STUDIES WITH A NEW GROWTH REGULATOR DIKEGULAC-SODIUM

III. Effects on Root Growth and Geotropic Response in *Helianthus annuus* L.

DIKEGULAC-sodium (sodium 2,3 : 4,6-di-O-isopropylidene-*a*-2-furanosonate) or ATRINAL[R] is a new growth regulator introduced by Dr. R. Maag Ltd., Switzerland. Recent work has shown that dikegulac-sodium produces various physiological and morphological responses such as shoot elongation[10], production of axillary shoot[4], GA–induced DNA synthesis[5], growth of leaves and cell division[1], seedling growth and chlorophyll biosynthesis[8] and protein, sugar and oil biosynthesis of seedling[9]. No report is yet available pertaining to the effects of dikegulac-sodium on root morphology, geotropic responses in *Helianthus annuus* L.—an important oil yielding crop.

Seeds of *H. annuus* var. EC. 68414 were soaked in aqueous solutions of dikegulac-sodium for 6 hours, with the concentrations ranging between 25 to 500 mg per liter. Control seeds were soaked in distilled water. Seeds were germinated under continuous light ($2{\cdot}6 \times 10^{-4}$ ergs/mm^2 sec.) in sterilized petridishes on Whatman No. 1 filter-paper kept moist with distilled water or test solutions. The entire set with three replicates of 20 seeds was repeated three times at $30° \pm 2°$ C. Germination was recorded for 48 hours while morphological observations were made daily. The final observations were made on the 14th day after germination.

Comparison of the data for dikegulac-sodium-treated and control seedlings presented in Table I and Fig. 1.

TABLE I

Effect of dikegulac-sodium on seed germination, primary and lateral root growth, negative geotropism and swelling on Helianthus annuus L.

Concentration mg/l	Per cent germination	Length of primary root in cm.	Length of lateral root in cm.	Negative geotropism	Swelling and curling
H_2O	70·8	8·17	4·3	—	—
25	65·3	3·42	1·20	+	+
50	61·1	2·15	0·79	+	+
100	56·9	0·78	0·51	++	++
250	51·2	0·29	0·40	++	++
500	40·2	0·20	0·11	++	++
S.Em ±	33·26	0·76	2·19		
L.S.D. (0·05)	70·17	1·61	4·62		

— = No effect; + = mild effect; ++ = vigorous effect.

FIGS. 1–3. Fig. 1. Effects of different concentrations (25 mg/l to 500 mg/l) on hypocotyl and radicle growth of *Helianthus annuus* from left to right. Extreme left–Control. Note the inhibition of primary and lateral roots. Swelling and curling is quite evident. Fig. 2. Effects of 100, 250 and 500 mg/l concentrations of dikegulac-sodium (from left to right, extreme left is control) on radicle growth, note swelling and bending. Fig. 3. Negative geotropic response of *Helianthus annuus*. Roots are treated with 250 mg/l solution of dikegulac-sodium (Photograph taken on 14th day of germination).

revealed that dikegulac-sodium inhibits root growth and causes negative geotropic response. Such response was evident after 3 days of radicle emergence. These short term studies suggest that dikegulac actively retarded the growth rate during first 3 days. The reduction in root length increased with increased concentrations of dikegulac. The root tips were turned

brown. As growth proceeded roots became completely brown, curved and stunted. The growth of lateral roots was severely inhibited beyond 100 mg/l concentrations.

The per cent germination was not significantly affected by dikegulac treatment. After 48 hours of germination a very interesting observation was recorded, the radicles of all dikegulac-treated seedlings became negatively geotropic (Fig. 3). The lower concentrations (25 and 50 mg/l) caused negative plagiogeotropic responses whereas the remaining concentrations caused negative diageotropic responses. The growth of root hairs was also retarded in the same manner.

Dikegulac-sodium works counter to gibberellins and auxins and in some respects it may seem similar in action to morphactins[1]. In recent years evidence has accumulated suggesting that roots are the site of gibberellin (GA) biosynthesis and, at least some, if not all of the root-synthesized GA's are exported to the shoot in xylem sap[3]. The exact locus of GA synthesis in the root of *H. annuus* seedlings appears to be the root apex[6]. Young leaves of *H. annuus* plants are capable of carrying out GA synthesis which may be translocated to the roots via the phloem. The inhibition of primary and lateral roots and root hairs with different concentrations of dikegulac-sodium is possibly due to its effects on GA biosynthesis. The action may cause reduction in GA as well as GA–induced DNA biosynthesis[1], necessary for root growth. GA is known to increase the amount of auxins (mainly of IAA) by inhibiting synthesis of IAA–oxidase[12]. IAA promotes root growth in *H. annuus*[7]. If dikegulac-sodium does not affect IAA level through GA then it may directly reduce IAA level by increasing an amount of IAA–oxidase in roots.

Geotropic growth curvature results from unequal growth rates along the upper and lower sides of the responding organs. Dikegulac-induced negative geotropism and modification in root morphology (mainly swelling and curling) may be attributed to the disruption of auxin transport or the reduction of IAA level in roots. These effects are similar to those of morphactins. Swelling of hypocotyl (Fig. 2) with dikegulac treatment also suggests that this growth regulator must have initiated the production of ethylene in root cells, but this needs confirmation. Ethylene is involved in the supra-optimal auxin inhibition of root growth[11].

At present we have little information about the nature of inhibiting effects of dikegulac-sodium on root growth and its morphology. Experiments are in progress to resolve the precise mechanism of the action of dikegulac-sodium.

The author is grateful to Dr. R. Maag Ltd., Switzerland, for their support.

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December 11, 1979.

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1. Arzee, T., Langenauer, H. and Gressel, J., *Bot. Gaz.*, 1977, **138**, 18.
2. Bocion, P. F. and de Silva, W. H., In *Plant Growth Regulation, 9th International Conference on Plant Growth Substances*, Ed. P. E. Pelit, 1977, p. 189.
3. Crozier, A. and Reid, D. M., *Can. J. Bot.*, 1971, **49**, 967.
4. de Silva, W. H., Graf, H. R. and Walter, H. R., *Proceedings British Crop Protection Conference —Weeds*, 1976, p. 349.
5. Gressel, J., Kadouri, A., Atsmon, D. and Cohen, N., In *Collected Abstracts of Paper Demonstrations, 9th International Conference on Plant Growth Substances*, Ed. P. E. Pelit, 1977, p. 117.
6. Jones, R. L. and Phillips, I. D. J., *Plant Physiol.*, 1966, **41**, 1381.
7. Purohit, S. S., *Ph.D. Thesis*, University of Udaipur, Udaipur, 1977.
8. —, *Comp. Physiol. Ecol.*, 1979, **4**, 264.
9. —, *Ibid.*, 1980, **5** (1), 24.
10. Sachs, R. M., Hield, H. and Debies, J., *Hort. Sci.*, 1975, **10**, 367.
11. Waering, P. F. and Phillips, I. D. J., *Control of Growth and Differentiation in Plants*, Pergamon Press Ltd., Oxford, 1970.
12. Pilet, P. E., *C.R. Acad. Sci. (Paris)*, 1957, **245**, 1327.

POLYPEPTIDES OF *PARTHENIUM* CHLOROPLASTS OF SDS GELS*

Parthenium hysterophorus Linn., (family: Compositae), is a common weed, spreading throughout the country, posing a serious health hazard to both humans and livestock[1,2]. The efficient photosystems present in the chloroplasts of this weed probably allows it to have uncontrolled luxurious spreading and hence it is worthy of investigating its polypeptides residing within the chloroplasts lamellae and stroma.

Chloroplasts isolated from the young leaves were fractionated into subchloroplastic particles by treating them with digitonin as described earlier[3]. The light dependent photosystem reactions were carried out as described previously[4]. The SDS gel electrophoresis was carried according to Weber and Osborn[5], and the molecular weight of the polypeptides residing in them was determined as described by them. The 10% gels were scanned in a Joyce Loble chromoscan. The carboxylase activities were assayed both radiometrically and spectrometrically[6].