Grower Summary

CP 134

“eyeSpot” – leaf specific herbicide applicator for weed control in field vegetables

Annual 2018

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Further information

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

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Project title:	"eyeSpot" – leaf specific herbicide applicator for weed control in field vegetables
Project number:	CP 134
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Report:	Annual Report, June 2018
Previous report:	Annual Report for 2016/17
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GROWER SUMMARY

Headline

- Experiments on precision manual applications of herbicide droplets to leaves of the natural weed infestation in field trials with cabbages and leeks. Dose –response relationships to droplet applications were compared for glyphosate and glufosinate-ammonium in a glasshouse study. Performance characteristics of a protoype herbicide droplet applicator were determined.
- Weed control in cabbages by glyphosate droplets reduced herbicide active applications by up to 98% compared to pendimethalin pre-emergence spray. In leeks, applications of herbicide actives were reduced by 74% compared to pendimethalin pre-emergence spray or 50% compared to post-emergence bromoxynil. These herbicide reductions were achieved in both crops *without affecting marketable crop yield or quality* compared to the weed-free, hand-weeded control.
- The field experiments with leeks and cabbages in 2017 included droplet applications of glufosinate-ammonium. Adequate weed control was achieved and although it was less effective than glyphosate. So, if approval for use of glyphosate were to be withdrawn, an alternative product has been identified and tested.
- Performance of the prototype applicator was optimised at 20 psi. Deviations due to wind during operation of the applicator were consistent and so could be compensated for in real applications.
- For commercial field vegetable crops, sequential treatments with droplets should take account of the crop's 'critical weed-free period' so that late germinating weeds, with potential to affect crop yield, are controlled. This approach will also mitigate risks of herbicide resistance, since weeds surviving an initial treatment, would be retreated on a subsequent visit.

Background

Weeds and their control play a vital role in maintaining vegetable yields and quality and herbicides are a highly efficient method of managing weeds. However, improper or inappropriate use of herbicides may have adverse effects on human health and the environment. Even though their use is subject to stringent regulation in the UK, the EC

Regulation No. 1107/2009, the Water Framework Directive (2000/60/EC) and the Sustainable Use Directive (2009/128/EC) are leading to the loss of herbicide actives and make it more difficult for new compounds to gain approval. This predicament is worse for field vegetable growers because of their reliance on a limited range of herbicides (first released in 1960s and 1970s) which require a lot of funding and effort in order to keep them in the market.

This project represents a paradigm shift to post-emergence weed control in field vegetables. Some use of chemicals is retained, but it explores an engineering solution rather than chemistry and genetics (e.g. herbicide-tolerant crops). Moreover, the concept is plant-specific, with no direct herbicide applications to the crop or the soil. The concept is to apply single droplets of a non-selective, systemic herbicide to the individual leaves of unwanted plants (i.e. weeds). The approach is the state of the art in precision agriculture. Overall objectives are to:

- minimize herbicide inputs and meet demand for more sustainable crop production, providing an efficient and effective means of controlling weeds in vegetables where few post-emergence herbicide options are allowed or available;
- eliminate herbicide drift and reduce run-off to the soil, crop and non-target organisms; and
- provide an engineering alternative to herbicide tolerant crops (whether by conventional plant breeding or by genetic modification).

Plant specific weeding by hand is what growers have traditionally done. Individual plants are examined and if unwanted are hoed or removed. Even were the labour available and willing to hand-weed crops, the process is unlikely to be cost-effective and the task is dull, difficult, dirty and perhaps even dangerous (the four “Ds” of robotics).

The proposed system also offers advantages over mechanical intra- and inter-row tillage systems. Energy and fuel use will be much lower and the absence of soil disturbance means fewer weed seeds will be stimulated to germinate.

The project therefore explores the possibility of achieving leaf-specific weed control using an autonomous platform. If successful, the project will demonstrate a pre-commercial system as an alternative to other systems that approximate to plant specific weed control using directed sprays, lasers or electrocution. The former is currently available and the latter two are the subject of research. Each method has advantages and disadvantages, which are not discussed here. A detailed comparison of the directed spraying option with eyeSpot is available on request, but perhaps the essence of the difference is that the former targets large individual weeds such as potato volunteers, whereas eyeSpot will target weed seedlings of field vegetable crops soon after they emerge.

Summary

Precision targeting of glyphosate droplets to leaves of weeds is a leading edge procedure. The droplets are very small (1-2 microlitres) – so that one teaspoonful (5 ml) is enough to treat 2500-5000 individual weeds if one droplet is put on each weed. A distinctive fature is that discrete droplets are emitted. The droplets are much larger than those used when spraying so that there is no risk of spray drift but there is still the potential for spattering on impact and some shattering of droplets on ejection from an applicator and the droplets are likely to be deflected by wind. So in 2017/18, trials were carried out in the USA to assess the impact of applicator pressure and distance from target on spattering. The effect of wind on deflection of droplets was also investigated in a multifactorial experiment comprising windspeed and direction, applicator pressure and distance from target as factors. Provided windspeed and direction are known, deflection could be modelled and compensated for. Applicator pressure of 20 psi avoided all spattering in our tests.

To avoid risks of resistance and to provide an alternative, we have also tested glufosinate ammonium this year. This active ingredient has limited systemic action and so is less suitable than glyphosate for droplet application, but it appeared to achieve reasonable efficacy. Trials in 2018 will explore combining both actives with 2,4-D.

Doses applied in every case are linked approximately to the ground cover of the weeds. There is a potential issue as regards approval, for although the amount of product applied to each square metre of field will always be less than the permitted dose, the same would not be true for every square millimetre. There are of course one million mm^2 in each square metre and the current approvals rules do not take account of more focussed targeting.

In this year's field trials with cabbages and leeks, respectively, herbicide inputs per unit land area with droplets reduced herbicide inputs by 98% and 74% compared to a

pendimethalin pre-emergence spray. Efficacy of weed control and crop yields were not significantly lower than the hand-weeded (“weed-free”) control.

Financial Benefits

Detailed analysis is planned for 2018/19 when all experimental results are available.

Action Points

As the research is not intended to produce a commercial product, no immediate action is needed. Growers are, however, encouraged to indicate their willingness to adopt an autonomous system.