Horticultural Development Company

Grower summary

FV 346

Desk Study for electrical weed control in Field Vegetables

Final Report 2009

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Use of pesticides

Only officially approved pesticides may be used in the UK. Approvals are normally granted only in relation to individual products and for specified uses. It is an offence to use non-approved products or to use approved products in a manner that does not comply with the statutory conditions of use, except where the crop or situation is the subject of an off-label extension of use.

Before using all pesticides check the approval status and conditions of use.

Read the label before use: use pesticides safely.

Further information

If you would like a copy of the full report, please email the HDC office (hdc@hdc.org.uk), quoting your HDC number, alternatively contact the HDC at the address below.

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Headline

Electrical weeding has potential as a niche alternative to chemical and mechanical control but there are no commercial electrical weeding machines available at present.

Background and expected deliverables

The concept of electric weed control is well established and relies on the application of a high voltage to growing plants, which causes rapid damage to cell structure and integrity leading to plant death. Prototype electrical treatment systems have previously been developed and evaluated in the UK, USA and Belgium to control weed beet in sugar beet, weeds that rise above the crop canopy or weeds that occur between crop rows.

There is currently an urgent need to find non-chemical alternatives for weed control given the ongoing reduction in herbicide options. The main aim of this project was therefore to carry out a desk study on electrical weed control systems in order to provide background information on the subject, ascertain the likely extent of applicability of the method to the industry and assess the potential health and safety implications of such systems.

The main deliverable of the project is to inform the industry of the current state of electrical weeding and provide pointers to its future potential as a non-chemical weed control technique.

Summary of the project

An extensive literature review has revealed that electrical weeding was a popular subject for research from the late 1970's to the early 1990's. A tractor-linkage-mounted machine was developed and sold commercially by Lasco's in the USA during this period, (Farm Show, 1981). The standard "Lightening Weeder" of 1981 had a 23 foot swath, required a tractor capable of developing a minimum 125 HP at the PTO and typically operated at speeds of 4 to 6 mph. UK sugar beet growers were particularly interested in the machine as a means of destroying weed beet in their crops. However, this interest and Lasco's machine disappeared with the advent of relatively low cost weed wipers which could do the same job at least as effectively.

If a suitable herbicide and application method is available for the control of weeds it will always out compete the electrical method from a cost and effectiveness point of view. However, given that the herbicide list is constantly being reduced the possibilities offered by alternatives such as electrical weeding need to be evaluated. The fact that approval for Glyphosate and its associated weed wiping application method is likely to be withdrawn means that electrical weeding could yet provide an important niche technique for future weed control in mainstream as well as organic farming.

Developing a practical and cost effective electrical weeder will present any prospective manufacturer with a range of challenging technical, safety and viability issues. As a prelude to embarking on a machine development programme it is therefore recommended that manufacturers should carefully establish what weed-crop combinations their machine would be capable of handling and whether the cost of development could be justified on the likely number of sales, i.e. establish the market. One of the most important targets would be the killing of volunteer potatoes in organic & main crop carrots and general organic crops such as beetroot, other targets are mentioned in the discussion.

A further priority for any potential manufacturer would be to ensure that their prospective machine would be able to meet the current health & safety standards. The health and safety executive (HSE) were closely involved in deciding the safety precautions needed to allow a UK research prototype to be built and tested in the field back in the 1980's, (Diprose, M.F. et al,1985). For this desk study the agricultural branch of the Health and Safety Executive were contacted, (HSE, 2009), and asked to comment on the contemporary safety implications associated with high voltage electrical weeding in the field. In summary, if the machine is equipped with the appropriate safety interlocks and guarding and complies with the requirements of the Machinery, Electrical Products and Electromagnetic Compatibility Directives then such a machine would be able to be used by suitable, trained UK farmers and contractors.

Comprehensive searches of patent and agricultural machinery databases indicates that commercially available electric weeding machines do not exist anywhere in the world. Should the UK develop a successful machine it is therefore likely that the market could be global.

In order to be commercially viable it is likely that any new machine should be capable of dealing with a broad range of weed types, sizes and positions relative to the crop. It is expected that the machine would also need to adaptable re. electrode geometry and suitably equipped with control equipment to minimise power consumption. Power consumption to weed electrically is very high and increases as the number of weeds increase. Even at low weed densities (of the order 15 plants/m^2) the technique requires twice the energy and is 5 times slower than chemical treatment and, like its mechanical counterpart, can require multiple passes, (Vigneault. C. et al, 1990). As weeds get smaller and therefore closer to the ground the technical challenges of controlling electrode height in order to make contact with the weeds yet prevent arcing to earth will need to be overcome.

The electrical weeding technique offers a number of advantages relative to more conventional methods. The technique would allow killing of inter-row windbreak crops yet protection would remain as plants wither. The advances in guided hoe technology could be exploited by deploying electrodes in place of conventional hoes or spray nozzles. Other benefits are mentioned in the main conclusions below.

The development of a commercial electrical weeder would provide an opportunity for a machinery company to create a new product and offer growers a useful extra tool they could use as some traditional methods become unavailable. However, overcoming the technical, financial and safety requirements of such a machine will require significant financial investment.

Main conclusions

- If a suitable herbicide and application method is available then it will always out-compete the electrical control method from a cost and effectiveness point of view.
- In the absence of herbicides electrical weeding could offer the industry a niche solution to control weeds in a range of mainstream and organic farming applications.
- There are no commercial electrical weeding machines available at present.
- If a product complies with all the relevant safety requirements and is in fact 'safe', properly CE marked, accompanied by operator instructions to ensure safe use and that it is a

machine “for use in agriculture” then the machine could be operated by anyone in that industry. The manufacturer would need to specify that training is required and it is the duty of the user to undertake this.

- Assuming the time required to kill a plant is 0.2 s and using an effective electrode width of 0.4 m results in a typical forward speed of 2 m/s. For a 6 m wide machine this translates into a theoretical work rate of 43200 m^2/h or 4.3 ha/h (ignoring power constraints).

- Electric weeding is a high energy technique that is best suited to low weed densities. Assuming 1.76 kJ of energy is required to kill a plant and 50 kW is continuously available at the electrode this equates to a killing rate of 28.4 weeds/s. To achieve 4.3 ha/h (12 m^2/s) the maximum weed density would therefore need to be less than 2.4 weeds/m^2. Higher weed densities would require proportionately more power.

- To date electric weeding has only proven to be fully effective, in one pass, in low density weed situations such as crop bolters in sugar beet (0.5 – 0.6 plants/m^2). With weed wiping expected to loose its approval the electric method could find a place as a replacement for the weed wiper. The development of an electric weed wiper for low density weeding is therefore seen as the most likely commercial application of the technique in the short term.

- Compilation of a list of the priority target weed–vegetable crop combinations by agronomists’ is required.

- Building an instrumented rig and testing it in the field on a range of weed types and vegetable weed-crop combinations (from the agronomist’s list) would fill in most of the knowledge gaps and provide key information on the broader applicability of the technique.

- Electrical weeding offers a number of advantages over conventional methods e.g. timeliness (could work after rain and in bad soil conditions when hoes would be inappropriate), does not disturb soil, lower cost than hand weeding, no toxic residue, no soil retention issues, not wind effected.

Financial benefits

The cost of electrical weeding is claimed to be 10% of that for hand weeding, (Balls, R., 2009).

The financial benefits of electrical weeding to the industry would accrue as a result of the technique being available as an alternative to herbicide, hand or mechanical treatments. Collection and assimilation of the agronomic data required to calculate the value of these benefits is out of the scope of this technical review.

Action points for growers

If growers wish to see the development and introduction of electrical weeders then they will need to lobby potential funding bodies such as the HDC, Defra and the Technology Strategy Board (TSB) to provide support for:

- A survey to estimate the potential market size and value for electric weeding.
- A contribution towards the cost of developing a technology demonstrator.