ON THE OCCURRENCE OF YELLOW SEEDLINGS IN A VARIEGATED STRAIN OF RICE*

Yoshiwo KATAYAMA and Shojiro SHIDA

Laboratory of Plant Breeding, Faculty of Agriculture Miyazaki, University,
Miyazaki, Japan

Received August 16, 1955

UDC 582. 542. 1 : 633.
18 : 631. 531. 12.

Introduction

The authors found a mutated line showing yellow seedlings in a variegated strain of rice named Fukui-jima (Katayama and Shida, 1954). Generally the yellow seedlings became green from near the vein of leaf on 5~6 days after germination. Thus after 8~9 days they showed a mosaic feature which was maintained for about one week, and then almost became usual green leaves.

Regarding such yellow individuals of rice, some reports are already seen such as those of Morinaga (1932), Hara (1944, 1946), and others. Two types are classified as chlorina and xantha. The authors' yellow line belongs to the chlorina type, but it seems to have a completely new character due to the following points, namely, (1) expression only at the seedling stage and (2) behavior as a maternal inheritance. Since this new character seems to be influenced by the seasonal temperature, some investigations were chiefly done in relation to it.

Experimental data

(1) Temperature treatment at germination

The feature of yellow seedlings was indistinct in one year, but it seemed to be clear when sowed in a season of low temperature. Therefore a test for temperature was done at the stage of germination. In late July of 1953-54, materials (sowed in sand dish) treated for 2~3 days with water were maintained (in thermostat) for 3~5 days at temperatures 5, 10, 15, 18, 21, 25 and 40°C respectively. Then they were removed to the usual room (*ca.* 30°C) and the colour of seedling leaves was observed. From this result (Table 1) the 2nd leaf of seedlings maintained at 15°C showed yellow clearly, but no reaction around 30°C (room temperature). Moreover, at a temperature as low as 5°C the change of colour was indistinct, perhaps depending upon almost stoppage of growth. At a high temperature of 40°C, the leaf also became somewhat yellow due to inhibition of chlorophyll formation.

* Contributions from the Laboratory of Plant Breeding, Faculty of Agriculture, Miyazaki University, No. 10.

Table 1 Temperature treatment at germination (5 days)

Days after treatment	Location of leaf	Temperature of treatment (°C)							Control ²⁾
		5	10	15	18	21	25	40 ¹⁾	
3	Prophyll	+ ³⁾	+	+	+	+	+	+	+
	1 st leaf	+	+	+	+	+	+	+	+
	2 nd "	.	.	.	.	.	.	.	.
	3 rd "	.	.	.	.	.	.	.	.
6	Prophyll	+	+	+	+	+	+	+	+
	1 st leaf	+	+	+	+	+	+	+	+
	2 nd "	.	- ⁴⁾	-	-	±	+	±	+
	3 rd "	.	.	.	.	.	.	.	.
9	Prophyll	+	+	+	+	+	+	+	+
	1 st leaf	+	+	+	+	+	+	+	+
	2 nd "	±	±	-	-	±	+	±	+
	3 rd "	.	.	.	.	.	.	.	.
12	Prophyll	+	+	+	+	+	+	+	+
	1 st leaf	+	+	+	+	+	+	+	+
	2 nd "	±	±	-	±	+	+	+	+
	3 rd "	.	+	+	+	+	+	+	+
15	Prophyll	+	+	+	+	+	+	+	+
	1 st leaf	+	+	+	+	+	+	+	+
	2 nd "	+	+	±	±	+	+	+	+
	3 rd "	+	+	+	+	+	+	+	+

1) Treated for 3 days 2) Room temperature (ca. 30°C) 3) + shows normal green leaf 4) - shows yellow leaf

(2) Days after wetting of seeds

The result mentioned above is that of materials treated after sowing in sand dish after 2~3 days from the wetting. The time required for wetting in the test were disposed as 0 (control), 1/4 (6 hours), 1/2 (12 hours), 1, 2, 3, 5, 7 and 9 days respectively after immersion. Then the materials were placed in two thermostats, regulated at 10°C (5 days) and 40°C (3 days). In late July, the seeds generally begin their germination in 2~3 days after wetting when they are placed in the usual room, in 5 days occur both of the prophyll and the 1 st leaf, and then in 7 days the 2 nd leaf appears. The result of treatment, as can be seen in Table 2, denoted no yellow leaf in the one day wetted material, but was distinct in that of 2 or more days. The results shown in Table 2 of the 10°C experiment were obtained chiefly in the year 1954, and partly in the preliminary 1953 test. But the results of 40°C were obtained only in 1953. Moreover the series at 10°C showed clearly yellow leaves in materials treated after 3 days from wetting, but those of 5 or more days became gradually indistinct. And the series at 40°C appeared clearly in the material of 5 days.

Table 2 Days after wetting of seeds

Days after treatment	Location of leaf	Days after wetting (10°C)									Days after wetting (40°C)			
		0	1/4	1/2	1	2	3	5	7	9	1/4	2	5	7
3	Prophyll	.	.	.	.	+	+	+	+	+	+	+	+	+
	1st leaf	.	.	.	.	.	+	+	+	+	.	+	+	+
	2nd "	.	.	.	.	.	.	.	.	±	.	.	-	-
	3rd "	.	.	.	.	.	.	.	.	.	.	.	.	.
6	Prophyll	+	+	+	+	+	+	+	+	+	+	+	+	+
	1st leaf	+	+	+	+	+	+	+	+	+	+	+	+	+
	2nd "	.	.	.	.	.	-	-	-	±	+	±	-	-
	3rd "	.	.	.	.	.	.	.	.	.	.	.	.	.
9	Prophyll	+	+	+	+	+	+	+	+	+	+	+	+	+
	1st leaf	+	+	+	+	+	+	+	+	+	+	+	+	+
	2nd "	+	+	+	+	-	-	-	±	+	+	±	-	±
	3rd "	.	.	.	.	.	.	.	.	.	.	.	+	+
12	Prophyll	+	+	+	+	+	+	+	+	+	+	+	+	+
	1st leaf	+	+	+	+	+	+	+	+	+	+	+	+	+
	2nd "	+	+	+	+	±	-	±	±	+	+	+	-	±
	3rd "	.	.	.	.	+	+	+	+	+	+	+	+	+
15	Prophyll	+	+	+	+	+	+	+	+	+	+	+	+	+
	1st leaf	+	+	+	+	+	+	+	+	+	+	+	+	+
	2nd "	+	+	+	+	±	-	±	+	+	+	+	±	±
	3rd "	.	.	.	+	+	+	+	+	+	+	+	+	+

(3) Days of treatment at germination

The treatment under low temperature (10°C) was carried out in series of 1, 2, 4, 6, 8, 10 days. This experiment was chiefly done in late July of 1954, and partly in 1953, the result being shown in Table 3. This result shows that no yellow leaf appears in the 2 days treated material, and yellowness scarcely shows after 4 days, with the longer days showing the clearer result.

Table 3 Days of treatment at germination (10°C)

Days after treatment	Location of leaf	Days of treatment					
		1	2	4	6	8	10
3	Prophyll	+	+	+	+	+	+
	1st leaf	+	+	+	+	+	+
	2nd "	.	.	.	.	.	.
	3rd "	.	.	.	.	.	.
6	Prophyll	+	+	+	+	+	+
	1st leaf	+	+	+	+	+	+
	2nd "	+	+	-	-	-	-
	3rd "	.	.	.	.	.	.

12	Prophyll	+	+	+	+	+	+	+	+	+	+	+	+
	1 st leaf	+	+	+	+	+	+	+	+	+	+	+	+
	2nd "	-	+	+	+	+	+	+	+	+	+	+	+
	3rd "	+	+	+	+	+	+	+	+	+	+	+	+
15	Prophyll	+	+	+	+	+	+	+	+	+	+	+	+
	1 st leaf	+	+	+	+	+	+	+	+	+	+	+	+
	2nd "	±	+	+	+	+	+	+	+	+	+	+	+
	3rd "	+	+	+	+	+	+	+	+	+	+	+	+

(5) Sowing time and degree of yellow appearance

The relation between sowing time and degree of yellow-appearance was compared, sowing in April 20, May 5, June 15, July 15, August 15 and September 20 respectively. A preliminary test was made in 1953 and exact one in 1954. The degree with respect to different location of leaves was identified by 6 classes denoting from 0 (complete green) to 5 (complete yellow). From this result yellow leaf was observed until the 3rd leaf at the seedling stage. Among these leaves the 2nd leaf was most remarkable and next the others were in order of 1st leaf, 3rd leaf and prophyll. Furthermore the degree of yellow leaves was in order of September, April- and May-sowing.

Table 5 Sowing time and degree of yellow appearance

Sowing time	Location of leaf	Degree of yellow						total	Average degree
		0	1	2	3	4	5		
April 20	Prophyll	·	8	7	·	·	·	15	1.5
	1 st leaf	3	·	4	8	·	·	15	2.1
	2nd "	·	·	2	3	4	6	15	3.9
	3rd "	4	2	2	5	2	·	15	1.9
	4 th "	15	·	·	·	·	·	15	0.0
May 5	Prophyll	1	7	7	·	·	·	15	1.4
	1 st leaf	2	4	4	5	·	·	15	1.8
	2nd "	·	·	3	4	7	1	15	3.4
	3rd "	6	·	4	2	3	·	15	1.7
	4 th "	15	·	·	·	·	·	15	0.0
June 15	Prophyll	3	11	1	·	·	·	15	0.9
	1 st leaf	3	3	2	7	·	·	15	1.9
	2nd "	·	2	3	7	3	·	15	2.7
	3rd "	5	8	2	·	·	·	15	0.8
	4 th "	15	·	·	·	·	·	15	0.0
July 15	Prophyll	3	12	·	·	·	·	15	0.8
	1 st leaf	2	2	6	5	·	·	15	1.9
	2nd "	·	2	6	7	·	·	15	2.3
	3rd "	5	6	3	1	·	·	15	1.0
	4 th "	15	·	·	·	·	·	15	0.0

August 15	Prophyll	4	11	.	.	.	.	15	0.7
	1 st leaf	3	4	3	5	.	.	15	1.7
	2 nd "	.	1	5	8	1	.	15	2.6
	3 rd "	5	8	2	.	.	.	15	0.8
	4 th "	15	.	.	.	.	.	15	0.0
September 20	Prophyll	.	7	8	.	.	.	15	1.5
	1 st leaf	3	.	4	8	.	.	15	2.1
	2 nd "	.	.	.	.	2	13	15	4.9
	3 rd "	.	4	6	5	.	.	15	2.1
	4 th "	15	.	.	.	.	.	15	0.0

Summary and conclusion

As described above, the behaviour of the new yellow character is summarized as follows. First (1) the optimum temperature for the growth of rice or the formation of chlorophyll brings usual green leaves, but somewhat low or high temperature for those inhibits their development and results in yellow leaf as the intermediate step. The degree of yellow appearance is most clear around 15°C. And (2) it seems to have a relation to the condition of activity of germination or growth because the influence of temperature is not effective in soon after wetting or in a low temperature near 5°C. Moreover (3) the character of these yellow leaves occurs usually until the 3rd leaf at the seedling stage, and especially it is most pronounced at the 2nd leaf.

Literature cited

- Katayama, Y. and Shida, S. 1954. Further investigations on the inheritance of a variegated strain in rice. *Jap. Jour. Breed.* 3(No. 3, 4) : 15—18.
- Hara, S. 1944. Genetical studies on the chlorophyll characters in rice. I. Occurrence and inheritance of chlorina types. *Jap. Jour. Genet.* 20 : 15—19.
1946. Genetical studies on the chlorophyll characters in rice. II. Occurrence and inheritance of xantha types. *Jap. Jour. Genet.* 21 : 1—9.
- Morinaga, T. 1932. The chlorophyll deficiencies in rice. *Bot. Mag., Tokyo* 46 : 202—207.