Botany. — *On the so-called traumatotropic curvatures of oat seedlings.* By NANNY TENDELOO. (Communicated by Prof. F. A. F. C. WENT.)

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According to DOLK (1926) an oat seedling forms a new physiological top about two and a half hours after decapitation. From this top growth-accelerating substances move basipetally. These facts have not as yet been taken into account by those who investigated the curvatures induced by incision of the coleoptile. Another explanation of the so-called traumatotropic curvature may be given in connection with DOLK's findings. In the experiments reported here I studied the relation between curvature and the formation of the new physiological top.

I. *Curvatures of decapitated seedlings.*

Etiolated oat seedlings about 35 to 50 millimeters long, were decapitated with a sharp blade about 5 millimeters below the apex. At the same time the primary leaf was pulled out of its sheath. Immediately after this operation an incision of 180° was made about two millimeters below the cut surface. Within a period of two hours after the decapitation and further operations a few seedlings showed a feeble positive curvature. These curvatures may be accounted for as follows: The decapitation removes the centre of formation of growth-accelerating substances. Only the substances still present in the stump move basipetally. At the intact side nothing hampers the transport of the substance. This is obviously not the case at the wounded side. The humidity of the air being low, the cut surfaces shrivelled a little and a small gap was formed forming a sufficient obstacle for any possible transport, the more so because the gap was quite dry. The insertion of a mica disc was therefore superfluous. Only the growth-accelerating substances present below the cut surface pass downwards in a normal way (see WENT JR., 1926). The positive curvature may therefore be explained by a slight excess of growth promoting substance at the intact side. Four hours after the incision the positive curvature has disappeared and a few plants show negative curvatures. This phenomenon occurred curiously enough only in such seedlings in which the incision was made too deep, passing beyond the centre of the coleoptile. In those cases the upper coleoptile-ring appeared in a slanting position and often broke off entirely from its base. Especially in the latter case the plants showed a strong negative curvature. All plants in which the incision passed

exactly through the centre remained quite straight. When the primary leaf had not been removed, its growth pushed off the upper coleoptile ring. In this case again a marked negative curvature ensued.

Table I shows the reaction of a few plants in six consecutive hours.

TABLE I.

Time	straight	+	−
after 2 hours	37	7	0
„ 3 „	39	4	1
„ 4 „	33	1	10
„ 5 „	24	3	17
„ 6 „	21	3	20

From these data it appears that the growth at the wounded flank becomes stronger four hours after decapitation which already indicates the formation of a new physiological top at the cut surface.

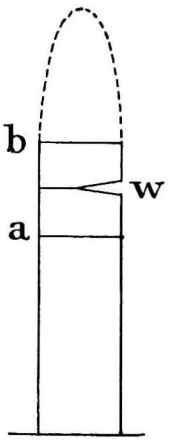

Fig. 1.

Oat seedling. The dotted line represents the top removed by incision; w = wound, b = coleoptile-ring above the wound, a = coleoptile-ring below the wound.

Proof of the formation of this top may be obtained by placing the coleoptile rings *a* (see figure 1) on newly decapitated seedlings. For specific curvatures of the seedlings should be a result of such a regeneration. Three hours after decapitation and wounding the tops were removed by completing the incision already made and placing the rings *a* three to four millimeters high by means of 10 % gelatin, on the new stump. Care must be taken to insure a good contact between ring and stump. The influence of atmospheric- and soil-humidity was very apparent here. If the atmospheric humidity is low the rings will dry out rather rapidly and a dry soil diminishes the reactivity of the plants. The experiments were therefore carried out in a room with constant humidity (87 %) and constant temperature (25° C.).

The plants were controlled every hour and after three hours the side of the original wound became convex. The coleoptile ring therefore produced more growth-substance at the wounded side, caused by formation of a new physiological top at that side. The promptness of the curvature and its rapid development (within three hours) excluded the possibility of another cause. For an imperfect contact between ring and stump should also give

rise to a curvature because certain areas of the stump could regenerate a new top independently. The latter process, however should take much more time. The curvatures ensuing within three hours after the application of the ring were only taken into account. When the rings were prepared already two hours after decapitation and wounding, no subsequent rapid curvatures were induced by placing these rings on new stumps. Here apparently the new physiological top has not yet been regenerated and the quantity of growth-accelerating substance remains the same at both flanks. Even five hours after the treatment of the new stumps no curvature could be observed. We will now investigate whether a new physiological top has been formed at the apex of the stump (ring *b* figure 1). In order to test out this fact I placed the ring *b*, three hours after incision on a new stump.

It appeared that a curvature of the stump ensued, showing an acceleration of growth at the flank corresponding to the intact part of the coleoptile from which the ring was obtained. This lends to show that the regeneration of the physiological top had only taken place where a basipetal continuity was assured. Rings *a* and *b* therefore give curvatures in opposite directions which may be demonstrated clearly by placing them on two neighbouring seedlings. When the wound was applied at the right flank the rings *a* caused a convexity at the right flank of the new stump and the rings *b* caused a concavity of the right flank of the new stump (see figure 2).

The experiments also show that the curvatures are not due to the

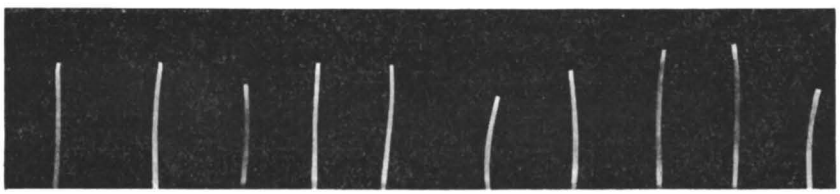

Fig. 2

wounding as rings *a* and *b* both contain the same wounded area.

Decapitation and apical wounding only gives rise to a new physiological top there where a basal continuity is assured.

This appearance of a top is therefore also the cause of the negative curvatures which occur four hours after wounding.

II. *Traumatotropic curvatures of normal, non-decapitated seedlings.*

Etiolated seedlings show a strong positive curvature already one hour after a one sided incision 6 to 7 millimeters below the apex. According to PAAL this is due to an interruption in the transport of growth-

accelerating substance. Care was taken not to injure the leaf. The insertion of a mica disc was necessary here. If such a disc was not applied, the cut surfaces stuck together and the wound healed more or less.

The cells at the cut surface are about as old as in the case of wounding after decapitation. The curvature of the non-decapitated seedling after wounding is very marked ; a difference in length between the convex and concave flank became visible already after one hour.

These positive curvatures were still more apparent after three hours.

The curvature appears immediately below the wound and proceeds towards the base. After four hours a straightening below the wound becomes visible. The positive curvature in this case remains visible over a much longer period than the curvature after decapitation. Table II shows the amount of curved and straight plants at various times after the wound had been applied.

TABLE II.

Time	straight	+	—
after 1 hour	4	23	0
„ 2 hours	2	25	0
„ 3 „	3	24	0
„ 4 „	8	19	0
„ 5 „	10	14	3

After 20—24 hours several plants are entirely straight especially the small ones (about 20 millimeters). It is doubtful whether these straightened plants are comparable to normal, unwounded plants. For the straightening and even convexity of the wounded flank may be due to the formation of new growth-promoting substances below the incision. What happens at this surface three to four hours after incision ? This question has been studied by the methods mentioned above.

Three hours after wounding the ring *a* (Fig. 1) below the incision was placed by means of 10 % gelatin on a new stump. In almost all stumps curvatures appeared, the convex flank of the stump situated directly below the originally cut surface. Figure 3 depicts these plants. Application of rings *b* on new stumps did not cause any curvature. No increase of growth substance has therefore taken place above the wound. No accumulation of this substance above the wounded surface could be demonstrated. No physiological top is regenerated above the incision. The plants which were quite straight after 24 hours are therefore not comparable to normal intact seedlings.

It appears from the above that it is desirable to observe the plants in short intervals after the wound has been inflicted. For the regeneration of

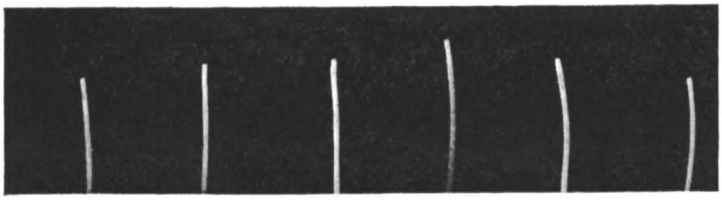

Fig. 3.

the new physiological top may cause a transition from positive to negative curvatures.

Curvatures which ensue after unilateral wounding have two causes:

a. The curvatures which appear within the first three hours after incision are caused by the interruption in the transport of growth-promoting substances.

b. The curvatures which appear three hours (and later) after incision, are caused by the formation of a new physiological top at the cut surface. The observed transition from positive to negative curvatures is due to the antagonistic action of factors *a* and *b*.

LITERATURE.

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