ELECTRICITY IN AGRICULTURE.

SOME thirty years ago Prof. Lemström, of the University of Helsingfors, sought to elucidate the Aurora Borealis by trying to imitate its appearance by electrical experiments. For this purpose he produced high-tension discharges of various kinds, and sent them through vacuum tubes until he got an appearance very like those of the northern lights. Some of these experiments he conducted in his greenhouse—to the best of my belief, according to his own account, given when on a visit to England—and he noticed incidentally that the plants seemed to thrive under the treatment, and that the electrification thus produced in their neighbourhood appeared to do them good. He also noticed, as remarkable, the flourishing development of plants in Arctic regions, where the sunlight was very weak, and he attributed part of this growth to the influence of electric discharges.

He says that when the plants in the north of Norway, Spitsbergen, and Finnish Lapland have resisted the frequently destructive night frosts, they show a degree of development which greatly surpasses that of plants in more southern regions, where the climatic conditions are more advantageous. This rich development appears principally in the fresh and clear colours of the flowers, in their strong perfume, in the rapid development of the leaves on the trees, and their scent, but particularly in the rich harvest which different seeds—such as rye, oats, and barley—will produce, when, as before stated, they are not destroyed by the frosts. From a bushel of rye sown there will often result forty bushels, and from barley twenty bushels, and so forth. It is the same with grass. These results are attained notwithstanding the fact that the people cultivate their soil very imperfectly, using only ploughs and harrows of wood.

He pursued the matter by careful observation, taking test-plants in pairs or groups; electrifying one group—that is to say, discharging some electricity into the air above it—and keeping a similar group away from the electricity, in order to be able to compare them. Then he photographed the two groups side by side, and found in nearly all cases a marked improvement as the result of the electrical treatment. He concluded that the needle-like shape of the leaves in fir-trees, and the beard on the ears of most cereals, have the discharge of electricity as their function; and he found that they do act in this way.

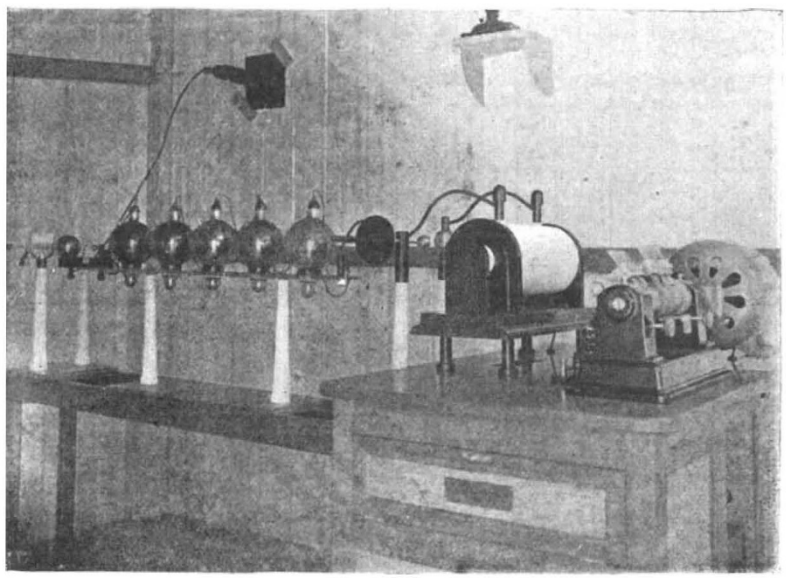


FIG. 1.—Inside the transformer shed, showing the inductive break, special coil, and high-tension valves.

This observation and these experiments of Prof. Lemström were not, indeed, the beginning of the application of electricity to plant growth, because pioneer attempts had been made long before by the Abbé Berthelon in 1783, but it was the beginning of a thorough and scientific treatment of the problem. Prof. Berthelot, at Meudon, has also attacked it; so have Dr. Cook and Mr. J. H. Priestley, of Bristol. During the winter of 1904 Mr. J. E. Newman installed a small trial apparatus, consisting of a small influence machine of the Wimshurst type and overhead discharge wires, at the Golden Valley Nurseries at Bitton, near Bristol. The wires ran about sixteen inches above the tops of the plants, or above the rows of tomatoes in the glasshouses; and short pieces of fine wire, with the free ends pointing downwards, acted as discharge points. Mr. G. R. Newman has now established a large-scale installation there.

Attempts of a different kind had also been made by other experimenters. Plates had been sunk in the ground, and a current passed between them among the roots of plants; but whatever effect is thus caused is of a totally different kind from that excited by high-tension electricity supplied to the air above them. Both in a manner are natural processes. There are natural earth currents, and these must flow among the roots of plants, though whether they produce an appreciable effect may be doubted. There is a natural atmospheric electrification, and this must be playing an important part in many phenomena. Atmospheric electrification is responsible for the coalescence of cloud globules into rain. During fine weather the electricity in the air is usually of one sign: positive. When wet weather sets in, the electricity in the air usually changes sign, becoming negative. The whole subject is a large one; a great deal is known about it, and vastly more remains to be known; but meanwhile it can hardly be doubted that the electrification of the air has some effect on growing plants. For it is found that under the influence of ultra-violet light, electrified plants can give off electricity into the air from the leaves; and the fact that the upper air is normally electrified, relatively to the soil, must cause all plants to be electrified also; so that in all probability they are in a constant state of slow electrical discharge, which becomes more rapid when the sun is up. In what way this discharge of electricity from their growing tips, and hair, and surface generally, really acts, must be studied and reported on by physiological botanists, but it is natural to suppose that it cannot be without influence, and reasonable to think that that influence may be beneficial—a hypothesis which direct experiment confirms.

Possibly in some sunny countries the effect is excessive, and might, with advantage, be moderated, but in this climate it turns out that artificial supply of electricity does increase the rapidity and assist the amount of growth. At any rate, the experiments of Lemström, which had been repeated and extended by others, clearly pointed in that direction. So when, after some preliminary experiments at Bitton, Mr. J. E. Newman, of 3 Howard Street, Gloucester, acting in conjunction with Mr. R. Bomford, of Bevington Hall, Evesham, at his farm near Salford Priors, determined to try the phenomenon on a really large scale, and came to me to see if I could help them electrically, and enable them to maintain a continuous high-tension discharge for hours together each day over ten or eleven acres by means of power furnished by an oil engine and dynamo, I very willingly assented, and set my son, Mr. Lionel Lodge, upon the work.

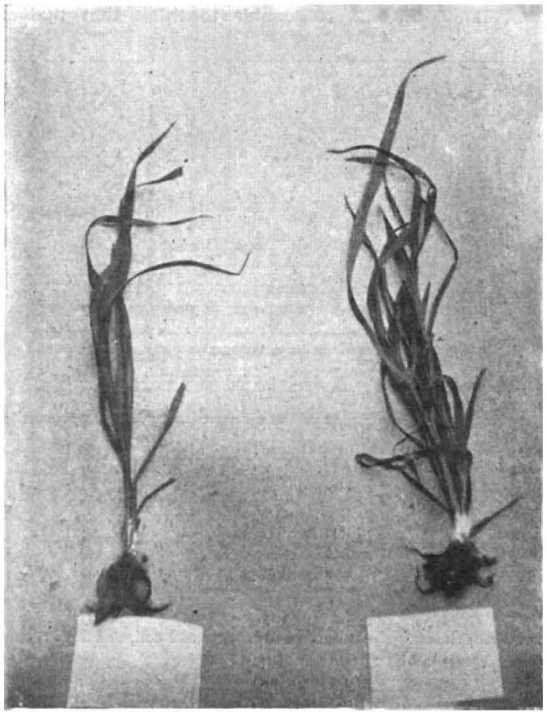
The method is to stretch over the field to be treated a number of wires on poles, something like low telegraph wires, but high enough for loaded waggons and all the usual farming operations to go on underneath the wires without let or hindrance. The wires are quite thin, and

are supported by a few posts in long parallel spans, about 30 feet apart. One pole per acre is enough. The electrified area was about 19 acres. The wires are supported on the posts by elaborate high-tension insulators, and they extend over all the acreage under experiment, a control plot of similar land under similar conditions being, of course, left without any wires.

The system of conductors is then connected at one point with a generator supplying positive electricity at a potential of something like a hundred thousand volts, and with sufficient power to maintain a constant supply of electricity at this kind of potential.

Leakage immediately begins, and the charge fizzes off from the wires with a sound which is sometimes audible, and with a glow which is just visible in the dark. Anyone walking about below the wires can sometimes feel the effect on the hair of the head, as of a cobweb on the face. They are then feeling the stimulating action of the electrification.

The electrification is maintained for some hours each day, but is shut off at night; it is probably only necessary



Control. *Electrified.*

FIG. 2.—Comparison of electrified wheat with wheat grown in the control field under the same conditions, an average plant being taken in each case. Note the broader leaves and greater number of shoots of the electrified wheat.

to supply it during the early morning hours in summer-time, and in spring-time or in cold cloudy weather for the whole day. During bright sunshine it seems unnecessary, and may even be harmful. But at what stages of the growth of a plant the stimulus is most effective has still to be made out; probably the earlier it is begun the better; and since in the case of wheat both the ear and the straw is valuable, the electrification should be applied for a time each day during the whole period of growth, except perhaps during drought.

The power required to generate the electricity is very small, for although the potential is high, the quantity is insignificant, and the energy is accordingly comparatively trivial. The electricity can be generated in more than one way. It can be generated by a Wimshurst machine, or it can be generated by transforming up to high tension, and rectifying to one direction, the current of a dynamo. The first is in many respects the simplest, and was used in the early and small-scale experiments, but it can hardly be regarded as an engineering method adapted to continuous or rough use. The latter is the one which in the trials now to be described we have adopted.

The power is generated by a two-horse oil engine driving a small dynamo in an outhouse of the farm. Thence the current is taken by ordinary overhead wires to the field, where they enter a suitable weather-tight hut, which contains the transforming and rectifying apparatus. The only moving part here is the "break," and if the original dynamo had been an alternator, even this might be dispensed with. The transformer is a large induction coil, specially made to stand continuous use, and its current is then rectified by means of vacuum valves in accordance with a patented device of my own.

The negative electricity is conveyed direct to earth, while high-tension electricity, all of positive sign, is led by a specially insulated conductor out of the shed to the nearest point of the overhead insulated wires, which are thereby maintained at continuous high positive potential

THE RESULTS AND FURTHER DETAILS.

The following is a very brief summary of returns and information supplied to me by Mr. Newman and Mr. Bomford, showing the results from the electrified as compared with the control unelectrified plots.

SUMMARISED RESULTS OF THE 1906 EXPERIMENTS.

Bushels of Wheat per Acre.

(*Estimated corresponding increase in straw not measured.*)

	From the electrified plot	From the unelectrified plot	Increase
Canadian (Red Fife)	35½	25½ ...	40 p.c.
English (White Queen) ...	40	31 ...	30 ,,

Moreover, the electrified wheat sold at prices some 7½ per cent. higher, several millers in baking tests finding that it produced a better baking flour.

The increase appears to be mainly due to better stooling. No marked difference was observable in the development of ears.

SUMMARISED RESULTS OF THE 1907 EXPERIMENTS ON WHEAT.

RED FIFE, SPRING SOWN.

Bushels per Acre (Head Wheat).

Electrified	Unelectrified	Increase
41·4	32	29 p.c.

Electrified wheat brighter, and a better sample.

Increase again partly due to better stooling, but this time there was better filling out of ears.

These results are for wheat alone, but a good many other crops were tried at the same time.

HOURS OF RUNNING.

1906.

March 16 to July 10, inclusive, 621¾ on 90 days.
Average electrical pressure corresponded to a ¾-in. spark.
Current shut off after ears in bloom.

1907.

March 28 to July 27, 1014 hours on 115 days.
Average pressure corresponded to a half-inch spark.
Current kept on to harvest.

Those interested in the experiments are much indebted to the enthusiastic cooperation of Mr. Bomford. It may be interesting to note that it was at a farm belonging to Mr. Bomford's father that the first steam ploughing in England was done.

Prof. Lemström is undoubtedly the pioneer in this sort of work, though circumstances connected with the natural electrification of the atmosphere and with the discharge of electricity from various surfaces have been pertinaciously examined by Profs. Elster and Geitel.

OLIVER LODGE.