山形大学紀要(農学)第2巻，第3号．昭和32年2月
Bull. of the Yamagata Univ., Agr. Sci. Vol. 2, No. 3. Feb. 1957

Degree of the Anti-geotropism of Seminal Root Induced by Eosin Solution in Rice.

Toshioki SHIBUYA

(Labor. Crop Sci. Plant Breed. Fac. Agric. Yamagata Univ.)
渋谷紀起：水稲のエオシン浸漬発芽種子根の背地性発現度について

The seminal root of rice seed grows in oxygen-rich part of bed. It is believed ordinarily to display the downward growth by geotropism, but the geotropism is able to be reversed by anti-auxin absorbed.

Anti-geotropism induced by anti-auxin causes not only the retardation of growth of seminal root but also the lying down (i. e. lodging) of seedling.

The present paper mentions about the studies on the anti-geotropism of seminal root of rice seed germinated in the eosin solution. Eosin is a growth inhibitor consisted of tetrabromofluorescein.

Methods

The embryos of rice seeds attached at two edges of slender and short glass-tubes were put outside of the tubes and to be upward. The tubes were on the glass-bars as is shown in Fig. 1.

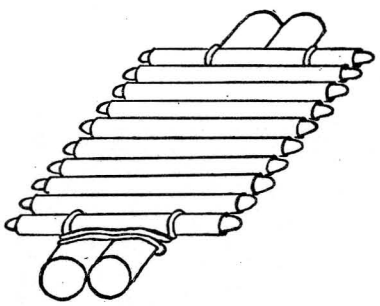

Fig. 1. Device for germination

The surface of the eosin solution filled in the dish reached just the seed. Germination was done in dark thermostat of 30℃.

Results

1) The degree of anti-geotropism which appeared in seminal root in relation to the concentration of eosin solution.

It is able to indicate the directions of seminal root with figures : downward-0 (zero), horizontal-1, upward-2. (cf. Fig. 2)

According to Table 1, the highest concentration induces the most remarkable anti-geotropism. This fact shows that the eosin molecules can inhibit such an activity of auxin as geotropic stimulus in seminal root, and the degree of anti-geotropism is proportionate to the molecular concentration of eosin.

2) The relation between the degree of anti-geotropism which appeared in seminal root and the germinating rate of seed.

Germinating rate is the percent of germinated seeds at the most active stage in a limited period. The rate indicates the degree of germinating activity of the variety employed, and shows the degree of after-ripeness of the seed.

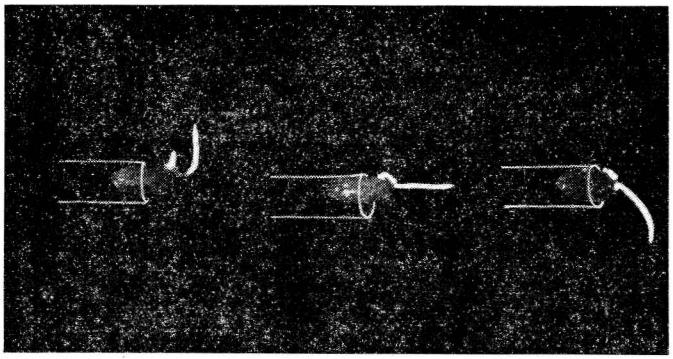

Fig. 2. Lefthand—U=2, Middle—H=1, Righthand—D=0.

Table 1. Concentration of solution and degree of anti-geotropism of seminal root. (Variety : Akibaé)

Concentration (%)		
0.001	0.005	0.01
U—2	H—1	U—2
D—0	U—2	U—2
H—1	D—0	U—2
D—0	H—1	U—2
U—2	H—1	U—2
D—0	U—2	U—2
D—0	U—2	U—2
D—0	D—0	U—2
D—0	D—0	U—2
U—2	U—2	U—2
Average 0.7	1.1	2.0

Remarks : U—Upward, H—Horizontal, D—Downward.

According to Table 2, the germinating rate and the sensibility to the eosin are almost parallel. Such variety as to germinate actively in the eosin solution of 0.01% has a high sensibility to the anti-auxin absorbed, because, perhaps, of the diminution of natural auxin in the course of after-ripeness.

Table 2. Germinating rate and sensibility to eosin

Variety	Germinating rate (%)	Degree of anti-geotropism
Obanazawa No. 4	87.5	2.00
Russia No. 71	90.0	1.90
Hatsunishiki	80.0	2.00
Ginmasari	72.2	1.72
Chōkai	60.0	1.70
Moritawasé	57.1	1.71
Sasashiguré	57.1	1.57
Ban-eikō	50.0	1.12

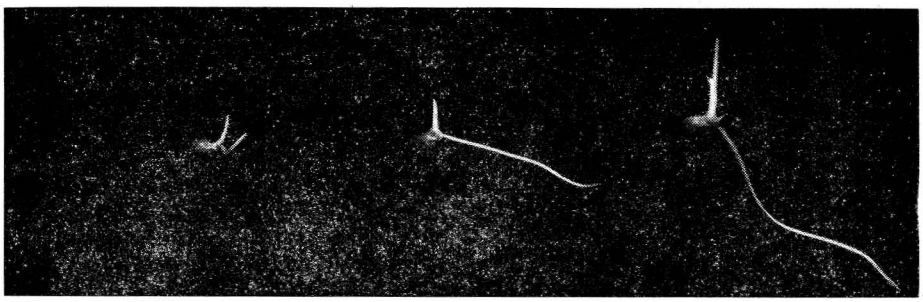

Fig. 3 Degree of anti-geotropism and length of seminal root.

3) The length of seminal root and young foliage passed through coleoptile is not independent of the degree of anti-geotropism in the seminal root.

The relation between the degree of anti-geotropism and the length of seminal root is shown in Fig. 3. Fig. 3 shows that the relation is exactly negative in correlation, that is to say, the shorter the length of seminal root, the more intense the anti-geotropism.

According to Table 3, the length of foliage passed through coleoptile is also in

Table 3 Length of foliage passed through coleoptile and degree of anti-geotropism of seminal root.

Variety	Concentration of eosin solution (%)	Length of foliage passed through coleoptile (mm)	Degree of anti-geotropism of seminal root
Akibaé	0.001	13.8	0.7
	0.005	8.1	1.1
	0.01	0	2.0
Norin No. 41	0.001	7.8	1.2
	0.005	2.6	1.6
	0.01	0	1.6
Fujisaka No. 5	0.001	9.4	0.1
	0.005	1.8	1.0
	0.01	0	1.9

a negative correlation against the degree of anti-geotropism of seminal root.

The facts as above show that the growth of foliage and root is not independent of the increase of auxin activity and sensibility to eosin.

4) Inhbiting effect of eosin on rooting in rice seedling.

Eosin inhibits the rooting of crown root in rice seedling. The inhibiting manner is shown in Table 4.

Table 4. Inhibition of rooting by eosin (0.01%) in seedling (Variety : Ginmasari)

Control		Eosin plot	
N, P, K (mm)	N, K (mm)	N, P, K (mm)	N, K (mm)
69.2	50.0	2.8	0

N, P, K—Nutrient. mm : Total length of renewed roots per seedling in 72h. in dark thermostat of 30°C.

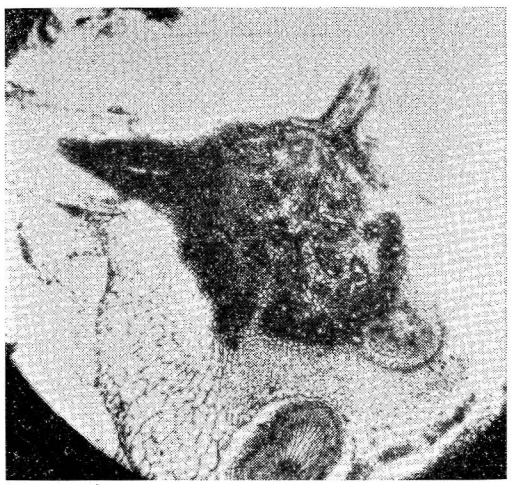

Fig. 4. Section of young node of seedling.

According to the result on Table 4, the growth of root at the young node of seedling and the natural auxin which is reversible with eosin are not independent respectively.

5) Intervarietal difference in the degree of anti-geotropism in seminal root of rice.

According to Table 5, there can be seen an intervarietal difference in the degree of anti-geotropism of seminal root. Norin No. 41 is high in the sensibillty to the anti-auxin, but Fujisaka No. 5 is compartively low. This difference is not always based upon the degree of ripeness and the age of the seed, for Norin No. 41 is seen to be later in the ripening time than Fujisaka No. 5.

6) The degree of anti-geotropism of seminal root in relation to the age of seed.

The degree of anti-geotropism of seminal root induced by eosin is seen to vary with the age of seed. In Table 6, the age of seed is shown with the days which elapsed after gathering in the field.

Table 5. Degree of anti-geotropism of seminal root.

Variety	Date……	Oct. 19			Oct. 20			Oct. 21		
	Eosin (%)…	.001	.005	.01	.001	.005	.01	.001	.005	.01
Norin No. 41					D	U	U			
			U	U	D					
		H	H				U			
					U				H	H
		U		U		H				
			H		U					U
		U	U				H			
		D		H		U				
			U					H		H
			U		U		U			
Fujisaka No. 5			H		D		U			
				U	H	H				
		D				D	U			
		D		U		H				
		D		H					H	
		D	H				U			
			U	U	D					
					D	H				U
					D	H	U			
					D	H				—

Remarks : U—Upward, H—Horizontal, D—Downward.

Table 6. Age of seed and degree of anti-geotropism at 0.01% eosin solution.

Variety	Age (months) 0.3	1.0	1.3	18.0
Russia No, 71	1.44	1.90	2.00	
Hatsunishiki		2.00		1.22
Norin No. 41		1.53		1.00
Kuhei-nigo		1.30	1.60	

Table 7. Location of anti-geotropic value of seminal root in a panicle. (Variety : Norin No. 41)

	Primary branch	Secondary branch
Apical branch	1.9	—
1st 〃	1.4	1.1
2nd 〃	1.3	1.0
Basal 〃	1.3	1.3
Neck 〃	1.6	1.3

The seed immediately after gathering has a low sensibility to eosin, and it can aquire the higher sensibility with the progress of after-ripeness, but such an extremely old age as 1.5 years makes the seed lose the sensibility.

7) Relationship between the degree of anti-geotropism and the position of seed on a panicle.

The degree of anti-geotropism measured by 0.005% eosin solution varied with the position of seed on a panicle.

In Table 7, the degree of anti-geotropism of seminal root is recognizable to be proportionate to the degree of after-ripeness of the seed and to the diminution of natural auxin in it.

8) The difference between autotetraploid seminal root and diploid seminal root in the degree of anti-geotropism induced by eosin.

There can be found a difference as next Table between 4x and 2x of Kōnan rice (i. e. a variety of *indica* type) in the degree of anti-geotropism of seminal root germinated in 30°C on the surface of eosin solution.

According to Table 8, the autotetraploid seminal root turns upward more easily than the diploid by the molecules of eosin.

Table 8. Degree of anti-geotropism of autotetraploid and diploid seminal root.

Concentration of eosin solution (%)	4x	2x
0.005	2.00	1.33
0.0025	2.00	1.44
0.001	1.55	0.78

Table 9. Diameter of cross-section of seminal root at 5mm distance to apex.

4x	2x
mm	mm
1.425	0.440

Besides, 4x-seed is always inferior to 2x-seed in the length of foliage which passed through coleoptile and that of seminal root when they are measured in the same hours after germination. That is to say, the longitudinal elongation of autotetraploid seminal root is inferior to that of diploid seminal root.

But on the contrary, the width of the former is always larger than the latter as is shown in Table 9.

The result of Table 9 is ascribable to the quantitative superiority of 4x-cell to 2x-cell in the initial volume.

According to two tables as are shown above, the larger the size of cell of seminal root, the more remarkable the anti-geotropism of it. This means that the genesis of natural auxin in 4x-cell is restricted or the auxin is diluted by other substances owing to those increase.

Discussion

H. Linser (1955) and K. Kindl (1955) mentioned that the growth-promoting activity of auxin or the growth inhibiting activity of such an anti-auxin as eosin increases in the binding of regulator molecules to the active sites of correlated sensitive area of living system. Therefore the intrinsic activity defined by the number of regulator molecules bound indicates the specific activity of receptor-regulator complex.

According to the present paper, the receptor is in the embryonic tissue, where naturally an auxin appears, and the molecules of eosin are able to be absorbed. The activity of receptor-eosin complex is antagonistic against that of receptor-auxin complex, so the antagonistic behavior proportional to the molecular concentration of eosin indicates the activity of natural auxin in the tissue.

Summary

The studies on the anti-geotropism induced by eosin in the seminal root of rice seed were carried out.

1) The more the concetration of eosin, the more remarkable the anti-geotropism.

2) The germinating rate of seed was proportionate to the sensibility to eosin.

3) The degree of anti-geotropism of seminal root was in negative correlation to the length of foliage passed through coleoptile and also to the length of seminal root.

4) Eosin inhibits the rooting at the node of young seedling of rice.

5) There was found an intervarietal difference in the degree of anti-geotropism which appeared in the seminal root.

6) The degree of anti-geotropism of seminal root varied according to the after-ripeness of seed.

7) The degree of anti-geotropism of 4x seminal root is more remarkable than that of 2x seminal root.

Reference

The chemistry and mode of action of plant growth substances (1955), England.

摘　　要

1) 水稲のエオシン浸漬発芽種子根の背地性程度は，エオシン液の濃度が大となるに従い顕著となる．

2) 稲種籾の発芽勢が低い場合に，種子根背地性の程度もまた小である．これは後熟度の進まない劣勢顕果が，多く混じているためで，未後熟種子が過剰のオーキシンを含むためであるとおもわれる．

3) 種子根長及び本葉の鞘葉から抽出せる部分の長さは，種子根の背地性程度と反比例的関係にある．

4) エオシンは稲苗発根（冠根の生長）を抑制する．

5) エオシンによつて誘発される種子根背地性の程度には，品種間差異が認められる．この品種間差異は，熟度の差異に基ずくだけではないようである．はつきり断言することはできないが，オーキシン生成能に関する差異かもしれない．

6) 種子根背地性の程度は，種子の年歯及び後熟度によつて変る．したがつて一つの穂内においても．第1次枝梗の優勢顕果が，後熟度大で，エオシンにより，種子根の背地性が強く現われる．

7) 4x 種子根は 2x 種子根よりも，エオシンによる背地性を強く現わす．これは，4x種子がオーキシン生成能において劣るからであろう．