after puddling or of one day after puddling, respectively. The duration of submerging after sowing was carried out properly as designed, and evaluated the grade of stand of seedling for each plot on 3rd, February, 1979.

4. Results

All plots were judged on 3rd, Feb, and those were classified into four grade : i.e. very good, good, ordinary and bad. (See Table-1) and point was given to all grade, i.e. "very good" is three, "good" is two, "ordinary" is one and "bad" is zero, respectively. Total are shown on Table-2.

From the Table-1 and 2, the following are obvious ;

1. By the comparison of the variety, IR-8 was best of germination stand in the field, and followed by C-11, TOS 103 and C-6. IR-20 could not have a good stand of sprouting in the field inspite of its highest germination energy among all tested varieties.
2. By the comparison of A1 to A2, that is incubation effect, the seed which had two days incubation treatment had always good results among varieties and also combination with other treatments.
3. By the comparison of B1 to B2, that is the better timing of puddling, B2, which is " puddled one day before seeding ", can be said to bring a better result slightly than " puddled just before seeding ".

4. The highest point has been marked in the treatment of A2 B2 C2 which is the combination of " two-days incubation ", " puddled one day before seeding ", and " submerged in the water for three days ".

5. But, variety by variety, the best treatment differed. In IR-20, it was in treatment A2 B2 C1, while in C-11, A2 B1 C3 was best.

5. Discussion and Conclusion

If the seeds are going to be sown without incubation, water should be applied for long duration after seeding. But if it is manually sown, incubation period is recommended to secure a better germination stand in the field, and that time, submerged duration must not be longer than three days.

The puddling should be recommended to be practiced one day before seeding, especially when the seed has not yet been germinated. The reason may be as following :

If it is sown just after puddling, it may be covered by fine light silt and eventually it may be suffocated before the buds come up the surface of those clayey soil.

Table-1 **Evaluation on the Grade of Stand of Seedlings of Each Plot**

Variety	Treatment	Replication No 1	2	3	4	Total Point
IR-8	A1 B1 C1	0	0	0	0	0
	C2	I	I	I	0	3
	C3	I	0	0	0	1
	A1 B2 C1	I	I	I	0	3
	C2	0	0	I	II	3
	C3	II	II	II	I	7
	A2 B1 C1	II	I	II	II	7
	C2	II	II	II	II	8
	C3	II	II	II	II	8
	A2 B2 C1	II	III	III	II	10
	C2	II	III	III	III	11
	C3	II	II	III	I	8
IR-20	A1 B1 C1	0	0	0	0	0
	C2	0	0	0	0	0
	C3	0	0	0	I	1
	A1 B2 C1	0	0	0	I	1
	C2	0	1	0	0	1
	C3	0	0	I	II	3
	A2 B1 C1	I	I	I	II	5
	C2	I	II	II	II	7
	C3	I	I*	I*	II	5 (-2)
	A2 B2 C1	II	II	II	II	8
	C2	II	III	0	II	7
	C3	0*	0*	I*	I*	2 (-4)
C-6	A1 B1 C1	I	0	0	0	1
	C2	0	0	0	0	0
	C3	I	I	0	0	2
	A1 B2 C1	0	I	I	I	3
	C2	0	I	I	I	3
	C3	II	I	II	I	6

	A2 B1 C1	I	0	I	I	3
	C2	I	II	I	II	6
	C3	I	II	II	II	7
	A2 B2 C1	II	I	II	II	7
	C2	II	II	II	II	8
	C3	II	II	II	II	8
C-11	A1 B1 C1	0	0	0	0	0
	C2	0	I	00	0	1
	C3	0	0	I	0	1
	A1 B2 C1	I*	0	0	0	1 (-1)
	C2	0	0	I	I	2
	C3	I	II	I	II	6
	A2 B1 C1	II	II	I	II	7
	C2	III	II	II	III	10
	C3	III	III	II	III	11
	A2 B2 C1	I	II	I	II	6
	C2	II	II	II	II	8
	C3	II	II	II	II	8
TOS -103	A1 B1 C1	0	0	0	0	0
	C2	I	0	0	0	1
	C3	0	I	0	I	2
	A1 B2 C1	I	I	0	I	3
	C2	I	I	0	0*	3 (-1)
	C3	I	I	II	I	5
	A2 B1 C1	II	II	II	I*	7 (-1)
	C2	II	II	II	I*	7 (-1)
	C3	II	I*	II	II	7 (-1)
	A2 B2 C1	I	II	II	II	7
	C2	II	II	II	II	8
	C3	II	II	II	I*	7 (-1)

See Note on page - 7 -

Note : 0 .... Bad

I .... Ordinary

II .... Good

III .... Very good

* .... The seed which died after sprouting can be seen because of submerged by water long time and those replication number is shown behind the point such as (-1), (-2).

Table-2 Total Point of Each Treatment

Treatment \ Variety	IR-8	IR-20	C-6	C-11	TOS-103	Sub-total A B C	Sub-total A B	Sub-total A	
A1 B1 C1	0	0	1	0	0	1			A1 63
C2	3	0	0	1	1	5	13		A2 218
C3	1	1	2	1	2	7		63	
A1 B2 C1	3	1	3	1(-1)*	3	11			B1 118
C2	3	1	3	2	3(-3)	12	50		B2 163
C3	7	3	6	6	5	27			
A2 B1 C1	7	5	3	7	7(-1)	29			C1 79
C2	8	7	6	10	7(-1)	38	105		C2 97
C3	8	5(-2)	7	11	7(-1)	38		218	C3 105
A2 B2 C1	10	8	7	6	7	38			
C2	11	7	8	8	8	42	113		
C3	8	2(-4)	8	8	7(-1)	33			
Total	69	40(-6)	54	61(-1)	57(-7)	281	281		

* Refer to Table-1

Table-3 Germination Energy

	IR-8	IR-20	C-6	C-11	TOS-103
Germination Energy	81	93	70	85	77
Average Duration for germination (day)	5.2	5.1	5.4	5.2	5.3

IV. Design of Experiment in The Pilot Farm

Ex. No. 1 to Ex. No. 10

Experiment on Rice Cultivation in Abu Gasaba Rice Project

No. & Theme	Ex. No. 1 Experiment on seed pot
Duration	15th, March to 22nd, March 1980
Objective	1. To clarify the best preparation of seed pot including soil and seed 2. To be accustomed for it's usage
Materials	Seed 5kg Water container 3 Seed pot 10 Sieve 1 Shovel 2
Method	1. Change the ratio of soil and seed 2. Change the ratio of soil and sand 3. Try to do several different way of it's preparation

Investigation Items:-

Observation of seed germination number in the pots, and find out it's best way of preparation.

No. & Theme	Ex. No. 2 Experiment on seed pot
Duration	17th, April to 5th, May 1980
Variety	C-15
Objective	The objective of this experiment is to find out best timing of submergense of seed pot.

Material & Treatment

1. Materials Seed, Soil, Sand, Seed pots, sieve and Sprayer.

2. Treatment

1) Ratio of soil and sand in seed pot

	Soil (kg)	Sand (kg)
A	3.5	0.5
B	3.0	1.0
C	2.5	1.5
D	2.0	2.0

2) Seed soaking treatment

1 Soaking in water for two days before sowing

2 No soaking treatment

3) Method of sowing seed in seed pot

a Mixed method

b Sowing by seeder

Design

A-2-a	B-2-a	A-2-a	B-2-a	A-2-a	B-2-a
C-2-a	D-2-a	C-2-a	D-2-a	C-2-a	D-2-a
A-1-a	B-1-a	A-1-a	B-1-a	A-1-a	B-1-a
C-1-a	D-1-a	C-1-a	D-1-a	C-1-a	D-1-a
A-2-b	B-2-b	A-2-b	B-2-b	A-2-b	B-2-b
C-2-b	D-2-b	C-2-b	D-2-b	C-2-b	D-2-b
A-1-b	B-1-b	A-1-b	B-1-b	A-1-b	B-1-b
C-1-b	D-1-b	C-1-b	D-1-b	C-1-b	D-1-b

No. & Theme	Ex. No. 3 Experiment on seed pot
Duration	6th, May to 24th, May 1980
Variety	C-15
Objective	The objective of this experiment is to find out the best amount of seed and better way of soaking seed, without soaking or with soaking.

Material and Method:-

1. Material — Seed, Soil, Sand, Seed pots, Sieve and Sprayer.
2. Method
   - A. The ratio of soil and sand is 2.5 and 1.5, respectively
   - B. Way of soaking seed.
     - a) Without soaking
     - b) With soaking
   - C. Replication ... 2

Investigation Items:-

The percentage and strength of germination of each treatment will be simply examined by eye estimation.

Result of eye judgement

	Germination percentage
1. 150g seed without soaking	90 %
2. 100g seed without soaking	90 %
3. 150g seed with soaking	70 %
4. 100g seed with soaking	75 %

No. & Theme	Ex. No. 5 Experiment on variety on main season
Duration	1st, August 1980 to January 1981
Objective	The objective of this experiment is to select out the varieties suitable to the Gasaba area with high yield and high resistance to disease, insect pest and lodging under the mechanized farm.

Varieties to be used:

The twenty seven varieties which have been introduced from IRRI/1, IITA/2, BRR/3, and etc. This varieties are selected according to:-

1. Many varieties from short term maturity one to long term maturity one.
2. High resistance to disease.
3. Good quality of rice kernels.

SOme characteristics from the privious experiment

No.	Variety	Duration	Quality		Yield ton/ha
1.	IR-5	120 day	Medium	2	7.3
2.	IR-20	145	Medium	1	8.1
3.	IR-22	125	High	2	6.8
4.	IR-24	145	High	1	7.4
5.	IR-28	125	High	2	6.0
6.	IR-29	140	High	3	8.0
7.	IR-30	134	Medium	1	6.0
8.	IR-36	136	High	1	8.1
9.	IR-38	133	Medium	2	7.3
10.	IR-40	133	High	2	8.1
11.	IR-127	130	High	2	6.8
12.	IR-298	145	High	2	7.9
13.	IR-1514	120	High	2	7.5
14.	IR-1561	120	High	2	7.7
15.	IR-2053	145	Medium	1	6.8
16.	IR-2153	118	High	2	6.3
17.	Tos-103	145	High	3	9.8
18.	BR-4	145	High	3	9.5
19.	BR-5	145	High	2	6.6
20.	Taichung 65	142	Medium	3	6.8
21.	Takao 21	145	High	3	5.6
22.	Hesinchu 65	145	High	3	5.1
23.	Dawn	147	High	2	6.3
24.	Taichung Ikukyu	147	High	3	5.5
25.	BG-11-11	141	Medium	1	6.8
26.	BG-34-8	120	Medium	2	7.5
27.	BG-90-2	150	Medium	1	8.0

Note:-

/1. International Rice Research Institute in Philippines
/2. International Institute of Tropical Agriculture in Nigeria.
/3. Bangladesh Rice Research in Bangladesh.

Design of Experiment

(a) Area of a plot; 10 x 3m
(b) Number of plot; 3 x 30 = 90
(c) Method of cultivation; seedling pot is to be used to raise seedlings. And it is transplanted ordinarily with 25cm x 15cm space.
(d) Amount of fertilizer applied and application method; Nitrogen (N) 200kg/ha, Phosphate is basicaly applied before planting. Nitrogen is applied at four times with equal amount, i.e. just before the transplanting, on 20 days after transplanting, at the spikelet differentiation stage (on 23 days before heading) and at full heading stage.

Investigation Items:-

The following specific items will be examined; the initial heading date, medium heading date, full heading date, disease resistance and lodging resistance. Yield analysis and milled rice grain yield per ha will be observed.

No. & Theme	Ex. No. 6 Experiment on seasonal planting
Duration	2nd Aug. 1980 starting and conducted twice a month continuously throughout a year
Objective	The objective of this experiment is to determine the optimum sowing and transplanting date for the main-season cropping as well as the off-season cropping for establishing the most suitable pattern of Double cropping a year for the Project area.

Variety BG-34, IR-24, IR-298-12-11, C-11

Design Sowing time; twice a month (1st, and 16th every month) and transplantings will be conducted all the year round

(a) Replication: Randomized exp. with 3 replications

(b) Area of a plot: 30.0m^2

(c) No. of plot: 3 x 4 = 12 plots per every time

(d) Amount of fertilizer and application method:-

P.....100 kg/ha is basically applied

N.....200 kg/ha is split applied at four times with equal amount, i.e. just before transplanting, 20 days after transplanting, at the spikelat differentiation stage (i.e. 23 days before heading) and at full heading stage.

(e) Spacing:

a. Seedling: 80 g of seed per one seed pot is to be prepared, and two seedpots are used for one variety each time.

b. Transplanting ..... 25 cm x 15 cm

Investigation Item:-

The following specific items will be examined. The initial heading date, medium heading date, full heading date, culm length, panicle length, disease resistance, insect pest resistance, lodging resistance, percentage of ripened grains, percentage of non-fertilized grains, 1,000 grain weight, quality of brown rice and grain yield per ha. Tiller number and plant height will be monitored at intervals of 7 days.

No. & Theme Ex. No. 7 Experiment on Herbicide

Duration 8th, August 1980 to January 1981

Variety BG-34-8

Objective The objective of this experiment is to establish the most effective and economical method for chemical weeding.(To find best herbicide, dosage and timing for application.)

Design of experiment:

(a) Treatment

1. Chemical; 1) Stam (DCPA) 2) Saturn
2. Dosage (per 10 a)
   1) Stam (1) 500 ml (2) 1,000 ml (3) 1,500 ml
   2) Saturn (1) 500 ml (2) 1,000 ml
3. Timing
   1. 20 days after sowing
   2. 20 days & 30 days after sowing
   3. 20 days & 40 days after sowing
   4. 20 days & 30 days & 40 days after sowing

Treatment No.	Chemical Name	Dosage ml/10a/once	Dosage ml/10a/total	Timing (after sowing)
1.	Stam(DCPA)	500	500	20 days
2.	"	1,000	1,000	20 days
3.	"	500	1,000	20 days & 30 days
4.	"	500	1,000	20 " & 40 "
5.	"	1,000	2,000	20 " & 30 "
6.	"	1,000	2,000	20 " & 40 "
7.	"	500	1,500	20 " & 30 " & 40 "
8.	Saturn	500	500	after first irrigation
9.	Saturn	1,000	1,000	" " "
10.	Control	-	-	-

(b) Area of a plot ; 3 m x 10 m (30 m^2)

(c) Number of replication; 8

(d) Number of treatment ; 10

(e) Number of plot ; 10 x 8 = 80 plots

Investigation item:-

Weed amount and plant toxicity (10 days after application), yield.

No. & Theme — Ex. No. 8 Experiment on application timing of nitrogen

Duration — 20th, August 1980 to January 1981

Variety — BG-34-8

Objective — It is essential to know suitable timing of nitrogen application on direct seeding method. This experiment is conducted to find the best timing of it.

Design

(a) Treatment (150 kg/ha is applied on different timing as next)

No.	Basal	Top dress (1st)	Top dress (2nd)	Top dress (3rd)
1.	150 (kg N/ha)	0	0	0
2.	75	75	0	0
3.	50	50	50	0
4.	50	0	50	50
5.	0	50	50	50
6.	100	0	50	0
7.	40	40	40	30
8.	50	100	0	0

* 1st top dressing is applied 30 days after sowing, 2nd top dressing is applied 23 days before heading and 3rd top dressing at heading time.

(b) Replication ; 4

(c) Number of plot ; 8 x 4 = 32

(d) Area of a plot ; 3 x 10= 30 m^2

Investigation item:-

The following specific items will be examined; the initial heading date, medium heading date, full heading date, maturity date, culm length, panicle length, disease resistance, insect pest resistance, lodging resistance, percentage of ripened grains, percentage of non-fertilized grains, 1,000 grain weight, quality of brown rice and grain yield per ha, also the following items must be checked every week;

1. Plant height
2. Tiller number

No. & Theme: Ex. No. 9 Experiment on Nitrogen Amount

Duration: 20th, August 1980 to January 1981

Variety: BG-34-8

Objective: The objective of this experiment is to find the suitable Nitrogen amount to maximize rice yield

Design of experiment

(a) Number of treatment ; 7
(b) Number of replication ; 4
(c) Number of plot ; 4 x 7 = 28
(d) Area of a plot ; 3 x 10= 30 m^2

Treatment	Total Nitrogen amount (kg)	Basal	Top dressing (1st)	(2nd)	(3rd)
(1)	0	0	0	0	0
(2)	50	20	30	0	0
(3)	100	30	20	30	20
(4)	150	50	30	40	30
(5)	200	50	50	50	50
(6)	250	100	50	50	50
(7)	300	100	100	50	50

Investigation Item:-

Besides the items in variety experiment, plant height and tiller number are to be checked every week from one month after sowing.

No. & Theme	Ex. No.10 Experiment on Phosphorus Fertilizer
Duration	20th, August 1980 to January 1981
Variety	BG-34-8
Objective	The objective of this experiment is to know the optimum amount of phosphorus

Design

(a) Area of a plot ; $3 \times 10 = 30\ m^2$

(b) Number of replication ; 4

(c) Number of treatment ; 5 (P...0,50,150,200,250 kg)

(d) Number of plot ; $4 \times 5 = 20$

Investigation item:-

Same as variety experiment (Ex. No. 5)

Ref. Nitrogen fertilizer is applied for all treatments with same amount of 200 kg N. (before transplanting, 20days after transplanting, the spikelet differentiation stage and full heading, 50 kg N each time)

V. Design and Result of Experiment on Direct Seeding in the Pilot Farm

Rice Growing Experiment
In Abu Gasaba Rice Project

Ex. No. & Theme	Ex. No. 1, Experiment on Direct Seeding
Term	5th, April, 1980 to 5th, May, 1980
Variety	C-15
Objective	To know suitable amount of seed and depth to be sown on direct seeding using drill seeder.

Design:

A. Treatment

1. Soaked Seeds

   1) Depth

      a. 1 cm b. 2 cm c. 5 cm

   2) Seed amount

      a. 75 kg/ha b. 100 kg/ha c. 150 kg/ha

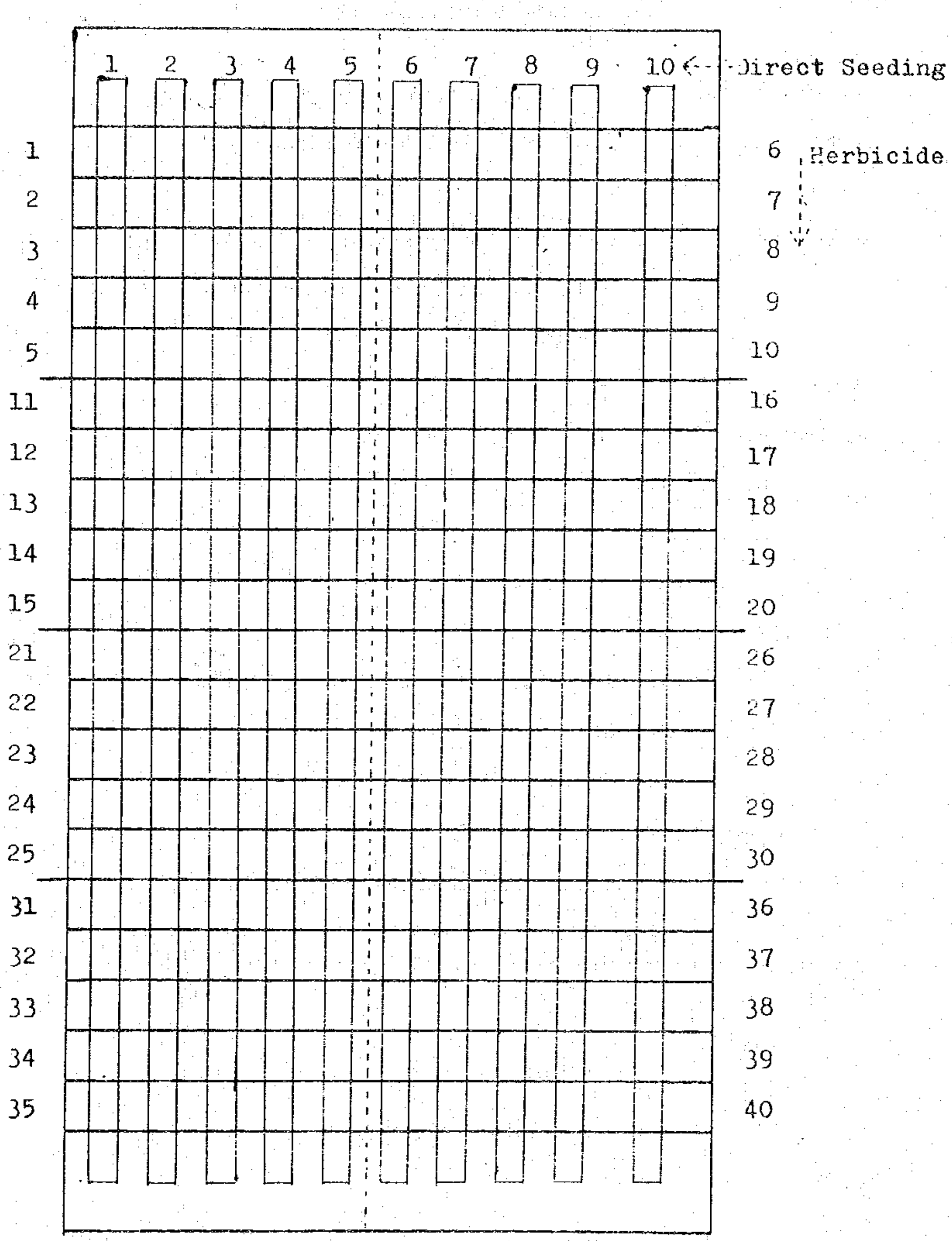
2. Without Soaking

   * 2 cm depth and 75 kg/ha seed amount

B. Plot Allocation

Plot No.	Treatment		
	Soaking	Depth (cm)	Seed Amount (kg/ha)
1	2 days	1	75
2	"	1	100
3	"	1	150
4	"	2	75
5	"	2	100
6	"	2	150
7	"	5	75
8	"	5	100
9	"	5	150
10	No Soaking	2	75

Experimental Plot Allocation



Result of direct seeding test

Seedling Stand∠ 1

Treatment		Replication				
Depth	Seed amount	I	II	III	IV	Total
1 cm	75 kg/ha	260 cm	260	410	200	13.1 %
1	100	790	400	600	180	31.6
1	150	700	630	820	450	41.7
2	75	440	190	110	320	17.0
2	100	60	530	460	340	28.4
2	150	755	610	320	300	31.8
5	100	970	510	530	350	37.8
5	150	970	620	310	340	35.9
2	100(Dry Seed)	165	100	100	150	3.3

∠ 1 Seedling Stand= $\frac{\text{Sprout(m)} \times 100}{15.6\text{(m)}}$ (%)

There are six 2.6 m rows in one plot (one replication) and total length of the row in one plot is 15.6 m. If the interval between adjacent rice seedling is less than 10 cm, it is considered as valid sprouting area, and is expressed by length (cm).

VI. Design and Result of Experiment on Herbicide in the Pilot Farm

Rice Growing Experiment

In Abu Gasaba Rice Project

Ex. No. & Theme — Ex. No. 2, Exp. on Herbicide in Direct Seeding.

Term — 5th April, 1980 to 15th May, 1980.

Variety — C-15

Objective — To kow the effectiveness of herbicides and plant toxicity to rice

Design:

1) Treatment;

A. Saturn

a. Just after sowing

1. 600 cc/10a
2. 1200cc/10a

b. After uniform germination
(10-15 days after sowing)

1. 1000cc/10a
2. 1500cc/10a

B. Stam

When no. of weed leaf is 2 or 3

1. 500 cc/10a
2. 1000cc/10a

C. Saturn & Stam (8 replication)

* Just after sowing
  Saturn 1000cc/10a
* When no. of weed leaf is 2 or 3
  Stam 1000cc/10a

D. Control (8 replication)

2) Replication; 4

3) Area of a plot; 30 m^2

4) Number of plot; 40

Design of Experiment

Plot No.	Treatment	Plot No.	Treatment	
1	B-1	6	A-a-2	
2	C	7	B-2	
3	D	8	D	Block I
4	A-a-1	9	A-b-1	
5	A-b-2	10	C	
11	A-b-1	16	A-a-1	
12	B-2	17	C	
13	D	18	D	Block II
14	B-1	19	A-a-2	
15	C	20	A-b-2	
21	A-a-1	26	B-1	
22	A-b-2	27	A-b-1	
23	D	28	D	Block III
24	A-a-2	29	C	
25	C	30	B-2	
31	A-b-2	36	A-a-1	
32	C	37	C	
33	D	38	D	Block IV
34	B-1	39	B-2	
35	A-a-2	40	A-b-1	

Result of Herbicide test

Chemical Name	Timing	Dosage	Result (No. of Grass in 30 m^2) Echinocloa Crusgari	Other Grass
Saturn	Just after sowing	600cc/10a	20.8	11.5
		1200cc/10a	27.8	7.8
	After uniform germination	1000cc/10a	17.0	7.5
		1500cc/10a	18.0	6.8
Stam	When no. of weed leaf is 2 or 3	500cc/10a	22.0	7.0
		1000cc/10a	6.0	3.8
Saturn & Stam			23.9	9.9
Control			58.6	15.6

VII. Research for the Occurance of Broken Rice in the Pilot Farm

Research for The Occurance of Broken Rice In Abu Gasaba Rice Project

Variety C-11

Objective......... To find out the original place where rice is cracked. The countermeasure must be taken for it to grade up the rice commercial value.

Date .... 12th, & 13th, Dec 1979

Method .... Three assumptions for the origin of broken rice are set.

1. Before harvest (During maturity time)
2. In between harvest and milling process (Storing time)
3. When it is milled by machine

The sudden change of misture content in rice grain is said to be a most influential cause of rice cracking. But, when we consider the complete difference of humidity of Sudanese climate from other rice growing country in monsoon area, other reason for cracking rice in this area must be studied. Air humidity is inevitably affecting to all three assumptions mentioned above. Air humidity are to be checked everyday.

To know the optimum harvesting time, the rice of three stage are examined on it's moisture content and percentage of head rice. (Yellow ripening stage, Full ripening stage and Dead ripening stage)

Secondary, moisture content of rice which is kept in sack in warehouse are measured.

Fourteen percent of moisture contents in rice is said to be optimum for milling rice. Hence, several trials to make the rice moisture content as said percentage were conducted.

The efficiency of our milling machine is to be tested, while most suitable rice moisture content for milling in this area is to be researched.

Result

(1) Percentage of head rice in each stage

Stage	Tested Grain Weight	Husked Brown rice Weight	Weight of head rice	Percentage of head rice in Product
Yellow Ripening	30 g	14.0 g	7.25 g	51.8 %
Full Ripening	30	17.75	9.75	54.9
Dead Ripening	30	20.5	15.5	75.6

(2) Moisture content in each stage

Stage	12:00 am
Dough	33.75 %
Yellow Ripening	21.25
Full Ripening	10.00
Dead Ripening	7.5

* Refer to Section VIII. Technical Discussion about further consideration of the broken rice.

VIII. Technical Discussion

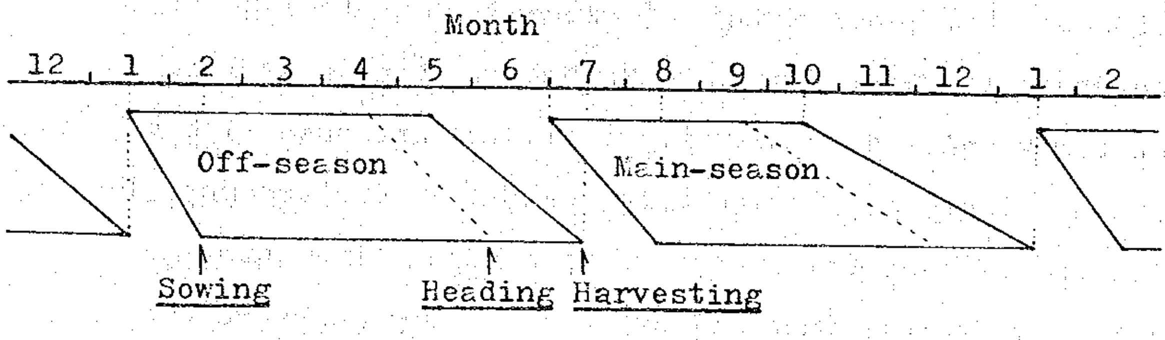
1. Variety and Double Cropping
2. Cultivation Method
3. Panicle Number
4. Broken Rice
5. Others

XIII. Technical Discussion

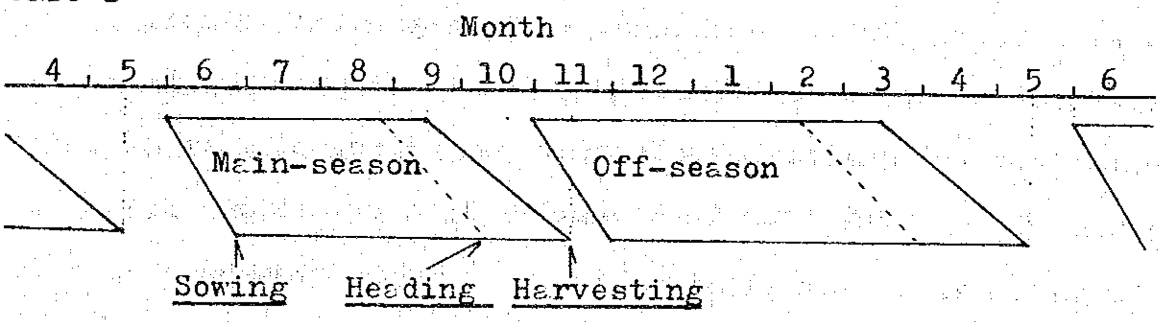
1. Variety and Double cropping

Suitable varieties in this Project can not be discussed without consideration of it's plantation time. Rice is going to be cultivated twice a year in this Project area, and the pattern of double cropping has not yet been fixed up to now. And each rice variety can not be anticipated stable performance in different planting time. So far, there are two possible patterns of double cropping a year. Those two cases are as follows:

Case 1



Case 2



In case 1, the sowing time in main season is starting at the beginning of July and lasts up to the middle of August. The sowing time in off-season is February. High yield is anticipated from February planting. While, in case 2, plantation starts on June, in which most stable high yield can be expected. And another cropping starts on November.

These two patterns still have some problems to be solved. For instance:

Case 1.....When harvesting works are delayed in off season, the sowing time in main season might be affected and sometimes delayed. And medium and late maturity varieties which are sown after the middle of August ought to be affected those percentage of ripened grain from the coldness starting from late November. (But, as long as early and medium maturity varieties are sown within August, there may not be a fertilization disturbance.) As for off seasonal cropping, if heading time coincides with high temperature and dry air, it may increase the percentage of unfertilized grains.

Case 2 ...... There, although, is less problem in main seasonal cropping, some difficulties to secure enough amount of panicle number and high percantage of ripened grains can be foreseen in November planting. The reason is that rice plant must pass through cold season during it's tillering stage and generative stage.

Though ten tons in total in a year may not be difficult for both of the case in future, the double cropping pattern has not yet been decided, and it will be clarified by many experiments in The Pilot Farm.

Accordingly, variety will be discussed in accordance with sowing time. But, some superior varieties in two seasons have been clarified from the privious experiment. Next varieties are high yielding varieties in each season:

Main season

BR-4, C-15, C-6, BG-33-2, BG-90-2, IR-36, BG-34-12, Tos 103, IR-29, BG-34-6, BR-5, IR-24

Off season

BG-90-2, IR-8, Taichung Native 1, IR-1561, Heshinchu-65, C-15, C-6, IR-2053, IR-22, IR-24, IR-2153

Quality and susceptibility to diseases and pests are to be considered as well when varieties are selected. The results of observations from previous investigation are shown in Table II-6. So far, next varieties may be recommended in each season:

Main season

IR-24, IR-36, Tos 103, BG-90-2, IR-29,
IR-2053, IR-298-12-1-1-1

Off season

IR-22, IR-24, IR-29, IR-2053, IR-2153,
IR-1561, BG-90-2, Dawn

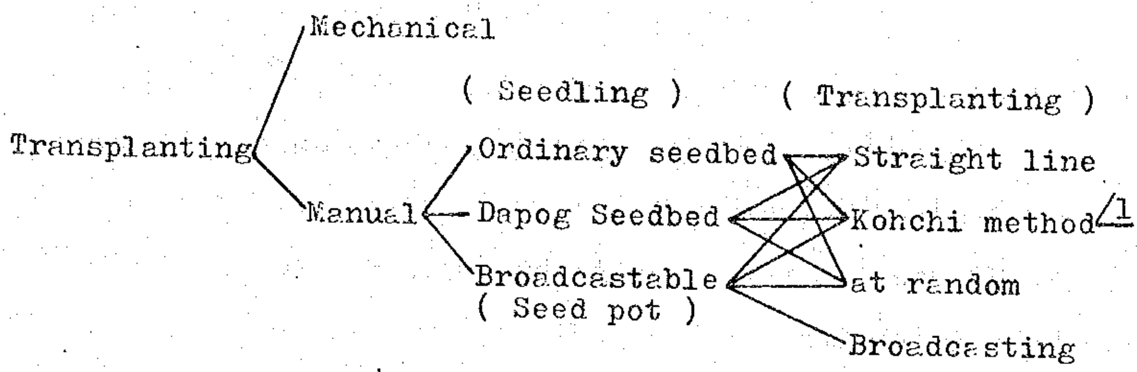
A flexibility for variety selection are required even in a same season according to sowing time.
For instance, when rice seed are obliged to be sown after the middle of August, some other varieties must be selected from early maturity ones like BG-34-8 or C-11, in despite of not recommended varieties.

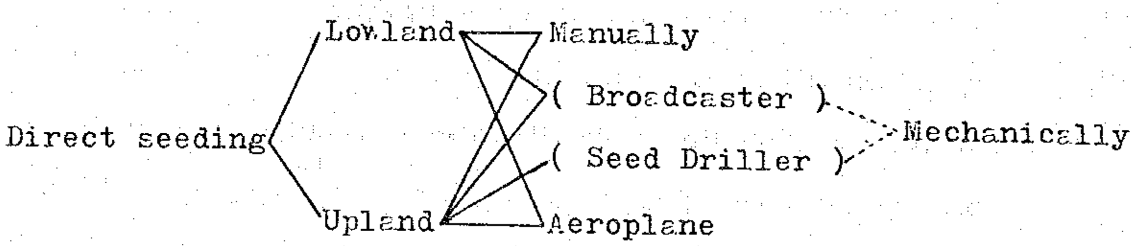
Other characteristics like fertilizer response, susceptibility to other diseases or etc. must be considered as well. From those trials and observations, recommended varieties in each sowing time (if possible, each 10 days) must be found.

It is believed that those difficult tasks will be performed by the efforts of the experts who are staying in this Project.

2. Cultivation Method

Cultivation method can be divided into transplanting method and direct seeding one roughly. The chart for possible cultivation method in this Project are as follows:





/1 ...Traditional way of transplanting in Kohchi region, Shikoku island, Japan. In which transplanter going backward after transplanting 6 seedlings from his left to right. It is fast.

Transplanting machine may not be able to be a practical one in this Project area on account of heavy clayey soil. Dapog is the traditional way of raising seedling in the Philippines, and can be applied in this area when there is laborer shortage and some machine troubles. Manual direct seeding may be employed only for experiment. Direct seeding by aeroplane will be a discussion object when the Project area is expanded in future.

Reviewing these facts, the cultivation methods shown below may be considered rational way:

Experiment

1. Transplanting straight by broadcastable seedlings raised by seed pot
2. Transplanting straight by ordinary seedling

Seed Multiplication

1. Broadcast transplanting by seedling raised by seed pot
2. Kohchi method or at random transplanting by ordinary seedling

Trial Cultivation

1. Broadcast direct seeding in lowland by broadcaster
2. Broadcast direct seeding in upland by broadcaster
3. Direct seeding in row by seed driller

3. Panicle Number

Fig. XI-1 is a graph from the record of the Pilot Farm operation in 1979. From this graph, high positive corelation between yield and no. of panicle per m^2 or no. of grain per m^2 can be read. It is, of course, clear that yield starts decreasing from some point if panicle number or grain number continue increasing. But, the target so far in this Project is to increase panicle and grain number in order to maximize rice yield. The critical point for increasing panicle and grain number should be investigated on one hand.

Though it is not so difficult to increase number of grain per panicle by suitable application of fertilizer, it may sometimes bring yield reduction by decreasing percentage of ripened grain. To aim to increase number of panicle per m^2 may be much safer way to increase yield rather than to increase grain number per panicle. The reduction of number of grain per panicle induced by increase of panicle number per m^2 can be well compensated by increment of percentage of ripened grain. Preferably, it is advantageous to decrease grain number per panicle because it may decrease grains on the secondary rachis branch and resulting high percentage of ripened grain. (Seizo Matsushima, "Crop Science in Rice")

To increase panicle number per unit area is to increase valid tiller number per unit area. As clear by many studies in Japan, end stage of valid tillering may come approximately one month after transplanting even in this Project. This phenomenon is seen in all varieties which differ maturity duration. The end stage of valid tillering come approximately 50 days after sowing in case of direct seeding method. Optimum number of valid tiller should be secured untill this stage in each case.

There may be no problem in main season on account of good weather with high temperature during rice growing time. While, there may be some difficulties for this in off season because of cold temperature in spite of much sunshine. Mean minimum air temperature during December to February is approximately 15° C to 18° C. And mean minimum water temperature in same period is approximately 11° C to 15° C.

A suitable intensive water management is required to raise water temperature, and amount of sowing seed (in direct seeding) and planting density must be increased to secure enough number of valid tiller in off season. If more than 500 panicle number per m^2 could be gotten finally, a good yield can be anticipated.

4. Broken Rice

Broken rice deteriorates the grade of rice and market value. Reputation of broken rice in Sudan is not good, and rice with many broken one is cheap in market accordingly. This is the reason why rice varieties with low percentage of broken rice is recommended.

But, the treatment after rice ripening could decide the percentage of broken rice. When and how rice will be broken? Especially, it is a great problem in hot and arid area like Sudan. And some investigation were carried out in this Project, and result is listed in Chapter VII. Only one investigation in one season can not conclude this problem, of course, but some items were clarified as next:

1) Crack in grain could be happen before harvesting in rice field. Especially hot and dry wind may hasten it.

2) Optimum harvest timing will be limitted when broken rice is expected to be minimized. Losing a good timing to harvest rice will result many cracks in grain on account of hotness and dryness. Sudden change of moisture content in the grain is said to be a biggest cause of rice crack.

3) Cracked rice is easily broken in a process of milling.

4) Moisture content in grain keep decreasing during it's storage time from harvesting to milling, and may increase broken rice.

5) A fine operation programme is required to minimize broken rice. Harvesting in optimum time, shortening storage duration and milling work must be well programmed with the consideration of speed and capacity of the milling machine.

Par-boiling is only one way to solve all of those problems. Several tests about Par-boiling were carried out primitively in this Project.

This modern facility, although, is expensive one, it should be argued when the Project expanded.

5. Others

Necessity of phosphorous and potassic fertilizer is low according to the results in previous experiments in this Project. While continuous fertilizer experiment in successive season in same plot are essential to know rice demand for phosphorous and potassic fertilizer in successive croppings.

Optimum economical amount of Nitrogen fertilizer is considered as 150 kg to 200 kg in ingredient. Further Nitrogen experiment is required for the themes like varietal difference of nitrogen response, planting season and different cultivation method.

It is regretful that kind of available herbicide is limitted in Sudan. It is recommended to accustomed for the usage of Stam (DCPA), Saturn and Basagran which are only available herbicide in Sudan so far.

IX. Some Texts about Rice Cultivation for Staff

MATSUBAYASHI, Minoru, " Theory and Practice of Growing Rice", FUJI PUBLISHING CO. LTD., 1967

1. LIFE HISTORY OF RICE PLANT

1. Outline of the Life History of Rice Plant

Under the climatic conditions in Japan, the life history of rice plant from the germination of seeds to the ripening lasts generally for 120 to 180 days, except for specific cases. The life history of rice plant can be divided into two periods: vegetative growth period and generative growth period (Fig. 3-1). The vegetative growth period is the period during which the rice plant itself grows. The increase in the number of tillers is the most salient feature of this period. The generative growth period is the period during which the growth of rice plant is completed to reproduce rice plants of next generation. This period is characterized by the panicle formation and its growth. The two growth periods are demarcated by the initiation of the young panicle formation. Namely, after the seed germination a rice plant grows and puts forth tillers. By and by leaves, roots, and culms grow up, but when the increase in number of tillers begins to slow down, young panicles are formed at the base of stalks. Until this period is called the vegetative growth period. Afterward, young panicles grow gradually and plant begins to develop ears and the ears ripen. This period is called the generative growth period.

The vegetative growth period is subdivided into two stages: nursery stage and tillering stage. The tillering stage is subdivided again into rooting stage, valid-tillering stage, and invalid-tillering stage. Though tillers develop at the nursery stage, most of them will usually die after the transplanting of seedlings, except strong ones. The rooting stage generally lasts for several days after the transplanting of seedlings. No tillers develop during this period, but when the plant has once rooted, many tillers develop rapidly. The increase in the number of tillers comes to a state of abeyance at the advent of a certain period. Subsequently to that period, weak tillers begin to die, thus showing a decrease in the number of tillers. However, by the time when the heading stage has come and the number of panicles has come to be fixed, the number of tillers has come to be fixed. The stage when the number of tillers reaches a maximum is called the maximum number of tillers stage. The stage when the number of tillers has come to coincide with the final number of panicles is known as end stage of valid-tillering period, and the period ranging from the rooting to the end stage of valid-tillering period is known as valid-tillering period. And the subsequent vegetative growth period is known as invalid-tillering period, viz., it means that only those tillers produced by the time of the end stage of valid-tillering period bear panicles, and that those tillers developed subsequently die and bear no panicles (speaking rigidly, however, it cannot always be said that every tiller developed before the end stage of valid-tillering period will bear panicle, while every tiller developed subsequently will die).

Next, the generative growth period lasts for the period from the young panicle differentiation to ripening, and is subdivided by the heading stage into two periods: young panicle developing period and ripening period. In case of the former, internodes at the base of a culm begin to elongate, and elongate markedly up to the heading period, and four or six internodes from the top will complete the elongation. And in this period, changes take place in the leaf-emerging velocity, viz., the leaf-emerging interval in the tillering period is usually four or five days, while that in the generative growth period takes a little longer, lasting for eight or nine days. The elongation of internodes, changes in leaf-emerging velocity, as well as the differentiation and development of young panicles are the outstanding characteristics of the pre-heading generative growth period. The young panicle developing period can be subdivided again into young panicle formation stage and booting stage. Generally speaking, the young panicle formation stage lasts from the initiation of the young panicle formation stage till the time just prior to the booting stage. The booting stage denotes the period in and about the reduction division stage (or meiosis stage). The young panicle formation begins from "about 30-34 days prior to the heading period" known as "primary bract primordium differentiation stage" (or neck-node differentiation stage), but it can not be seen with the naked-eye before the time of the secondary rachis-branch primordium differentiation. The secondary rachis-branch primordium differentiation stage sets in generally about 24-27 days prior to the heading period, when the young panicle measures about 0.5-1.0

millimeter in length. After that the young panicle grows slowly and sets in the spikelet primordium differentiation stage. When the young panicle grows larger than 1 millimeter long, the spikelet primordium differentiation begins at the tip of a young panicle. The differentiation stage lasts fairly long, usually lasting for 7-10 days. At the late differentiating stage of spikelets, a young panicle will generally grow to the extent of 1 centimeter in length. At this time the intercellular spaces begin to develop in the anthers and then the reproductive cells develop. By this time, the young panicle will grow to the extent of 3-5 centimeters long. From this period, the young panicle will grow markedly, reaching 20 centimeters long or more in about one week. At the time of its peak elongation, the reduction division of the pollen mother cells and the embryo-sac mother cells will take place. In the normal year, the reduction division begins to take place from 14 or 15 days before the heading period and arrives at the peak about 10 days before the heading period and will end usually about five days before the heading period. By the telophase of the reduction division, the elongation of the young panicle is nearly completed. Both the palea and lemma will reach almost full length and width, and the number of spikelet primordia per panicle has come to be fixed. When rice plant shoots out the ear, the anthesis will begin from that day or from the day following. Two or three hours after the anthesis, the fertilization will have been completed. The anthesis begins generally from the tip rachis branch of a panicle and then shifts to the lower ones. The anthesis lasts generally for 7-10 days. The fertilized embryos will grow gradually and the endosperm also will develop. It shows increases in length, width, and thickness of caryopsis (rice kernel) in the order. The fruiting stage after the heading can, according to the maturity of rice kernel or the paddy color, be divided into milk ripe stage, dough stage, yellow ripe stage, full ripe stage and dead ripe stage. Generally speaking, short-term varieties will ripen about 35-40 days after the anthesis, and long-term ones about 60-65 days after the anthesis.

2. Process in Determination of Grain Yields during the Life History of Rice Plant

The final objective of rice cropping is to increase the yields. Fertilizer application and caretaking must always be done from the standpoint of rice yielding increase. For this purpose, it is required to know when and how the rice yield be determined during the life history of rice plant. Grain (kernel) yield is determined by the following formula:

$$\begin{pmatrix}\text{Grain}\\\text{yield}\end{pmatrix} = \begin{pmatrix}\text{Number of}\\\text{panicles.}\end{pmatrix} \times \begin{pmatrix}\text{Number of}\\\text{spikelets}\\\text{per panicle}\end{pmatrix} \times \begin{pmatrix}\text{Percentage}\\\text{of ripened}\\\text{grains}\end{pmatrix} \times \begin{pmatrix}\text{Weight}\\\text{of 1,000}\\\text{kernels}\end{pmatrix}$$

Accordingly, in order to know how and when the rice yield is determined, it is needed to make clear how the above four contributing components are determined during the life history of rice plant (Fig. 3-2).

(i) The main stage at which the number of panicles is determined is the most active tillering stage ranging over the period lasting for 20 days before the maximum number of tillers stage. The number of panicles is affected most strongly by the environmental conditions during this period. In general, the number of panicles is finally determined on or about the 10th day after the maximum number of tillers stage.

(ii) The number of spikelets per panicle is determined by the difference between the number of differentiated spikelets and the number of degenerated ones. The number of differentiated spikelets begins to be affected chiefly by the environmental conditions from the neck-node differentiation stage, and is affected most adversely at the secondary rachis-branch primordium differentiation stage, and little or no adverse effect is brought about by the environmental conditions after the spikelet primordium differentiation stage. In or about the reduction division stage, there is a time at which spikelet primordia are most readily degenerated, and the number of degenerated spikelet primordia will have been determined finally by about "the 5th day before the heading date" (i.e., the end stage of the reduction division).

(iii) Percentage of ripened grains: This indicates the percentage ratio of fully-ripened kernels to the total number of grains produced. In non-ripened grains (paddy) are included non-fertilized grains (paddy), and imperfectly ripened ones.

It begins to have an adverse effect on the percentage of ripened grains chiefly from the neck-node differentiation stage. In the stages of reduction division, heading, and the most active ripening stage, there is a time at which the percentage of ripened grains is most readily affected, but the percentage of ripened grains will be fixed almost finally by the time about 35 days after the heading.

(iv) Weight of 1,000 kernels (husked rice): The weight of 1,000 kernels depends primarily upon the size of hulls which is determined before the heading, and secondarily depends upon the rate of filling up of hulls with caryopsis. As a result, if small-sized paddy has once been formed, kernels could no longer grow larger due to the mechanical restrictions by the size of hulls, whatever favorable the environmental conditions after the heading may be. In view of this, the weight of 1,000 kernels has direct bearing upon the two periods: (i) the period from the spikelet primordium differentiation stage to the reduction division stage and (ii) the most active ripening stage about 10-25 days after the heading.

3. Age of Rice Plant (Plant-age as expressed by leaf number) and Plant Development

As is the case with human life history, it is very convenient to observe the life history of rice plant according to the plant-age as expressed by number of leaves, because the development stage of rice plant can generally be judged from the plant-age as expressed by leaves. The plant-age by leaves is represented by the number of leaves born on the main culm after the germination of seed of rice. The leaves developing from the main culm during the period from the germination to the heading are generally less in number in the case of short-term varieties while more numerous in the case of long-term ones. The total number of leaves arising from the main culm up to the heading stage is called the "total number of leaves on the main culm". When the same variety is cultivated under the same cultural condition, the total number of leaves on the main culm is almost the same from year to year, except abnormal years, showing the total number of leaves peculiar to the variety. The leaves (excluding coleoptyle) are name as the first leaf, third leaf, and so on, respectively, in the order of the leaf emergence.

When each leaf has grown fully, it is called the first leaf stage, second leaf stage, third leaf stage, and so on, respectively. When a leaf has not grown to the fullest extent, e.g., when the sixth leaf has emerged only to the extent of 30 per cent of the full-grown sixth leaf, it is called the 5.3 leaf stage, and when it has grown up to the extent of 70 per cent, it is called the 5.7 leaf stage. In such case, the length of the full-developed sixth leaf is deduced from the length of the fifth or fourth leaf. From the standpoint of the plant-age by leaves stated above, it can safely be said that, in the case of rice varieties bearing the similar total number of leaves on the main culm, if these are similar in plant-age by leaves, these varieties would almost be at the same inner physiological development stage. However, in the case of rice varieties bearing the different total number of leaves on the main culm, it is usual that even if the plant-age by leaves be similar, these varieties are not always at the same development stage. In order to compare the inner development stages between the varieties bearing the different total number of leaves on the main culm, the "leaf-age index number" is used. The leaf-age index number is the figure obtained by

$$\frac{\text{(Present plant-age by leaves)}}{\text{(Total number of leaves on the main culm)}} \times 100.$$

By using this figure, the inner development stage of rice plant can be made clear to a fairly extent. Between the leaf-age index and the inner development stage being found the relationship as given in Fig. 3-3, the status of development of young panicle could be made clear by the use of leaf-age index number without attempting any analysis or microscopic examination. Determination of plant-age by leaves can not be made without counting the number of leaves from the beginning of plant growth. However, the reduction division stage which is regarded as most important throughout the life history of rice plant can be judged exactly by the other method. In this case, the judgment is formed by measuring the distance in-between two auricles (ear-shaped appendages to leaves). The distance in-between auricles indicates the distance between the auricle of flag-leaf and that of the immediately lower leaf, and when the flag-leaf blade projected partly and its auricle was still remaining in the sheath of the next leaf, it is represented by minus sign (-)

when the auricles of both leaves coincide with each other, it is represented by zero (0); and the state in case where the flag-leaf auricle has projected partly is indicated by plus sign (+). Hence it can be said that the reduction division stage will begin nearly from the time of (-) 10 centimeters in the distance in-between the auricles, and will reach nearly its most active stage at the time of (0), and will close at the time of (+) 10 centimeters or so. Nor can be applicable the leaf-age index number to the judgment of the development stage of rice plant after the heading. The development stage of rice plant after the heading is subdivided into milk ripe stage, dough stage, yellow ripe stage, full ripe stage, and dead ripe stage, or, in most cases, it is represented by the number of days after the heading. However, when expressed in such parlances, the development of rice kernels, though similar in ripeness, would often be taken differently according to the years, varieties or areas, and it is also unreliable in preciseness. In contrast to this, the judgment formed from the "specific gravity of grain (rough rice)", "kernel-hull (weight) ratio", or "proportion of the translucent area to its whole area in cross-section of a grain" is more recommendable, because when judged by such criteria, the same result can always be obtained from the same test samples, irrespective of the time or place of test and of tester. Namely, the specific gravity of dried grain (rough rice) indicates the size of the space between the hull and the kernel which is developing in the hull, and indicates exactly the degree of plumpness of a kernel in the hull. "Kernel-hull weight ratio" indicates the ratio between the volume of a hull and the size of the kernel which is developing therein. The judgment by this ratio is highly precise and reliable. However, these two methods can not be easily applicable because there are in reality fairly much complicated.
In contrast to these methods, the judging method by the "proportion of the translucent area to its whole area in the cross-section of a grain" is the most convenient method. Speaking generally, the transversal section of a kernel reveals the increase in its translucent area step by step from the central part, with the progress in the ripening of a kernel, and this translucent area can be seen distinctly. Conseqently, the ripening degree can be judged by the measure with the eye based upon the criteria established for the respective grades of

transparency (Fig. 3-4). The ripening degree of a panicle as a whole can be made clear by measuring the transparency of the first two kernels from the tip of the central rachis-branch.

4. Regularity in the Plant Growth Behavior

The growth of the respective organs of rice plant is completed orderly, but not disorderly. Regularity in the production of tillers and in plant growth is found in the vegetative growth period. The tiller produced directly from the main culm is called the primary tiller, the tiller from the primary tiller is called the secondary tiller, and the tiller from the secondary one is known as the tertiary one, respectively. The following relationship is found between the appearance of each tiller and the emergence of leaf on main culm. Namely, simultaneously with the appearance of the fourth leaf (4/0) from the main culm, the "first leaf of the primary tiller No. 1" (1/1) emerges. Simultaneously with the appearance of the fifth leaf, sixth leaf, ... (5/0, 6/0......) on the main culm, the second leaf, third leaf, ... (2/1, 3/1......) emerges from the primary tiller No. 1. Leaves represented by (2/1, 3/1 ......) and (5/0, 6/0 ......) are called the synchronously-emerged leaves. In case of the primary tiller No. 2, its first leaf (1/2) appears simultaneously with the appearance of the fifth main culm leaf (5/0), and its leaves (2/2, 3/2 ....) emerge simultaneously with the main culm leaves (6/0, 7/0 ......). The same can be said of the primary tiller No. 3 and downward. Next, the "first leaf of the secondary tiller No. 1" (1/1.1) emerges simultaneously with the "fourth leaf of the primary tiller" (4/1). Accordingly, this period just falls on the emergence of the seventh main culm leaf (7/o). Table 3-1 will give help in understanding the above relationship.

As stated above, each of the respective leaves both on the main culm and tillers develops at a definite inerval, and all the leaves from tillers develop in parallel with the development of leaves on the main culm. Accordingly, tillers and leaves from one hill as a whole can be divided into groups: groups of synchronously developed leaves and groups of synchronously developed tillers. And since the synchronously developed tillers not only develop simultaneously but also each of all leaves (including leaves from the first leaf to the flag-leaf) develops simultaneously, these tillers always have each own corresponding leaf. This is known as synchronous homologue of the main culm and tillers. This regularity is observed exactly until immediately before the maximum number of tillers stage, while in and after this stage, it is usual that the emerging velocity of leaves from some tillers is slowed down and the relative growth is disturbed to a considerable extent (these tillers become invalid-tillers.)

In the generative growth period, a definite regularity can also be found among (i) the elongation of internodes, (ii) growth of young panicle, leaf blade, and leaf sheath, (iii) time of leaf emergence, (iv) rooting nodes, and (v) the increase in root number.

5. Inter-Relationship between Vegetative Growth Period and Generative Growth Period

The life history of rice plant is, as stated before, divided into two periods: the vegetative growth period which is characterized by the increase in the number of tillers, and the generative growth period in which the development of young panicle constitutes the principal feature. However, there are not a few cases where a clear line of demarcation can not be drawn between these two growth periods. In most cases, as shown in Fig. 3-1, young panicle differentiation begins from the time when the increase in the number of tillers begins to stop, while in the cases of (i) short-term varieties, (ii) late transplanting of seedlings, or (iii) colder areas, it is usual that, even after the young panicle differentiation, rice plant still continues to put forth tillers. Namely, the vegetative growth period and the generative growth period often overlap each other. However, in the cases contrary to the above, the two growth periods can, in most cases, be clearly demarcated. As the period in which tillering begins to be slowed down coincides with the maximum number of tillers stage, the latter can be regarded as the close of the vegetative growth period. Since the beginning of the generative growth period is the young panicle differentiation stage, the problem of the overlapping or separation of the two growth periods can after all be attributed to the relationship between the maximum number of tillers stage and the young panicle differentiation stage. The relationship can be summarized in three phases: (i) young panicle differentiation takes place before the maximum number of tillers stage (overlapping of both growth periods); (ii) the maximum number of tillers stage just coincides with the young panicle differentiation stage (continuation of the two growth periods); and (iii) the young panicle differentiation takes place after the maximum number of tillers stage (segregation of two periods). Needless to say, Fig. 3-1 represents only one of these three cases. Connected with this, it is worth while to notice that in the case of rice plants transplanted simultaneously under the same cultural condition, their maximum number of tillers stage reach almost simultaneously, irrespective of varieties of different maturity, i.e, it cannot be recognized that the stage of short-term varieties always reaches earlier than that of long-term ones. From such fact, it can be inferred that the relationship between the maximum number of tillers stage and the young panicle differentiation stage varies according to the varieties of different maturity. This is due to the fact that in a normal year, no marked difference according to the varieties is found in the number of days from the young panicle differentiation stage to the heading period.

To sum up, the relationship between the maximum number of tillers stage and the beginning of young panicle differentiation can be summarized in the three cases: overlapping of both periods; clear separation between the two periods; and the intermediate state. However, the relationship between the two periods varies according to the cultivating areas as well as according to the cultural methods and the varieties of different maturity even in the same cultivating area. This is an important point from the viewpoint of rice cultivation, particularly important in judging the right time for the top dressing of fertilizer at the panicle formation stage, herbicides application, mid-summer drainage practice, and final weeding operation. In view of this, it is needed for rice grower to make clear in advance the relationship between the beginning of young panicle differentiation and the maximum number of tillers stage with respect to each of his own rice fields.

IV. RIPENING OF RICE PLANT

It seems that any exact definition of "ripening of rice plant" has not been given as yet, but from the plant physiological viewpoint, it may be understood that the "ripening of the rice plant" is the phenomenon that the valuable plant components such as carbohydrates, protein, and inorganic substances are translocated to the seed and accumulated therein. From the viewpoint of utilization, as the grains that accumulated the valuable components more than a certain amount in the endosperm are useful, the ripening of rice plant can also be understood as the cause and process contributing to the formation of such useful grains as well as to the formation of other useless grains. From such viewpoints, the descriptions will be made below under the following three captions: (i) accumulation of useful substances (chiefly carbohydrates) in seed; (ii) translocation of useful substances according to the progress in ripening, and (iii) percentage of ripened grains (percentage of the number of fully ripened grains to the total number of spikelets).

1. Changes in the Amount of Various Components in the Seeds of Rice in the Ripening Process

1. Carbohydrates

When the sugars translocated from the stems and leaves to the panicle reach the leucoplasts of endosperm cells, all the sugars are, by reacting with adenosin triphosphate, transformed into D-glucose-1-phosphate which is rich in energy. In the leucoplasts are contained the enzyme, phosphorylase, and other enzymes which mediate the production of α-1-6 bond (by "leucoplasts" may be meant "group of these enzymes"). These enzymes act on D-glucose-1-phosphate and form a stabilized polymer by removing phosphorus, thus 1 molecule of amylopectin is synthesized. Then by the action of phosphorylase, glucose radical comes to stick to the terminal of amylopectin in succession, thus forming starch grains (granules). The main pathway of transformation from sugar into starch has mainly been interpreted as the action of phosphorylase.

A small quantity of starch grains is found only in the limited part of an epicarp until about the fifth day after anthesis and fertilization. Afterwards the starch grains found in the epicarp are becoming increased in quantity and reach to a maximum on the 6th or 7th day after anthesis and fertilization. After that time the starch grains show a decreasing trend and after the opening of the yellow-ripening stage, little or no starch grains come to be found. Starch grains come to be found in the endosperm from about the 4th day after anthesis and show a marked increase from about the 6th day after anthesis, and from the 8th day onwards a rapid increase in the starch grain accumulation is observed. The starch grain accumulation procee-ds from the inner part of an endosperm to the outside. On and after the 20th day after anthesis, the rate of starch grain accumulation per day begins to decrease, and it falls down to a very small increment per day on and after the 30th day after anthesis.

Taken a seed as a whole, sugars are observed from the time immediately after anthesis, and show an increasing trend as time goes on, reaching a maximum amount at about the milk ripe stage. Afterwards they show a marked decrease.

2. Inorganic phosphorus

The equilibrium of the following reaction, by which the starch is synthesized,

$$\text{D-glucose-1-phosphate} \rightleftarrows \text{Starch+Inorganic phosphate}$$

is regulated by the concentration of glucose-1-phosphate and the concentration of inorganic phosphorus. In order to have a reaction

$$\text{D-glucose-1-phosphate} \longrightarrow \text{Starch+Phosphate},$$

the concentration of inorganic phosphorus must be low. For this reason, the inorganic phosphorus evolved from this reaction must be removed from the site of starch synthesis or inactivated. Phosphorus-content in the endosperm immediately after fertiliz-ation is high, but it shows a decrease with the progress in the starch formation. Immediately after the anthesis, though the phosphorus-content is high in the various parts of a seed , it shows a decrease as time goes on. At the beginning of the yellow-ripening stage, it decreases to a very small quantity in every part of a seed, except aleuron layer and embryo. In this case, the starch formation in the endosperm proceeds from the central part to the periphery, while inorganic phosphrus seems to begin decreasing from the central part of the endosperm and then to proceed to the periphery. At the beginning of the yellow-ripening stage, little or no inorganic phosphorus is found in the central part of the endosperm, but some quantity remains still in the periphery, and none remains after the yellow-ripening stage. On the contrary, in the aleuron layer or embryo containing a small quantity of starch, inorganic phosphorus eliminated from the starch formation reactions accumulates according as the ripening proceeds, and it is accumulated in the form of "phytin" which is the most efficient storage from of phosphorus.

3. Nitrogen

Nitrogen in the endosperm being kept at about a constant concentration from the time immediately after fertilization to ripening will indicates that the changes in the amount of nitrogen in ripening seeds are in parallel to that of the carbohydrates. Most of nitrogen is reserved in the form of protein in the embryo and endosperm.

2. Growth of Seeds

1. Growth of embryo

In most cases, the fertilization of a spikelet is completed in 2-4 hours after flowering. The egg nucleus is divided into 2-4 by fission. Afterwards, the cell division is repeated increasingly and the egg nucleus becomes greater in size. On the second day after anthesis, an egg nucleus develops into an elliptical spherical shape. Six cells can be found on the the longer axis and four ones on the shorter axis. On the fourth day after anthesis, primary vascular bundle is found for the first time. On the fifth day after anthesis, the initial of the radicle, the initial of the plumule, and the vascular bundle system come to be observed somewhat clearly. On the seventh day after anthesis, the development of the respective organs of a young plant is nearly completed and the embryo is formed. In some ten days after anthesis, the embryo formation is perfectly completed.

2. Growth of endosperm

It is generally accepted that the fission of an endosperm nucleus begins at the earlier time than the fission of an egg nucleus. In six hours after anthesis, four endosperm nuclei can be found. In 24 hours after anthesis, some 50 endosperm nuclei are seen scattering at regular intervals in the inner wall of an embryo sac. In 46 hours after anthesis, it shows a rapid increase in the number of endosperm nuclei, but cell membrane is not formed as yet, but the endosperm nuclei are covered with protoplasts only. On the third day after anthesis, a cell membrane is formed by the 4th day after anthesis, the endosperm cells are almost completed and an ovary becomes filled with them. By the fifth day after anthesis, starch grains are found for the first time. Some ten days after, they show a rapid increase in the starch accumulation. Besides, on the fourth day when the ovary has been filled with endosperm cells, the outermost layer (i.e., the cell layer formed for the first time from the endosperm nuclei) is transformed gradually into aleurone layer. Afterwards with the increase in the starch accumulation, the endosperm grows larger and heavier, thus becoming increasingly ripened.

3. Growth of rice grains

On the first day after anthesis, an ovary shows an increase in its length and begins to show a leaning towards the palea, thus growing larger along the palea. By the sixth or seventh day, the tip of the ovary reaches the peak of the glumes. Afterwards, it becomes increasingly thicker and plumper. About seven days after anthesis, the length of the ovary reaches a maximum and the width reaches nearly a maximum 12 days after anthesis. Afterwards it shows some increase in width, thus reaching a maximum about 24 days after anthesis. The thickness of the ovary reaches nearly a maximum 12 days after anthesis. Afterwards it shows some increase, reaching a maximum about 28 days after anthesis. The fresh weight reaches maximum about 20-30 days after anthesis, and the dry weight reaches a maximum on 20-50 days after anthesis. The increase in grain weight varies widely with rice varieties, environmental conditions, and position of grains on a panicle. For instance, in the case of a short-term variety which passes the ripening stage at a high temperature, it shows a rapid increase in the grain weight, while the increase in the grain weight in the case of a long-term variety is slow. The development of the vascular bundle from a panicle axis (rachis) to a rachis-branch and from the rachis-branch to a grain varies markedly according to the position in a panicle. In the case of a strong spikelet with well-developed vascular bundle, the growth of rice grains is rapid, while in the case of a poor spikelet with poor vascular bundle the growth of rice grain is delayed. The rapidity of the growth of rice grains according to the position in a panicle coincides well with the order of sequence in flowering.

3. Translocation of Substances with the Progress in Ripening

1. Carbohydrates

About 10-40 per cent of the total starch accumulated in a seed is derived from the starch stored in the leaf sheath and culm before heading, and the remaining 60-90 per cent is derived from the photosynthate after heading. The above ratio varies with such factors as spacing and arrangement of stand, plant components at the heading stage, and climatic conditions at the ripening stage.

Generally speaking, however, when the carbon assimilation in rice plant is affected favorably by the environmental conditions at the ripening period, the rate of dependence upon the carbohydrates reserved before heading is low, while when the carbohydrates reserved before heading are markedly great in quantity and when the carbon assimilation at the ripening period is low, the rate of dependence upon the starch reserved before heading becomes high. The starch stored in the leaf sheath and culm before heading begins generally to translocate rapidly to a panicle immediately after the completion of flowering and fertilization. Most of the stored starch is translocated into seeds during the period from 10 to 20 days after heading. Sugars assimilated in the leaf blade after heading are immediately translocated to the panicle. At the milk-ripe stage, the photosynthates of the first leaf (top leaf, or flag leaf), second leaf, and third leaf translocate into seeds in 15-24 hours, 24-72 hours, and 48 hours or more, respectively. Namely, the upper the position of a leaf, the higher the rate of utilization of photosynthate. The starches stored before heading in the stems and leaves are transformed into sucrose, glucose, fructose, and other sugars by the action of the enzymes such as phosphorylase, amylase, invertase, or maltase, while the carbohydrates produced by photosynthesis after heading are transformed into sucrose, glucose, and other sugars. These sugars are transported to the panicle through the phloem. (Not only sugars are transported through the phloem but they outflow to outside of the phloem in the course of their translocation, and sometimes they are transported through the xylem). In the liquid translocating from stems and leaves to the panicle is not included any phosphorus ester, such as glucose-1-phosphate. As the reactions, "sugar -- glucose-1-phosphate -- starch", occur in a seed, a fairly great amount of energy is required in the seeds. For the starch formation in the panicle, a great amount of energy evolved in the process of respiration is required. The activity of these various enzymes participating in the translocation of sugars as well as in the starch formation is influenced depending upon the temperature. For these reasons, the translocation of carbohydrates from the stems and leaves are greatly affected by the air temperature, e.g., within the range of temperature of 17-29°C. The higher the temperature, the faster the translocation. However, the optimum temperature for the accumulation of carbohydrates in the seed varies according to the ability of seeds receptive of carbohydrates, the amount in the supply of carbohydrates, and the number of seeds (paddy). The driving force for the translocation of sugars to the panicle is deemed to be due to the difference in the osmotic concentration of the cells between the sugar supply sources (stems and leaves) and the sugar receiving organ (panicle), i.e., due to the sugar concentration head between the two. Accordingly, the sugar translocation from stems and leaves to the panicle reaches a peak at the time about 2-4 p.m. in the course of a day. The translocation in the daytime is observed to reach 2-4 times greater than that in the night. During the ripening period, the translocation of sugars into seeds shows it maximum at the milk-ripe stage, at which the increase of seed dry matter is also at its maximum (at this stage the activity of enzymes such as phosphorylase becomes highest). However, from 30 days after heading onwards the dry matter increase in the seed becomes slowed down and when the amount of carbohydrate production comes to exceed the amount of carbohydrates translocated to the panicle, starch comes to be accumlated again in the stems and leaves.

2. Nitrogen

During the period from the time immediately after fertilization to ripening, the nitrogen-content in the seeds remains almost constant. This indicates that the translocation of nitrogen from stems and leaves to the seed takes place in parallel with the sugar translocation. Most of translocating nitrogen is in the form of amino acids and amides. At the ripening period as the nitrogen supply from soils becomes extremely short, a great part of nitrogen in the seed is the nitrogen translocated from the stems and leaves, particularly from the leaf blades and sheaths. In the case of the leaf blades, the nitrogen-content shows a particularly rapid decrease according as the ripening proceeds, while in culms and roots, little or no decrease in nitrogen-content is observed.

3. Phosphorus

The behavior of phosphorus during the ripening period is nearly similar to that of nitrogen, but the translocation of phosphorus from the straws (stems and leaves) to the panicle is particularly marked.

4. Potassium

The amount of potassium translocated from the stems and leaves to the panicle is extremely small, as compared with the cases of nitrogen and phosphorus. Potassium-content in the respective parts of stems and leaves (excluding culms) shows a decrease according as the ripening proceeds. Contrary to the fact that nitrogen and phosphorus content in the straw decreases due to the translocation to the panicle, the decrease in potassium content in the straw is mostly due to the leaching loss from the dead part.

5. Silicate

In contrast to nitrogen or phosphorus, the translocation of silicate from the stems and leaves to the panicle according to the progress in ripening is not so active. Silicate-content in the stems and leaves remains almost unchanged.

As stated above, various components in the stems and leaves translocate to the panicle according as the ripening proceeds. As a result, photosynthesis, respiration, and other physiological functions become declined and the aging is progressing increasingly. In view of this, in order to supplement the decreased nitrogen in the leaf blades, nitrogenous fertilizer is applied again at the heading stage. In doing so, the decrease in the rate of carbon assimilation can be checked to some extent.

4. Percentage of Ripened Grains

"Percentage of ripened grains" is figures indicating the ratio between the total number of spikelets produced of a hill and the number of kernels (perfect brown rice) obtained. Spikelets which do not yield brown rice are: non-fertilized paddy caused by the damage of reproductive organs; non-ripened paddy caused by the suspension of endosperm growth after fertilization; and abortive kernel with under-developed endosperm. A close relationship is found between the extent of endosperm growth and the specific gravity of a paddy. A grain of 1.06 or more in specific gravity (non-glutinous rice) and 1.02 or more (glutinous rice) can be qualified for perfect brown rice.

1. Non-fertilized grains

Non-fertilized grain occurs by the troubles in the reproductive organs due to the cool or drought damage and sunlight shortage during the period from the spikelet initiation stage to the heading stage centering around the stage of pollen-mother-cell reduction division, as well as due to the bad weather at anthesis. Without these damages the rate of non-fertilized grains is considered as low as some five per cent.

2. Abortive kernels

Although there are many factors in the occurrence of abortive kernels, the balance between the number of spikelets, produced per hill (per unit area) and the quantity of starch production per hill (per unit area) as well as the rate of translocation of carbohydrates are regarded as the contributing factors. Particularly, the former is more influential in causing the abortive kernels. Namely, the number of abortive kernels shows a decrease according as the supply of carbohydrates per spikelet increases.

3. Optimum number of spikelets

In contrast to the amount of starch per hill (per unit area) which has been produced during the plant growth period, there exists the optimum number of spikelets per hill (per unit area), with which a maximum yield of perfect brown rice is obtained. This is called "the optimum number of spikelets."

However, the optimum number of spikelets does not always indicate a maximum percentage of ripened grains. When the number of spikelets is less than the optimum number of spikelets, the percentage of ripened grains is, in most cases, high, but as a great amount of starch remains in the stems and leaves vainly, the rice yield shows a decrease. On the contrary, when the number of spikelets exceeds the optimum number of spikelets abortive kernels show a marked increase in number and the rice yield decreases, thus bringing about an absurd result that "he succeeded in growing rice plants, but failed in producing rice". This is an important point in rice culture.

IV. METHODS OF FERTILIZER APPLICATION TO PADDY FIELDS

The results of the experiment for the three fertilizer elements conducted on the principal paddy fields in Japan are as given in Table 4-25. Table 4-25 indicates clearly that the yields of paddy rice, wheat or barley in non-N plots are lowest next to those in non-fertilizer plots, but the paddy rice yields in non-P plots or non-K plots show no great difference from those in NPK plots, namely, this fact indicates that the rice yields are affected most by the fertilizer effect of nitrogen.

1. Methods of Basic Application of Fertilizer

1. Nitrogen

When a paddy field is submerged, top soils are differentiated into two layers: oxidation layer and reduction layer, and the change will take place in the form of nitrogen, thus causing the loss of nitrogen. In order to minimize the loss of nitrogen, the method of applying fertilizer throughout the top-soil layer is devised (Table 4-26). In carrying out such fertilizer application, if not submerged as early as possible (within 3 or 4 days), ammonia would be converted into nitrate, and after submergence nitrate would flow away or denitrification would occur (Table 4-27). A "ball" fertilizer application method is by far more intensive than the whole top-soil layer placement. SUZUKI et al. made ball fertilizer weighing 70-80 grams each by mixing urea with earth, and on the tenth day after transplanting one ball fertilizer per 4-hills was placed at 6-7 centimeters deep at the center of 4 hills. The test results are given in Table 4-28.

Fig. 3-1. Life History of Rice Plant

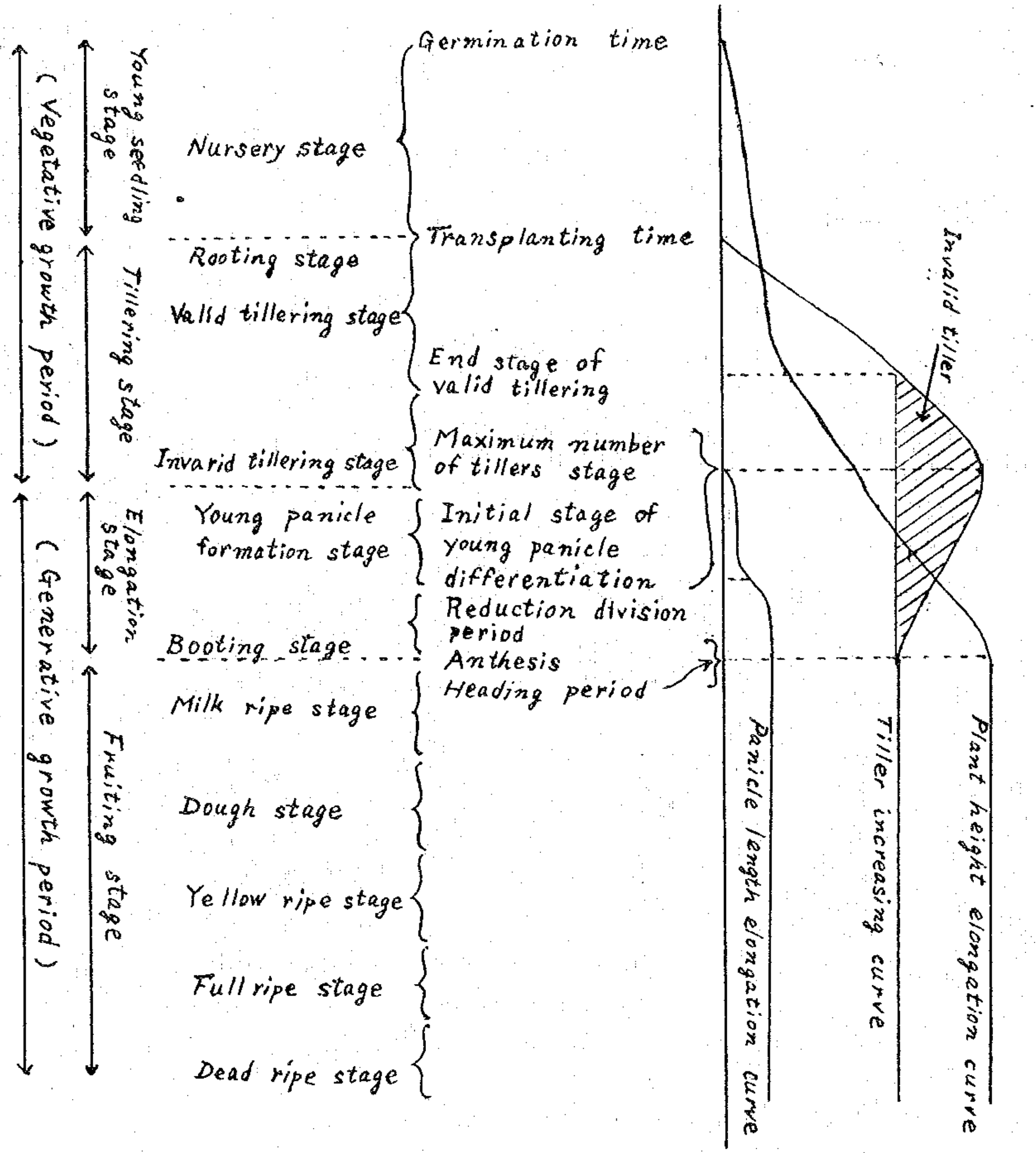
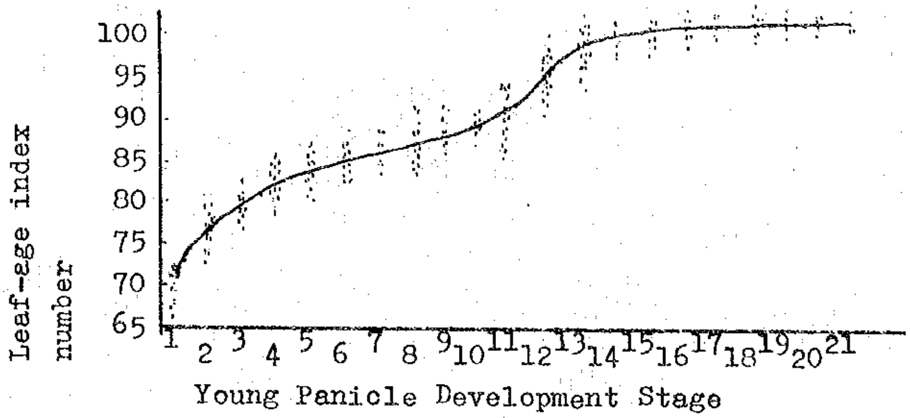
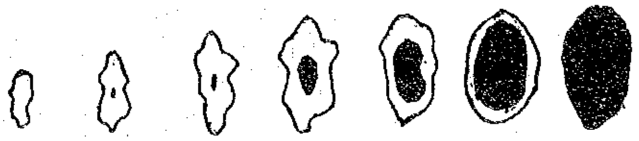


Fig. 3-3. Relationship between Leaf-Age Index Number and Young Panicle Developmental Stage (Matsushima and Manaka, 1956)



No.	Young panicle developmental stage	Leaf-age index number
I	Flag-leaf primordium differentiation	71
II	First bract primordium differentiation	76
III	Bract primordium increase	78
IV	Primary rachis branch primordium differentiation (Early stage)	80
V	Ditto (Medium stage)	82
VI	Ditto (Late stage)	83
VII	Secondary rachis branch primordium differentiation (Early stage)	85
VIII	Ditto (Late stage)	86
IX	Spikelet primordium differentiation (initial stage)	87
X	Ditto (Early)	88
XI	Ditto (Medium)	90
XII	Ditto (Late)	92
XIII	Pollen mother cell development	95
XIV	Pollen mother cell reduction division (Early)	97
XV	Ditto (First stage)	98
XVI	Ditto (Second stage)	98
XVII	Ditto (Tetrad stage)	99
XVIII	Extine formation (Early)	100
XIX	Extine formation	100
XX	Pollen ripening (Beginning)	100
XXI	Pollen ripening (Completion)	100

Fig. 3-4. Transversal Section of Kernel Indicating the Proportion of Width of Translucent Area to its Whole Area
(Matsushima and Tanaka, 1961)



0 1 2 3 4 5 6
Class

Note: Translucent area is indicated by dark spot.

Table 3-1. Relationship of Synchronously Developed Leaves and Tillers in Rice of a "Standard Plant"
(Katayama, 1951)

4/0	5/0	6/0	7/0	8/0	9/0	10/0	11/0	12/0	13/0	14/0	15/0
1/1	2/1	3/1	4/1	5/1	6/1	7/1	8/1	9/1	10/1	11/1	12/1
-	1/2	2/2	3/2	4/2	5/2	6/2	7/2	8/2	9/2	10/2	11/2
-	-	1/3	2/3	3/3	4/3	5/3	6/3	7/3	8/3	9/3	10/3
-	-	-	1/4	2/4	3/4	4/4	5/4	6/4	7/4	8/4	9/4
-	-	-	-	1/5	2/5	3/5	4/5	5/5	6/5	7/5	8/5
-	-	-	-	-	1/6	2/6	3/6	4/6	5/6	6/6	7/6
-	-	-	-	-	-	1/7	2/7	3/7	4/7	5/7	6/7
-	-	-	-	-	-	-	1/8	2/8	3/8	4/8	5/8
-	-	-	-	-	-	-	-	1/9	2/9	3/9	4/9
-	-	1/1P	2/1P	3/1P	4/1P	5/1P	6/1P	7/1P	8/1P	9/1P	10/1P
-	-	-	1/11	2/11	3/11	4/11	5/11	6/11	7/11	8/11	9/11
-	-	-	-	1/12	2/12	3/12	4/12	5/12	6/12	7/12	8/12
-	-	-	-	-	1/13	2/13	3/13	4/13	5/13	6/13	7/13
-	-	-	-	-	-	1/14	2/14	3/14	4/14	5/14	6/14
-	-	-	-	-	-	-	1/15	2/15	3/15	4/15	5/15
-	-	-	-	-	-	-	-	1/16	2/16	3/16	4/16

Some Problems of Germination Establishment on Direct Seeding Method under Dry Condition

A. Land Preparation before sowing

1) Leveling

Find out economical cross point between product and expenditure for leveling. Ideal combination of machinery operation is to be tested.

2) Rotavation

It is easy to make soil particle fine by rotary in sandy soil. On the contrary to it, it is a big problem how to make soil fine when the soil is clayish and hard. Moisture content in such a soil when rotavated must be examined and experimented.

B. Sowing seed

1) Depth and amount of seed

Both of them should be optimum and must be experimented many times to clarify them.

2) Uniform germination (or sprout)

We say, if we get uniform germination on this method, 50 per-cent is succeeded. Uniformity is quite essential for this method. Next chart may be refered.

CHART FOR UNIFORM GERMINATION

(INTER-ACTION BETWEEN EACH OPERATION)

- Uniform germination
  - Good and uniform seed germination energy ....Selection by salt water
  - Free from pest ....Disinfection of seed
  - Uniform land condition
    - Moisture or irrigation...Good land leveling
    - Oxygen ....Good land leveling
    - Uniform depth ....Good land leveling & operation of seed drill
    - Uniform top soil thickness...Uniform plowing
    - Soil characteristic......Uniform land preparation
    - Density of seed ....Operation of seed drill
    - Fine soil ....Rotavation (without big clod)

X. Operation Programme of The Pilot Farm in 1979 (Draft)