附表1　道立農試各場の昭和51年旬別気象平年比較(上段は昭和51年、下段は平年比較)

(1)日平均気温と平年差(℃)

場所＼月旬	4		5			6			7			8			9			10	
	中	下	上	中	下	上	中	下	上	中	下	上	中	下	上	中	下	上	中
北見農試	4.3	7.7	8.3	13.4	15.8	15.2	12.8	14.9	17.1	18.0	23.5	18.2	15.7	15.9	16.0	13.0	10.8	10.1	9.4
(訓子府町)	0.1	△0.3	△1.1	2.2	3.7	2.2	△1.9	△1.1	0.6	△0.6	3.0	△1.9	△4.1	△2.6	△0.9	△2.2	△2.4	△0.5	1.2
上川農試	4.8	8.3	8.7	13.7	15.5	16.6	16.2	16.9	18.7	19.3	23.6	20.0	18.5	17.6	18.1	15.4	12.4	10.8	9.4
(旭川市)	△0.1	△0.3	△1.8	△1.3	2.2	1.3	△0.5	△0.9	0.3	△1.4	0.6	△2.1	△2.7	△2.2	0.5	0.2	△1.0	△0.2	0.6
原原種農試	3.9	8.2	8.4	12.8	14.2	15.9	15.4	16.3	17.7	19.0	23.3	20.1	18.7	17.9	17.8	15.9	12.8	11.0	9.8
(滝川市)	△1.1	△0.3	△1.9	0.9	1.1	0.9	△1.1	△1.3	△0.2	△1.5	0.7	△2.2	△2.8	△2.3	△0.3	△0.1	△1.4	△0.5	0.2
中央農試稲作部	5.6	8.7	8.4	12.9	14.3	15.8	14.8	16.2	17.5	18.7	23.8	20.0	18.7	18.1	18.2	16.0	13.2	11.3	10.6
(岩見沢市)	0.2	0	△2.0	0.9	1.2	1.0	△1.8	△1.5	△0.8	△1.9	1.1	△2.5	△3.2	△2.4	△0.4	△0.2	△1.1	△0.7	0.5
道南農試	7.0	8.9	7.9	12.7	14.5	15.3	15.3	16.3	16.4	18.2	22.6	19.7	19.7	19.0	18.1	16.6	14.8	13.3	11.4
(大野町)	0.6	0.7	△2.5	1.3	1.6	1.4	△0.3	△0.7	△1.6	△1.6	0.7	△2.6	△2.7	△2.6	△1.4	△1.2	△0.6	0	△0.3

(2)日最高気温と平年差(℃)

場所＼月旬	4		5			6			7			8			9			10	
	中	下	上	中	下	上	中	下	上	中	下	上	中	下	上	中	下	上	中
北見農試	11.8	13.8	15.2	21.3	21.5	21.0	17.3	18.6	24.0	22.6	30.5	23.3	20.8	22.4	22.1	18.8	17.3	16.8	16.3
	1.7	△0.7	△1.3	3.5	3.8	1.9	△3.7	△2.4	3.1	△1.4	3.9	△2.3	△3.5	△1.2	0.2	△1.3	△1.3	△0.5	2.1
上川農試	10.0	13.1	15.5	19.3	22.3	22.1	21.4	21.3	25.7	24.1	28.4	24.1	23.0	23.5	23.2	19.8	19.4	16.8	15.9
	△0.5	△1.4	△1.1	1.1	3.2	1.1	△0.6	△1.1	2.5	△1.3	1.1	△2.6	△2.6	△1.1	0.7	△0.9	0.4	0	1.9
原原種農場	9.2	13.0	14.8	18.8	20.9	21.0	19.4	20.7	24.3	23.6	28.2	24.9	23.5	23.9	23.0	20.8	19.5	17.7	16.1
	△0.5	△1.1	△0.9	0.9	2.7	1.0	△1.9	△1.3	1.8	△1.1	1.5	△1.6	△2.1	△0.9	0.3	△0.3	0	0.4	△1.5
中央農試稲作部	11.5	13.7	14.3	18.2	20.0	20.4	17.9	20.1	22.9	22.3	28.2	24.5	22.6	23.6	22.4	20.7	19.4	17.8	16.6
	0.8	△0.7	△1.7	0.3	2.0	0.8	△3.5	△2.0	0.1	△2.7	1.3	△2.4	△3.6	△1.6	△1.0	△1.0	△0.7	△0.4	0.9
道南農試	12.7	14.2	12.8	18.3	20.7	19.3	18.4	19.5	21.7	21.9	27.6	23.8	23.6	23.5	22.2	20.6	19.4	19.0	17.8
	1.6	0.8	△3.0	1.7	3.1	1.4	△1.2	△0.4	0.1	△1.4	2.0	△2.1	△2.5	△1.8	△1.6	△1.7	△0.7	0.6	1.3

(3)日最低気温と平年差(℃)

場所＼月旬	4		5			6			7			8			9			10	
	中	下	上	中	下	上	中	下	上	中	下	上	中	下	上	中	下	上	中
北見農試	−3.4	1.5	1.5	5.9	5.3	8.3	7.0	10.1	8.5	12.4	16.5	13.6	11.9	10.4	10.8	9.4	4.0	3.3	2.4
	△1.7	0.2	△1.8	1.7	0	1.4	△1.6	△0.6	△2.8	△1.0	0.3	△2.1	△3.4	△3.5	△1.2	0.4	△3.0	△0.5	0.3
上川農試	−0.3	3.4	1.8	8.2	9.0	11.0	11.0	12.4	11.7	14.6	18.8	15.9	13.9	11.7	12.9	10.9	5.3	4.7	3.0
	△0.1	0.9	△2.5	1.7	1.4	1.5	△0.3	△0.7	△1.9	△1.2	0.4	△1.7	△2.8	△3.2	△0.2	1.2	△2.5	△0.4	△0.6
原原種農場	−1.4	3.4	2.1	6.8	7.4	10.8	11.4	12.0	11.0	14.5	18.3	15.4	13.9	11.8	12.5	11.0	6.1	4.4	3.6
	△1.6	0.6	△2.7	0.4	△0.5	1.0	△0.2	△1.3	△2.9	△1.7	△0.1	△2.6	△3.5	△3.8	△1.0	0.2	△2.7	△1.8	△0.9
中央農試	−0.3	3.6	2.5	7.6	8.5	11.2	11.8	12.2	12.2	15.1	19.3	15.5	14.8	12.5	14.0	11.4	6.9	4.8	4.6
稲作部	△0.5	0.6	△2.3	1.5	0.4	1.3	0.1	△1.0	△1.5	△1.1	0.7	△2.5	△2.7	△3.3	0.2	0.7	△1.6	△1.0	0.2
道南農試	1.2	3.6	3.1	7.2	8.3	11.3	12.2	13.1	11.0	14.5	18.0	15.7	15.8	14.4	14.0	12.6	10.1	7.5	4.9
	△0.4	0.5	△2.0	2.5	0.2	1.4	0.6	0.1	△3.5	△1.8	△0.3	△2.9	△2.9	△3.4	△1.2	△0.8	△0.5	△0.8	△2.0

(4)降水量と平年差(mm)

月旬 / 場所	4		5			6			7			8			9			10	
	中	下	上	中	下	上	中	下	上	中	下	上	中	下	上	中	下	上	中
北見農試	2	3	17	10	5	23	9	70	4	18	17	51	25	24	30	27	2	64	67
	△13	△12	6	△17	△24	1	△24	35	△21	△ 5	△22	1	△13	△19	△17	△ 7	△39	49	43
上川農試	26	18	13	26	12	19	15	32	0	34	41	34	67	18	30	23	2	58	51
	8	2	△ 7	△ 6	△24	△ 1	△17	6	△20	1	△22	△11	10	△39	△49	△24	△41	26	14
原原種農場	27	15	15	16	17	38	8	41	0	24	17	22	72	21	49	40	6	69	62
	6	△ 1	△ 6	△ 9	△14	7	△27	13	△19	△ 8	△23	△17	15	△47	△31	△14	△48	29	18
中央農試	10	4	31	17	28	19	13	33	3	12	50	17	69	24	39	35	11	39	52
稲作部	△14	△17	9	19	4	△16	△19	8	△23	△23	20	△19	13	△46	△11	△ 4	△39	6	14
道南農試	24	7	0	12	28	64	13	51	3	11	6	40	20	11	53	110	12	33	85
	△ 2	△19	△22	△20	△ 2	31	△12	19	△40	△37	△35	△ 1	△36	△36	△ 6	50	△38	△ 5	50

(5)日照時数と平年差(時間)

月旬 / 場所	4		5			6			7			8			9			10	
	中	下	上	中	下	上	中	下	上	中	下	上	中	下	上	中	下	上	中
北見農試	72	66	69	62	100	53	63	70	4	18	17	51	25	24	30	27	2	64	67
	5	3	10	8	39	△ 1	6	35	△21	△ 5	△22	1	△13	△19	△17	△ 7	△39	49	43
上川農試		48	59	52	90	49	46	30	75	46	43	32	32	43	32	32	57	45	33
		△ 9	13	5	30	△ 4	△13	△21	31	△ 2	7	△11	3	7	△11	3	7	4	△11
原原種農場	76	77	79	85	116	82	77	68	108	71	84	68	72	92	61	58	73	72	75
	△ 1	1	11	10	29	2	△ 4	△11	33	△ 3	5	△10	7	15	△ 2	△ 9	7	10	22
中央農試	73	60	63	80	106	71	50	60	106	79	66	58	71	75	54	53	77	61	61
稲作部	1	△12	2	11	32	3	△25	△ 4	45	16	△ 1	△ 8	15	6	△ 5	△ 9	13	△ 1	9
道南農試	64	72	56	77	93	62	30	40	101	58	57	37	38	63	35	38	60	67	68
	4	5	△11	14	26	9	△29	△14	55	15	4	△11	△ 9	10	△18	△14	5	8	16

(6) 灌がい水温 (℃)

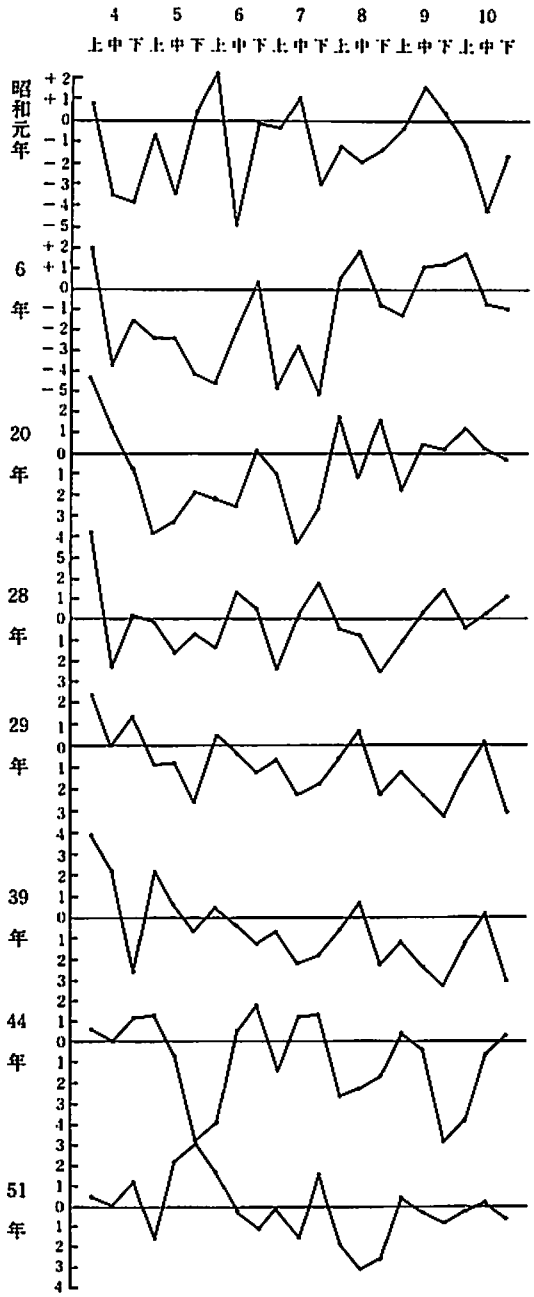
	5	6			7			8	
	下	上	中	下	上	中	下	上	中
上川農試	11.9	13.7	13.7	14.2	15.4	16.1	19.3	17.8	
	−	−	−	−	−	−	−	−	
原原種		16.1	16.7	17.3	18.6	19.8	22.6	20.4	19.7
農場		3.3	0.8	0.1	0.7	△ 0.1	0.5	△ 0.7	1.0
中央農試	10.4	12.2	11.6	12.3	13.5	15.1	17.2	15.3	16.6
稲作部	△ 1.1	△ 1.1	△ 3.5	△ 3.9	△ 3.4	△ 3.7	△ 3.5	△ 5.1	△ 2.6
道南農試	13.2	16.6	15.6	17.1	18.5	20.4	22.4	19.6	19.0
	−	2.9	0.7	1.2	2.2	3.2	3.7	0.5	△ 0.8

（7） 稲田水温（℃）

	5	6			7			8		
	下	上	中	下	上	中	下	上	中	下
北見農試		18.6 0.1	17.1 △ 2.7	18.0 △ 2.3	21.1 1.6	19.6 △ 0.8	22.2 0.9	19.3 △ 1.0	16.8 △ 2.7	17.1 △ 1.7
上川農試	18.7 -	22.4 2.7	21.1 0.6	20.0 △ 1.0	22.6 2.1	21.0 △ 0.3	22.8 -	20.8 -		
原種圃場		20.3 3.3	20.2 1.3	19.1 △ 1.7	19.1 △ 1.2	20.4 △ 1.3	22.9 0.4	20.6 △ 0.8	19.3 0.4	
中央農試 稲作部	17.2 0.3	19.5 0.6	18.5 △ 2.0	19.7 △ 1.7	21.5 △ 0.1	22.7 △ 0.5	25.8 1.8	22.0 △ 1.3	21.4 △ 0.8	
道南農試	19.2	20.4 0.6	18.5 △ 2.9	21.0 △ 1.3	22.5 △ 0.1	22.2 △ 1.0	24.4 △ 0.2	20.9 △ 3.7	20.3 △ 3.9	

（8）稲田地温（20cm, ℃）

	5	6			7			8			9		
	下	上	中	下	上	中	下	上	中	下	上	中	下
北見農試			16.6 △ 0.6	18.1 0.7	19.2 0.8	20.8 1.1	22.5 0.8	20.9 △ 0.4	18.7 △ 1.8	18.3 △ 0.6			
上川農試	16.7 -	17.3 -	18.0 -	18.8 -	19.1 -	20.3 -	21.8 -	20.1 -					
原種圃場		16.3 0.5	17.2 △ 1.3	18.1 △ 0.5	18.6 1.4	20.3 △ 0.1	21.8 △ 0.3	21.0 △ 1.8	19.5 △ 1.9	18.2 △ 1.8	17.8 △ 1.7	16.4 △ 0.2	14.5 △ 1.0
中央農試 稲作部	13.8 0.7	15.3 0.4	16.1 △ 0.9	17.3 △ 0.9	18.5 △ 0.3	19.6 △ 0.7	21.6 △ 0.1	20.9 △ 0.9	19.7 △ 1.5	18.4 △ 1.8	17.6 △ 0.8	16.4 0	13.9 △ 0.9
道南農試		17.3 1.2	16.9 △ 0.8	18.8 △ 0.2	19.7 △ 0.5	20.9 △ 0.3	22.3 △ 0.5	20.9 △ 2.1	19.9 △ 2.8	19.2 △ 2.8			



附図－1　遅延型冷害年の気温偏差図(平年は昭和16～45年の30ヵ年平均)

附表2　遅延型冷害年の様相(参考)

型別	年次	品種名	出穂期 月日	成熟期 月日	稔実歩合 %	収量割合 %	備考 %
1	元年	坊主(直)	8.15	9.30	−	96	
		〃(移)	8.20	10.5	−	89	
1	6年	坊主(直)	8.20	10.7	−	94	
		坊主2号(〃)	8.19	10.7	−	85	
		坊主6号(〃)	8.16	9.26	−	89	
		坊主(移)	8.23	10.14	−	52	
		坊主2号(〃)	8.21	10.14	−	66	
		坊主6号(〃)	8.21	10.8	−	70	
1	20年	農林20号(直)	8.10	9.30	82.8	5～7%減収	
		坊主6号(〃)	8.16	10.4	88.0		
		富国(〃)	8.16	10.18	81.5	17～30%減収	減収
		農林20号(移)	8.11	10.9	85.0	98	
		坊主6号(〃)	8.14	10.13	88.3	105	
		富国(〃)	8.17	10.20	81.9	75	
2	28年	農林20号(冷)	8.4	9.13	86.9	平均92	
		栄光(〃)	8.9	9.22	88.9		
		中生栄光(〃)	8.10	9.27	79.4		
1	29年	農林20号(〃)	8.4	9.23	87.9	100	
		栄光(〃)	8.10	10.7	83.2	95	
		中生栄光(〃)	8.16	10.7	75.4	90	
1	39年	農林20号(〃)	8.2	9.21	45.5	60	障害不稔
		栄光(〃)	8.11	10.10	81.8	86	
		ユーカラ(〃)	8.13	10.13	89.9	86	
1	44年	農林20号(〃)	7.31	9.26	82.6	平均82	
		栄光(〃)	8.9	10.3	84.7		
		ユーカラ(〃)	8.16	10.11	82.5		
2	51年	イシカリ	7.30	9.30	85.3	105	豊作
		ほうりゅう	8.6	10.5	69.4	92	
		さちほ	8.10	不途	84.5	78	
		農林20号	7.29	9.22	78.7	110	豊作

注　直は直播
移は水苗移植
冷は冷床苗移植

附表3　障害型冷害年の様相（参考）

年次	品種名	出穂期 月.日	成熟期 月.日	稔実歩合 %	収量割合 %	備考
昭和7年	坊主（直）	8. 12	9. 27	44.8	33	花粉障害
	坊主2号（〃）	. 13	. 27	29.2	31	
	坊主6号（〃）	. 11	. 17	60.2	55	
	坊主（移）	. 14	. 29	47.0	30	
	坊主2号（〃）	. 14	. 29	45.5	37	
	坊主6号（〃）	. 12	. 18	39.3	60	
9年	坊主2号（直）	8. 9	9. 18	78.8	72	
	坊主6号（〃）	. 9	. 18	76.6	72	
	坊主（〃）	. 4	. 14	80.9	74	
	坊主2号（移）	. 10	. 20	87.3	77	
	坊主6号（〃）	. 10	. 20	83.6	84	
	坊主（〃）	. 7	. 18	88.0	76	
10年	坊主（直）	. 10	9. 27	83.5	104	
	坊主2号（〃）	. 9	. 26	85.1	91	
	坊主6号（〃）	. 6	. 22	85.3	94	
	坊主（移）	. 12	10. 1	78.7	61	
	坊主2号（〃）	. 11	. 28	83.6	−	
	坊主6号（〃）	. 8	. 26	82.7	−	
16年	坊主2号（直）	8. 15	9. 28	50.8	86	
	坊主6号（〃）	. 11	. 23	73.4	104	
	富国（〃）	. 14	. 28	89.1	79	
	坊主2号（移）	. 15	. 28	58.1	72	
	坊主6号（〃）	. 13	. 25	55.4	81	
	富国（〃）	. 15	. 28	58.4	78	
31年	農林20号（冷）	. 7	9. 22	78.6	92	開花障害不稔発生年
	栄光（〃）	. 13	10. 7	42.4	55	
	中生栄光（〃）	. 15	. 10	36.8	50	
41年	農林20号（〃）	. 9	9. 28	62.1	70	花粉障害
	栄光（〃）	. 18	10. 11	55.8		
	ユーカラ（〃）	. 19	. 11	57.4		
46年	農林20号（〃）	. 3	9. 25	17.5	24	
	栄光（〃）	. 8	. 30	43.9	62	〃
	ほうりゅう（〃）	. 6	. 28	33.7		

Technical Analysis of Factors Concerned with Rice Damaged by Cool-Weather Conditions in Hokkaido in 1976

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Summary

Generally, the transplanting date was about five days later than standard date, and the growth of rice plant was delayed due to low temperature in mid-June. Fortunately, having not fatal temperature at the miotic stage of PMCs, the occurrence of destructive sterility was a little. However, the date of heading and flowering were extremely delayed due to vary low temperature in August. The most part of medium and late maturing cultivars or the rice plants cultivated by the mechanical transplanting with young seedlings flowered later beyond limits of the safty heading date. Already, the cool-summer damage had been decided at that stage.

We made an effort to examine the actual situation of damage and analysed various factors concerned many investigations now proceeding. In this paper we were going to obtain a guide in order to consider how to cope with the cool-weather damage. Characteristics of rice cropping and cool-weather damage were summarized as follows:

Cultivated area of paddy rice are 205,200 ha and 19,700 ha of them have newly reduced in 1976. The growing area by mechanical transplanting has reached 79% of total one.

In the area from Hidaka to Ishikari Bay through Chitose and Sapporo, the cool-summer damage due to delayed growth had been enlarged by the eastery wind. Since brown rot disease of rice plant (*Pseudomonas fuscovaginae* A. Tanii, K. Miyajima, et T. Akita sp. nov.) was occurred widely and severely, the sterility was increased and the ripening of grain was inhibited. Percentage of yield decrease suffered by this disease was estimated to be at least 7%.

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In August, the most critical month for rice plant growth, monthly mean temperature were 1-4°C below normal in Hokkaido. Conditions of flowering and fertilization were very poor. It was found that the later heading date, the more sterility. In spite of the ripening period was perlonged from late in September to middle of October by the protection of frost damage, the immature grains were much produced. The rate of higher grade rice was only 2.1% and the rice quality was the worst in recent years.

The rice crop index was 80 and average yield was 361kg per 10 a in Hokkaido. Especially, yields in Ishikari, southern Sorachi, Iburi, Hidaka, Tokachi, and Abashiri districts were greatly decreased. The type of cold damage in 1976 belongs to so-called delayed growth one, but is unsimilar to past years.

Contents of this paper are the following chapters: I. Outline of rice cropping in 1967. II. Out-line of metorological information and types of cool-summer damage due to delayed growth. III. Technical analysis of rice growth. IV. Effect of fertilizer and soil fertility. V. Ecology and control of brown rot disease. VI. Out-line of rice quality. VII. Survey in actual situations, and VIII. Problems and plans in mechanical transplanting culture. VIII are summarized as follows:

Regional differences of cool-weather damage were found. Since the mechanical transplanting culture with poor seedlings were increased, growth and development of rice plant were delayed, and the too late maturing cultivars as Matsumae in Hidaka and Shiokari in northern Kamikawa and Abashiri districts were transplanted with young seedlings.

In the regions where Ishikari and Yunami were grown with young seedlings, they had not headed within limits of safty heading date, so that crops were rather unstable. In these regions, it is satisfactory to transplant medium seedlings with three leaves instead of young ones or to use early cultivars as Hayakogane. Cultivation method to obtain high yields by early cultivars is the subject for a future study.

In order to raise healthy medium seedlings to be used as the mechanical transplanting, the necessary leaves should be ensured, seedlings may be highly uniform, and the growth of rice plant must be stimulated by the drilling with lower sowing density in very narrow-spaced rows. In the seedlings raised by plastic frame (Katawaku-nae in Japanese), the root of seedlings have been almost cut at the transplanting time. Accordingly, dry matter/plant length should be raised, and the water balance between evaporation and absorption should be improved.

In the regions as the wind is strong, air and water temperature are low in spring, the mechanical transplanting by the paper pot seedlings should be adopted. Because, it has been found that the rooting ability and the incipient growth of this kind of seedlings are better under low temperature conditions. However, the effect of yield increase are not so much in ordinaly years. It is necessary to improve the method of root-stopping in raising of seedlings, paper pot more suitable, and the manuring method in paddy field, etc..

The kind of cool summers might recur as long as the climatic cooling in the Polar regions continues. In the main producing districts of rice belt in Hokkaido, we must provide such

cultivars for the future mechanical transplanting culture under expected more severe cool-weather, as follows. Early maturing: Cultivars in this class must have one leaf less than Ishikari in number of leaves on the main stem, high yield, resistance to cool-weather and blast, and good quality. Medium maturing: Maturity in this class equals to Ishikari and Tomoyutaka, and the breeding of cultivar with more cool-weather resistance and better quality are needed. Late maturing: Maturity in this class will be limited from Kitahikari to Sachiho, and the breeding of cultivar with higher yield, more resistance to cool-weather and blast, and good taste are needed.