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Occurrence of Hull Dehydration of Rice in Honam Plain Area in 1998

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호남평야지에서 1998년 벼알마름 현상 발생

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ABSTRACT

The hull dehydration in dough stage did not serious affect the rice yield though grain appearance texture may decline by severe occurrence of the symptom. As to white head in heading stage of rice, the occurrence of hull dehydration in 1998 was directly affected by high temperature, low air humidity and sometimes of strong wind and sunshine in early September. At harvest stage, 1,000-grain weight of brown rice was not found to be significantly different between the hull dehydrated grains and normal ones. That reason can be considered that the hull dehydration occurred hill was not injured on the leaf and rachis branches therefore the function of assimilation and translation of rice plant was not affected. The ratio of imperfect rice kernel such as green, cracked and white belly increased. The increase of cracked rice by the hull dehydration may caused by concurrent dehydration of kernel, or by insufficient water supply into kernel due to breaking of vascular bundles in glume.

Key words : **hull dehydration, rice yield, climatic conditions**

I. INTRODUCTION

During the September of 1998 in Honam plain area, the hull dehydrated grains which showed white discoloration of surface at the glumes, were found on rice plants at ripening stage. The symptom was different from that of some bacterial hull dehydration. And dehydration which differed from that of white head occurred around heading stage was appeared during ripening stage of rice. The white head of rice panicle have been occurred sometimes during heading stage and affected severely damaged rice yield by reduction of grain fertility ratio and discolored or withered grains and rachis branches (Kido, 1950; Lee 1996; Matsuo *et al.*, 1951; Tsuboi, 1961). The causing factors are considered by complex weather conditions such as high temperature, dry and strong wind during night and strong solar radiation at the following day (Choi, 1981; Kim *et al.*, 1983; Muramatsu, 1976, 1982; RDA, 1994; Tsunoda & Kitaka, 1952). Such weather conditions accelerate the transpiration from the surface of spikelets and the dehydrated surface tissues is withered.

On the other hand, the weather conditions during the rice growing period in 1998 showed some unusual changes with both many rainy and cloudy days from June to August and some days with high

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temperature during September, particularly in Honam area, compared with normal years. Recently, normal weather have frequently recorded and global climate is widely expected to change throughout world as the increased results of greenhouse effects or El Niño and La Niña (Lee, 1996). Therefore the hull dehydration of rice is possible to increase in future, but the information is very limited. The previous investigations related weather injury of rice in Korea and Japan concentrated mainly on low temperature (RDA, 1981; Lee *et al.*, 1990; Lee & Park, 1991) and some on high temperature (RDA, 1994; Satake & Yoshida, 1978; Ryu *et al.*, 1982).

In this study, we have investigated the characteristics of hull dehydration occurred in Honam area in 1998 and also analysed their causing factors focusing on both weather condition and plant growth.

II. MATERIALS AND METHODS

The symptoms of hull dehydration were found firstly in some paddy fields in Honam area on September 7, 1998, and it was rapidly increased on September 9, in the experimental field of National Honam Agricultural Experiment Station (NHAES) in Iksan, Chonbuk. According to an estimation by provincial government of Chonbuk and Chonnam, the symptoms of hull dehydration occurred field areas were 112 ha and 13 ha, respectively.

On September 16, 1998, the field surveys such as growth stage and injured grain ratio by hull dehydration in the symptom occurred fields were conducted in regions of Puan, Kochang and Kunsan in Chonbuk Province, and Naju, Hampyong and Yeongkwang in Chonnam Province. Most rice cultivars in the surveyed fields were Dongjinbyeo, besides of two fields in Yeongkwang where the cultivars were unknown. The investigated fields were 3 for both Kochang and Kunsan and 2 for Puan in Chonbuk, while in Chonnam those were 2 for each region and each field was devided into 3 sites by 3 injured degrees. The sampling and surveying rice plants were done with 2 hills at three replications for each field or site and then determined average value.

In order to compare the 1,000 brown rice weight and grain texture at harvesting time among the injured degree, the sampling was conducted at one field of each region in Chonbuk, upon classifying into 4 injured degrees, i.e., severe in Puan, mid in Kunsan, and both low and none at NHAES.

The weather data such as air temperature, relative humidity, sunshine hours, wind speed and precipitation were obtained from the Kwangju Meterological Station for Kwangju and a meterological observation apparatus located in NHAES for Iksan.

III. RESULTS AND DISCUSSION

3.1. General features of hull dehydration

As the results of field survey on September 16, the symptom of hull dehydration at dough ripening stage of rice was observed on the surface of palea and lemma of spikelets as a white discoloration lesion. The symptom within a rice hill was observed more on a normal panicle with long culm compared to on a late-emerging head with short culm. And the symptom severely occurred not only on spikelets of upper part within a panicle than on those of lower part, but also on the tip-mid region in a spikelet than lower region. In contrast, the primary and secondary rachis branches and rachilla even on a severely injured panicle by the hull dehydration did not show any injured symptoms and keeping the green color (Fig. 1).

The ratio of hull dehydrated grain between primary and secondary rachis branches was showed in Table 1, which investigated at 3 regions in Chonbuk classified into 3 degrees of injured severity. The injured spikelets were found more on primary rachis branches than on secondary ones. The spikelets on the primary rachis branches positioned upper part of panicle had probably more sunshine than those on secondary rachies positioned lower part. And the difference in the flowering time and ripening stage between the spikelets of primary and secondary rachis branches may affect that differences.

In Honam area, the hull dehydration occurred sporadically in plain area located near west coast, but hardly in fields of mountain area. The symptoms were found more severely in Chonbuk than Chonnam. Among the surveyed regions of Chonbuk, the injured grain ratio was the highest in Puan with 70.4 %, and followed in Kunsan with 61.9% and Kochang with 18.9%. In Chonnam, the ratio ranged from 6.0 to 35.0% (Table 2).

The severity of hull dehydration was somewhat

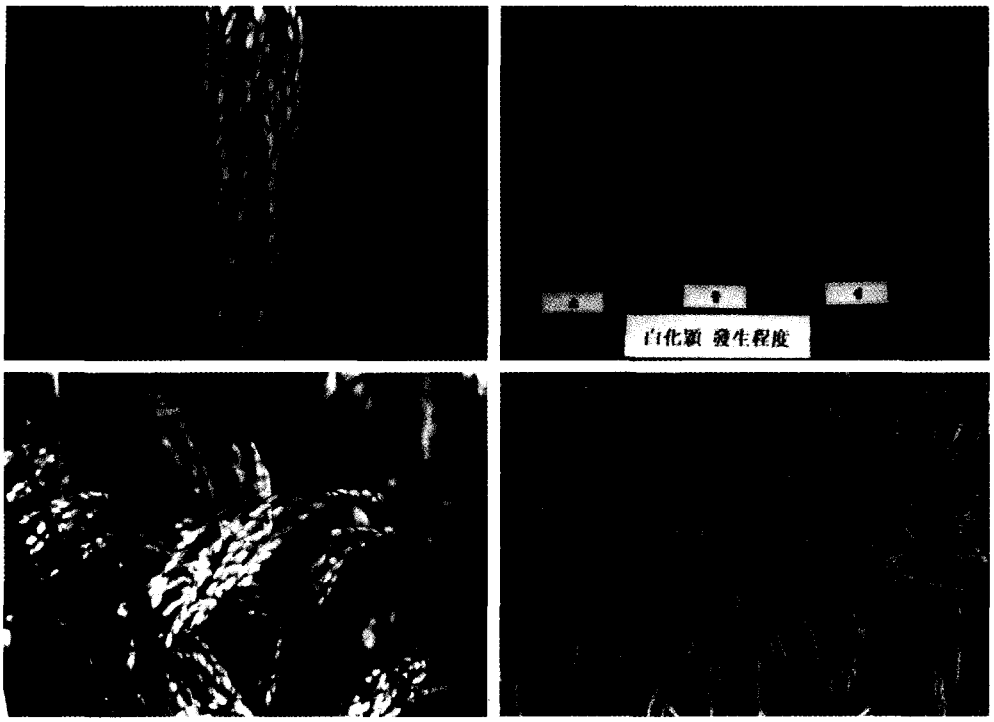

Fig. 1. The feature of hull dehydration.

Table 1. Difference in injured grain ratio by hull dehydration on each rachis branche as determined by dehydration severity in Chonbuk

Region	Severity of hull dehydration	Ratio of hull dehydration grains			(A/B) × 100
		Primary rachis branch (A)	Secondary rachis branch (B)	Total	
		----------%----------			
Kochang	Low	12.9	6.0	18.9	215
Kunsan	Mid	44.8	17.1	61.9	261
Puan	Severe	51.5	18.9	70.4	272

Table 2. Regional differences in the occurrence of hull dehydrated grain

Surveyed region	Severity of hull dehydration	Growth stage	Grain no. per panicle	dehydrated grain number	Injured grain ratio (%)
Chonbuk					
Kochang	Low	Dough	86.7	16.4	18.9
Kunsan	Mid	Dough	66.5	41.2	61.9
Puan	Severe	Dough	58.6	41.3	70.4
Chonnam	Low	Yellow	71.7	5.0	6.0
	Mid	Dough	60.3	9.7	16.1
	Severe	Dough	63.7	22.3	35.0

*Chonnam : Naju, Hampyong and Yeongkwang

different among the sites of the symptom occurred fields. In plain area the symptoms were founded more on the rice hill of first or second order rows from the levee than on the rice hill of inner sites. In Hampyong of Chonnam, the degree of hull dehydration was markedly reduced as the distance was

Table 3. Occurrence of hull dehydrated grain according to the distance from the levee in a field of Hampyong, Chonnam

Distance from levee (m)	0.3	1.5	2.7	3.9	5.1
Ratio of dehydrated hull grain (%)	52.1	33.7	20.4	10.2	9.8

far from the levee, which the rate of hull dehydrated grain showed 52.1% at nearest row and 10.2% at 3.9 m apart row from the levee (Table 3).

3.2. Effects on grain weight and texture

At harvest stage, 1,000 grain weight of brown rice was not significantly different between the hull dehydrated grains and normal ones (Table 4). That reason could be considered that the plant with the hull dehydration was not injured on the leaf and rachis branches therefore the function of assimilation and translation of rice plant were not affected.

Table 4. Comparison of 1,000-grain weight and grain characteristic of brown according to the severity of hull dehydration

Severity of hull de -hydration	Region	1000 grain weight of brown rice		Head rice ratio	Imperfect rice kernel ratio				
		Injured	Normal		Green	Cracked	White belly	Others	Total
		g			%				
Severe	Puan	21.6	21.6	80.1	2.7	5.9	3.3	8.0	19.9
Mid	Kusan	22.0	22.1	87.1	2.3	2.1	2.0	6.5	12.9
Little	Iksan 1	23.5	23.5	92.6	-	1.7	2.0	4.6	7.4
None	Iksan 2	23.5	23.5	94.2	-	1.7	1.9	3.8	6.8

Table 5. Weather condition during the frist two weeks of September in 1998 in Kwangju and Iksan

Region	Date	Maximum temperature			Mini. humidity		Sunshine hours	Max. wind speed (m sec^{-1})
		Normal (°C)	1998 (°C)	1998 time	%	Time		
Kwangju (Chonnam)	Sept. 1	30.5	29.0	15:26	48	15:14	8.2	6.2
	2	29.4	28.2	15:08	51	13:52	10.2	6.9
	3	28.5	29.6	14:52	41	15:31	10.9	5.4
	4	28.7	30.6	15:41	37	15:35	10.6	7.5
	5	27.8	27.6	12:14	49	14:17	8.7	8.5
	6	27.0	31.6	15:53	35	16:20	9.1	7.7
	7	27.5	29.0	15:57	68	13:18	2.0	5.8
	8	27.6	31.0	15:08	64	15:00	5.2	6.0
	9	26.2	33.1	15:02	52	16:00	8.7	7.8
	10	27.2	32.8	15:03	51	17:00	7.3	5.3
	11	26.1	32.3	15:40	62	13:00	5.9	5.2
	12	26.7	33.0	15:05	53	14:00	8.8	6.9
	13	25.4	31.8	14:36	51	15:00	6.1	7.7
	14	26.9	31.7	15:15	37	15:00	9.6	5.3
Iksan (Chonbuk)	Sept. 1	28.9	29.3	13:51	41	13:15	8.7	5.2
	2	28.7	28.1	15:44	55	13:17	6.9	5.2
	3	28.6	28.3	13:55	46	12:02	8.7	5.2
	4	28.6	29.6	14:25	35	14:15	8.8	3.2
	5	28.0	27.9	12:46	56	12:18	4.9	6.3
	6	28.4	29.8	13:41	54	15:19	8.0	4.7
	7	28.7	27.8	13:07	64	13:09	1.9	7.3
	8	28.0	29.3	13:34	78	13:07	5.0	5.5
	9	27.1	33.2	16:17	47	16:31	7.9	3.7
	10	27.1	32.0	15:53	59	15:50	6.1	3.9
	11	26.8	32.9	15:30	36	13:55	6.6	4.3
	12	26.9	33.0	15:35	42	14:27	7.7	3.6
	13	26.6	30.6	15:08	66	14:26	5.8	4.5
	14	26.2	30.4	15:53	57	13:48	7.9	5.4

However, the ratio of imperfect rice kernel such as green, cracked and white belly increased as the increase of severity of hull dehydration. According to the Togari (1940), the dehydration of rice panicle by a thypoon increased the rate of rusty rice. The increase of cracked rice by the hull dehydration maybe caused by concurrent dehydration of kernel, or by insufficient water supply into kernel due to breaking of vascular bundles in glume.

3.3. Weather condition before and after occurring of hull dehydration

The white head of rice during the heading stage was greatly affected by the combination of dried and strong wind and high air temperature, particularly lower than 65% in air humidity, faster than 8 m sec^{-1} in wind speed and higher than 25°C in air temperature. Therefore, the weather effects as a causing factor of hull dehydration were analysed. The maximum air temperature (Choi, 1981; Kido, 1950; Muramatsu, 1976, 1982; RDA, 1994; Tsunoda, 1992), minimum relative air humidity, maximum wind seed and sunshine hours during the frist and second weeks of September 1998 in Kwangju and Iksan, as the represents of Chonnam and Chonbuk, respectively, were showed in Table 5. The symptoms of hull dehydration in Chonnam and Chonbuk was firstly observed on September 7 and widely occurred on September 9. During September 1 to 3 in 1998, the maximum temperature ranged from 28.2 to 29.6°C which were similar with normal year in Kwangju and Iksan. And during that period the minimum humidity and maximum wind speed between both area were not big different, with the range of 41 to 55% and 5.2 to 6.9 m sec^{-1}, respectively. The hull dehydration observed on September 7 might be caused mainly by the weather condition from September 4 to 6. During that period, especially except for September 5, it was higher maximum air temperature ranged from 29.6 to 31.6°C and lower the minimum humidity ranged from 35 to 54% in both area. In particular, Kwangju had also higher maximum wind speed ranged from 7.5 to 8.5 m sec^{-1} during September 4 to 6. And from September 8 to 14, the maximum air temperature was maintained to higher condition above 30°C which is 4~5°C higher than that of normal year. Especially September 9, the maximum air temperature showed unusually higher value of 33.2 in Iksan and 33.1°C in Kwangju, where the minimum humidity showed relatively low values of 41% and 52%, respectively.

IV. CONCLUSION

In conclusion, the hull dehydration in dough stage did not serious affect the rice yield though grain appearance texture may decline by severe occurrence of the symptom. As to white head in heading stage of rice, the occurrence of hull dehydration in 1998 was directly affected by high temperature, low air humidity and sometimes of strong wind and sunshine in early September.

요 약

1998년 9월에 호남평야지에서 호숙기 전후의 벼가 벼알이 흰색으로 탈색되며 마르는 현상이 보고되어 현지에서 그 증상을 관찰하고, 벼알마름의 원인과 벼알마름에 따른 수량 및 미질 변화를 조사한 결과를 요약하면 다음과 같다. 벼알마름 현상 발생원인은 9월 1일부터 9월 6일까지는 강풍은 불지 않았으나 기온이 높고 대기의 습도는 전북 35~56%, 전남 35~51%로 매우 건조하였으며, 9월 9일~9월 14일에는 최고기온 30~33°C(전북 9월 9일, 전남 9월 12일)의 이상고온과 함께 최저습도가 전북 36%(9월 4일), 전남 37%(9월 14일)로 매우 건조한 상태이고 일조도 강하였기 때문에 벼알마름 증상이 발생되었던 것으로 판단된다. 벼알마름 증상은 정상적으로 등숙하던 호숙기 경의 벼가 주로 벼이삭의 상위에 부착된 1차 지경의 벼알이 탈수, 퇴색되었으며 한 벼알에서도 직사광선을 받는 위 부분에서 심하였다. 탈수된 벼알도 벼알마름 발생 후 1주일경인 9월 16일 조사당시까지 계속 등숙이 진행되고 있었고 탈수된 벼알이 붙어있는 소지경과 1, 2차 지경은 탈수되지 않고 정상이었다. 완숙기의 현미천립중은 정상립이나 벼알마름립간에 차이가 없었으나 벼알마름립은 정상립보다 동할미와 복백이 많아 불완전립 비율이 높았다.

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