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Possible Role of Germination Inhibitors on Dormancy in Rice

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ABSTRACT

Lemma and palea play an important part in retaining dormancy in rice seeds due to the presence of functional inhibitors than mechanical resistance. The bioassay in the extract of intact seeds (lemma and palea) indicated clearly certain facts with regard to germination of embryo in sucrose solution. The embryo germination was nil between Rf 0.750 - 0.833 and it is possible that certain inhibitors or toxic substances may be responsible for the decrease in germination percentage. Effect on root length appeared to suggest that there was quite an amount of inhibition in most cases on elution of chromatograms.

INTRODUCTION

Many investigators have studied the possible influence of covering structures on dormancy. A study was initiated, therefore, to explore the possible influence of covering structures on a dormant type of rice, T. 2105.

MATERIALS AND METHODS

In order to investigate the extent to which structures other than the lemma and palea impose dormancy in rice an experiment was conducted following the line of investigations by Roberts (1961) and Hay (1962). The germination experiments were conducted using conventional methods at ambient temperature in petri dishes.

The extraction and inhibitor separation technique reported by Hay (1962) was adopted. This was done in intact and hulled seeds. For the bioassay, seeds were hulled and allowed to imbibe water for 2-3 hours before the embryos were removed. Then, the embryos were germinated on sections of chromatogram strips eluted with 3% sucrose solution and distilled water separately, and the average length of root and shoot determined after incubation for 96 hours in the dark at 25°C.

RESULTS AND DISCUSSION

The possible influence of covering structures on dormancy was studied in the dormant variety of rice T. 2105 and the results are given in Table 1. Removal of lemma and palea accompanied by scarification of testa gave the highest germination of 92.5% while the intact seeds recorded 9%. It was shown that lemma and palea play an important role in keeping the seeds dormant perhaps due to the presence of certain inhibitors.

Seeds of the dormant type T. 2105 soaked for 24 hours were subjected to treatments as shown in Table 2. Where lemma and palea, and portion of lemma over embryos were removed higher percentages (58 and 59) of germination were recorded. The other treatments did not help in accelerating germination or breaking dormancy.

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Using the same variety, a set of eleven treatments were given for the dry seeds and later germination test conducted in the conventional method. The results are presented in Table 3. This also amply proved that treatments wherein lemma over embryo was removed and lemma and palea were removed, higher germination of 81.5 and 72.5% respectively was recorded. The other treatments atlhough recorded germination ranging from 4 to 44.6%, there appeared to be some inhibiting factor in the lemma and palea.

It was shown that the partial removal of husk was sufficient to break the dormancy. The present work is also in line with the previous work of Roberts (1961) who has also demonstrated the inhibitory influence of lemma and palea. Gopinathan (1961) also demonstrated the inhibitory influence of lemma and palea in rice varieties. The observation of Wellington (1956) suggested that it is the pericarp of the wheat which is important while considering dormancy. Roberts (1961) suggested that the "main inhibitory action of the husk is not due to its possible content of inhibitors". This has been confirmed by the surgical experiments done in this study. If inhibiting substances in the husk were important, it is unlikely that the removal of a small portion of the husk would have such marked stimulating effect. This is also indicated in the present study. Roberts (1961) was not able to locate the water-soluble or ether-soluble inhibiting substances in the endosperm, bran or embryo fractions, and suggested that it was not probable that lemma and palea act by restricting the outward diffusion of such a substance. The surgical experiments here have also confirmed the above results. The indirect evidence of the experiments concerned with leaching also supported this suggestion. The extent of possible leakages through the seeds in the experimental treatments is not known. Where the perforations were sealed with lanolin, the observations supported this idea.

The leaching of seeds (with lemma and palea intact) did not promote germination up to 96-120 hours. But there was a 5% increase in germination and hence a study was made for the detection of a methanol soluble inhibitor. The results of the bioassay studies with non-dormant embryos of Co. 13 in the extracts of intact seed and kernels of the dormant variety T. 2105 are indicated in Tables 4 and 5. The bioassay in the extracts of intact seeds revealed certain facts with regard to germination in sucrose solution. The germination between Rf 0.750 - 0.835 was nil and it was possible that certain inhibitors or toxic substances may be responsible for the decrease in germination. It is possible that in such region of the strips where lesser development was recorded the concentration of the inhibitors may be higher. However, the inhibitors were not identified in the present study.

Regarding germination in 3% sucrose solution or distilled water, the kernel had lesser inhibitory reaction when compared to intact seeds (with lemma and palea). The information was not adequate to offer any explana-

tion. Mikkelsen and Sinah (1961) reported the presence of an extractable germination inhibitor in the hull of rice but made no claims to have differences in the inhibitor levels between the intact seeds and kernels.

Hay (1962) stated that "in the absence of inhibitor, a small amount of growth is produced by the excised embryos in water, and this is increased in the presence of sucrose". This is in close agreement with the present investigation. Compared to the intact grains and kernels, intact grains (with lemma and palea) exhibited the presence of a methanol soluble inhibitor which suppressed the growth of embryos. This means the hulls contain certain "inhibitors" or the "hull factor". Further, Hay (1962) confirmed that kernels of wild oat contain inhibitors and suggested that "the fact that inhibitors in the hulls of *Avena fatua* L. prevents growth of excised embryos in the presence of sucrose shows that it is possible to block germination at a point other than conversion of starch to sugar". La Croix *et al.* (1962) suggested that lemmas and paleas of barley apparently contained a substance "hull factor" which inhibited cell extension and stimulated cell division in the embryo. The present study, as well as earlier work in this laboratory confirmed their work and may be in the earlier period of "ontogeny" embryo plays a part in causing dormancy in addition to lemma and palea which contain inhibitors.

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TABLE 1. Effect of covering structures on germination of dormant variety T. 2105 in relation to treatments (average of 4 replications)

Tt. No.	Treatments	% germination (Av.)
1	Lemma and palea intact	9.0
2	Lemma and palea intact, cut into half transversely	32.5
3	Lemma and palea removed	52.0
4	Lemma and palea removed, cut into half transversely	70.5
5	Lemma and palea removed, pericarp scarified with a fine sand paper in the position of the centre of the palea	92.5

TABLE 2. Percentage germination of seeds of dormant T. 2105 as affected by different treatments given 24 hours after soaking (average of 4 replications)

Tt. No.	Treatment	% germination (Av.)
T_1	Lemma and palea intact (control)	11
T_2	Lemma and palea removed	58
T_3	Palea removed and exposed to air	9
T_4	Palea removed and in contact with water	5
T_5	Distal half of Lemma and palea removed	17
T_6	Part of lemma over the embryo removed	59
T_7	Part of lemma over the embryo removed, exposed area covered with anhydrous lanolin	3
T_8	Part of lemma over the embryo removed, exposed area covered with moist filter paper	7

TABLE 3. Effect of outer coverings on the germination percentage of dormant T. 2105 (average of 4 replications)

Tt. No.	Treatment	% germination (Av.)
T_1	Lemma and palea intact	8.5
T_2	Lemma and palea removed	72.5
T_3	Lemma and palea removed, lanolin placed over embryo	52.0
T_4	Palea perforated at the proximal region	44.6
T_5	Lemma perforated at the proximal region (i. e. over embryo)	35.0
T_6	Lemma perforated at the proximal region; perforation sealed with lanolin after three days (72 hours)	32.0
T_7	Median region of lemma perforated; perforation sealed with lanolin immediately	23.0
T_8	Lemma perforated at the median region; perforation sealed with lanolin after 72 hours	43.5
T_9	Lemma perforated at the distal end	12.0
T_{10}	Lemma and palea intact; lanolin placed in median lemma position	4.0
T_{11}	Part of lemma over embryo removed	81.5

TABLE 4. Rice embryo (Co. 13 non-dormant) bioassay for germination, shoot and root growth on chromatograms of methanol extracts of dormant (T. 2105) intact seeds after 96 hours in the dark

RF VALUE	Eluted with 1% sucrose solution						Eluted with distilled water					
	% germination	% on control	SHOOT length (mm)	SHOOT % on control	ROOT length (mm)	ROOT % on control	% germination	% on control	SHOOT length (mm)	SHOOT % on control	ROOT length (mm)	ROOT % on control
Control	90	100.0	3.10	100.0	1.50	100.00	70	100.0	2.10	100.0	1.10	100.0
0.000–0.083	100	111.1	3.40	109.6	3.25	216.60	80	115.5	1.50	71.4	0.30	27.2
0.083–0.166	100	111.1	3.80	122.5	0.65	43.10	70	100.0	1.80	85.7	0.18	16.3
0.166–0.250	100	111.1	2.60	83.6	0.23	15.33	100	142.8	2.05	97.6	0.48	43.6
0.250–0.333	90	100.0	4.30	135.5	1.60	106.66	80	115.5	1.30	61.9	0.08	7.3
0.333–0.416	100	111.1	2.20	64.5	1.65	110.00	90	128.5	1.50	71.4	0.13	11.8
0.416–0.500	100	111.1	3.30	106.4	1.35	90.00	100	142.8	1.90	90.5	0.30	27.2
0.500–0.582	80	88.8	1.45	46.7	1.30	86.60	30	42.8	0.30	14.2	—	—
0.582–0.666	90	100.0	2.90	93.5	0.70	46.60	100	142.8	1.40	66.6	0.10	90.9
0.666–0.750	90	100.0	2.82	90.3	0.90	60.00	100	142.8	1.35	64.2	0.15	10.36
0.750–0.833	—	—	—	—	—	—	20	28.5	0.45	21.4	—	—
0.833–0.915	80	88.8	2.65	85.4	0.55	36.60	50	85.5	1.00	47.6	—	—
0.915–1.000	70	77.7	1.85	59.6	0.73	47.60	100	142.8	1.03	48.8	—	—

TABLE 5. Rice embryo (Co. 13 non-dormant) bioassay for germination, shoot and root growth on chromatograms of methanol extracts of dormant (T. 2105) kernels (lemma and palea removed) after 96 hours in the dark

RF VALUE	Eluted with 1% sucrose solution						Eluted with distilled water					
	% germination	% on control	SHOOT length (mm)	SHOOT % on control	ROOT length (mm)	ROOT % on control	% germination	% on control	SHOOT length (mm)	SHOOT % on control	ROOT length (mm)	ROOT % on control
Control	100	100.0	3.05	100.0	1.65	100.00	100	100.0	3.65	100.0	0.95	100.00
0.000—0.083	90	90.0	4.50	147.5	1.80	109.9	100	100.0	3.20	87.6	1.30	136.80
0.083 - 0.166	100	100.0	5.05	165.5	0.40	24.20	70	70.0	2.00	54.7	0.02	2.02
0.166—0.250	100	100.0	1.84	60.3	1.25	75.70	100	100.0	2.95	80.1	—	—
0.250 - 0.333	90	90.0	2.60	85.2	1.00	60.60	100	100.0	3.00	80.2	0.30	31.50
0.333 - 0.416	100	100.0	5.25	172.1	1.10	66.60	100	100.0	2.05	56.1	—	—
0.416—0.500	100	100.0	6.25	204.9	1.85	112.10	90	90.00	2.60	71.2	0.35	36.80
0.500—0.582	100	100.0	3.20	104.9	0.40	24.20	90	90.0	2.20	60.3	0.30	31.50
0.582 - 0.666	90	90.0	2.65	86.8	0.45	27.20	100	100.0	3.05	83.5	0.20	21.05
0.666 - 0.750	100	100.0	3.60	118.03	0.40	24.20	90	90.0	1.70	46.6	1.70	178.90
0.750 - 0.833	70	70.0	3.20	104.9	0.50	30.30	60	60.0	1.25	34.2	0.10	10.60
0.833 - 0.915	90	90.0	3.40	111.4	0.50	30.30	90	90.0	2.35	64.3	—	—
0.915 - 1.000	80	80.0	1.95	63.9	0.15	9.09	70	70.0	1.30	35.5	—	—