BIOLOGY

Influence of Electrostatic Fields on Seed Germination

RECENT investigations have stimulated wider interest in the possible biological significance of naturally occurring electric fields and related phenomena. Murr[1-3] has shown that high intensity electric fields appear to inhibit development in grass seedlings; he points out, however, that earlier workers, notably Jorgensen and Priestley[4], and Shibusawa and Shibata[5], observed increases in plant growth under electric field conditions, although the frequent occurrence of contradictory results in much of the early work on this subject has been emphasized by Lund[6]. The physiological effects of air ionization have been studied by a number of workers[7]. Krueger *et al.*[8] report that exposure to positively or negatively ionized air produced more rapid germination in *Avena sativa* seeds with subsequent increases in growth and dry weight; slight increases in growth were also noted with seedlings placed in positive or negative electric fields of 955 V over 30 cm; in these experiments, however, the seed containers were grounded to prevent the accumulation of surface charge. The present communication directs attention to an apparent dependence on polarity of the response of germinating seeds to induced electrostatic charges.

Four batches of 100 seeds of lettuce (*Lactuca sativa*), variety 'Cluseed Borough Wonder', were sown on filter paper laid on each of four 6 cm square sections of aluminium foil attached by a thin film of 'Vaseline' to the upper surface of a sheet of glass 45 cm × 7·5 cm. Foil sections were similarly attached to the under-surface of a second sheet of glass resting on spacers so arranged as to separate the two sets of 'field plates' by a vertical distance of 0·5 cm. Two pairs of plates were connected to 90 V batteries arranged in series to give a potential difference of 180 V, one pair positive over negative and the other pair negative over positive; the remaining pairs were left uncharged as controls; the relative positions of charged and uncharged plates were changed after each replication. After sowing, each batch of seeds was moistened with 1·5 c.c. of water, the apparatus being then enclosed in a polythene container and placed in a constant-temperature room for 24 h. Most of the experiments were conducted either in total darkness or with 12/12 photoperiod, but no attempt has been made to discriminate between the two conditions in the results given in Table 1. A comparison is given in Table 2 between twenty paired replications carried out in light and dark rooms simultaneously.

The criterion of germination in these experiments was taken as the emergence of the radicle when viewed under a ×15 lens. The margin of error inherent in purely visual determinations of this type must obviously be so great as to preclude the possibility of obtaining any precise estimate of the magnitude of the electrostatic response. Sufficient results have, however, been obtained to provide some indication of the general pattern of response, although it must be emphasized that considerable variation occurs in the germination level within any one treatment.

The results of 150 replications (Table 1) are in agreement with the work of Murr[1], in that a positive field appears to inhibit plant development, but from the present work it is further apparent that the nature of the plant response is dictated by the sign of the electrostatic field, and not merely by the presence of the field *per se*. The possible influence of light in reducing the magnitude of this polarity effect may be significant (Table 2). A comparison with the work of Krueger *et al.*[8] is not possible in the absence of ion-density and current measurements, but Edwards[9] found that a positive field slowed down the rate of development of *Nepytia* pupae; he also suggested that contact-induced electrostatic charges might influence insect behaviour[10,11].

Table 1. DIFFERENCE IN PERCENTAGE GERMINATION AVERAGED OVER 150 REPLICATIONS

Difference from control		Difference between polarities
+ over −	− over +	
−4·9468	+0·9863	5·9331

Variance-ratio = 3·95 (5 per cent significance point = 3·00).

Table 2. COMPARISON OF GERMINATION BETWEEN TWENTY REPLICATIONS EACH IN LIGHT AND DARK

	Difference from control		Difference between polarities
	+ over −	− over +	
Dark	−12·2	+4·65	16·85
Light	+0·85	+6·4	5·55

The present experiments were initiated in an attempt to provide a possible basis for correlation between geo-electric phenomena and the manifestation of psychiatric disturbance symptoms, assuming such a relationship to be mediated through variations in neuro-hormone activity resulting from electrostatically induced changes in tissue respiration levels. Preliminary gas-analysis studies appear to indicate a possible polarity-dependent electrostatic influence on the rate of production of carbon dioxide in germinating seeds. Further work along these lines is in progress.

I thank D. G. Heathcote for carrying out the statistical analysis; I also thank Prof. G. F. Asprey, Dr. J. R. Etherington and Dr. A. G. Lyon for their advice and encouragement.

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Some Responses of *Drosophila* to Weak Magnetic and Electrostatic Fields

A VARIETY of reactions of organisms to natural levels of electromagnetic fields has been reported in recent years. This communication reports an investigation of the responses of *Drosophila melanogaster* to magnetic and electrostatic fields of low intensity. Previously, Barnwell and Brown[1,2] cited unpublished work showing that *Drosophila* responded to weak magnetic fields. Edwards[3] reported that electrostatic fields depressed the activity of *Drosophila*.

An orientational–statistical approach was used in this investigation because it was thought that the response to these fields would be weak. Oregon *S* wild type flies were allowed to emerge from a 'Plexiglas' and 'Masonite' corral, through a narrow corridor, into an expanded field. The amount of turning from a straight line was determined by noting the 10° sector crossed by the insect 3 cm from the corridor exit. The flies were returned to the corral by shaking after they had all emerged. About fifty flies were allowed to orient for each sample. The orientation chamber was inclined 30° and centred under an illumination of 2 lux in a black compartment. The flies were raised under an 8 a.m.–8 p.m. light–dark cycle. Experimental runs were conducted between April 4 and August 25, 1962, from 9.30 to 11.30 a.m. and 2.30 to 4.30 p.m. C.S.T.

The amount of turning was noted in the measured 2-G horizontal field of an 18 cm alnico magnet centred under the experimental chamber in a rotatable standard. The flies emerged headed toward true 'Earth' magnetic north under the following configurations of the experimental