Field vegetables: Mechanical weed control in transplanted cabbages

Mechanical weed control methods may replace herbicide use in transplanted white cabbage and Brussels sprouts

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OBJECTIVES

New intelligent weeding robots are now available for mechanical control of intra-row weeds growing in the crop line of transplanted field vegetables. These machines are new options in transplanted cabbage in addition to current mechanical tools working without intelligence. The purpose of the work was to study the weeding effectiveness of mechanical weed devices with and without intelligence in transplanted white cabbage and Brussels sprouts.

APPROACH (EXPERIMENTS, ASSESSMENT TOOLS, …)

White cabbage – on-station experiments in Denmark

Two field experiments, one in 2012 and one in 2013, were conducted with intelligent and non-intelligent mechanical intra-row weeding in transplanted white cabbage. A herbicide treatment and a reference treatment consisting of pure manual weeding were included for comparison with mechanical treatments. The intelligent weeding device was the Danish Robovator *weeder (www.visionweeding.com) that uses cameras for the detection of individual crop plants. This information is used to guide a mechanical weeding device so as to avoid crop injuries. The non-intelligent tools were finger weeding and weed harrowing.*

Brussels sprouts – on(experimental) farm tests in the Netherlands

Three field experiments were conducted with intra-row weeding in transplanted white cabbage and Brussels Sprouts (2012 – 2014). These experiments were done on trial farms where a lot of people are visiting the trials. In the trials herbicides were compared with mechanical treatments. In 2012 the Steeketee IC Cultivator was used (using cameras). In the other years the Radis 2.0 (using a light sensor) was used.

PESTS

A very common assembly of annual weed species occurred in the Danish field experiments, notably Chenopodium album, Tripleurospermum inodorum, Solanum nigrum, Capsella bursa-pastoris *and* Poa annua.

A very common assembly of annual weed species occurred in the Netherlands field experiments, notably Chenopodium album, Senecia vulgaris, Capsella bursa-pastoris *and* Stellaria media.

C. album T. inodorum S. nigrum C. bursa-pastoris

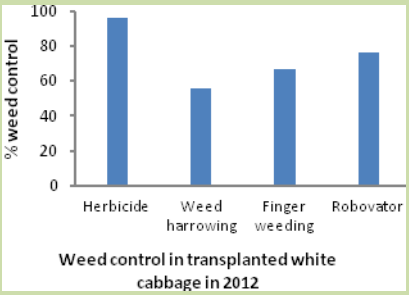

S. vulgaris


S. media

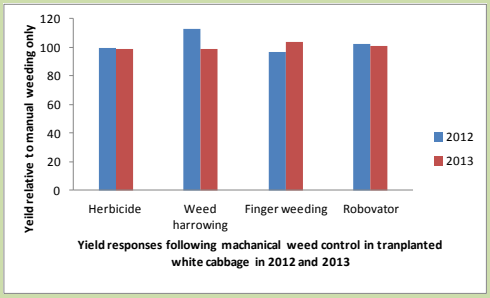
TECHNICAL RESULTS

White cabbage - the Danish results

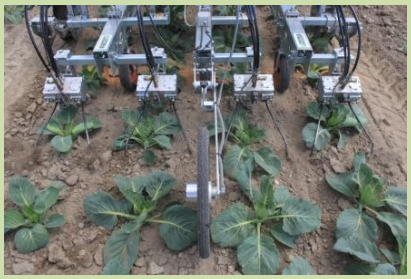
The intelligent weeder controlled slightly more weeds than the tools without intelligence in the 2012-experiment and the effectiveness of Robovator *was almost similar to the herbicide treatment. Unfortunately, there were not enough weeds to estimate the weed control effects in 2013. Either of the implements studied or the herbicide treatment caused any noteworthy injuries on the crop.*



Weed control in transplanted white cabbage in 2012



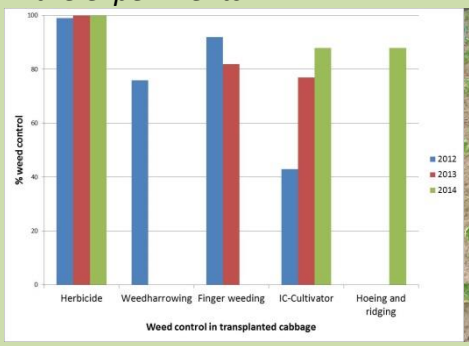
Yield responses following machanical weed control in tranplanted white cabbage in 2012 and 2013



Robovator, left and right

Brussels sprouts – the Dutch results

Weed control level with the IC-Cultivator was at the same level as the non-intelligent mechanical weeding tools, except for 2012, when IC-Cultivator implementation was untimely. No yield effects were found in the experiments.



Weed control in transplanted cabbage

Radis 2.0

SUSTAINABILITY OF IPM SOLUTIONS

DEXIPM-analyses for Danish cropping systems with white cabbage

*Danish cropping systems with white cabbage have 80% cereals in the crop sequence for the prevention of clubroot infestations. From a farmer perspective the **social sustainability** increases from low in current systems to intermediate in more advanced systems with the inclusion of mechanical weed control. A lower health risk due to reduced pesticide use is the main cause. **Environmental sustainability** comprises the three equally weighted attributes: resource use, environmental quality and biodiversity. The environmental sustainability increases from very low in the current system to medium in advanced systems. The use of resources improves for example by the progress in energy use caused by the reduction of pesticides. Herbicide reduction also lead to various improvements concerning biodiversity. Environmental quality improves greatly for the advanced systems. This factor is composed of the quality of water, soil and air. For example leaching of pesticide residues is less with the substitution of herbicides with mechanical tactics. The **economic sustainability** decreases from high in the current system to medium in cropping system with less reliance on pesticides. The extensive use of mechanical tactics is more prone to control failures. Economic sustainability is mainly judged on profitability (short-term sustainability) and economical viability (long-term sustainability).*

DEXIPM-analyses for Dutch cropping systems with Brussels sprouts or white cabbage

*Mechanical weed control technically is very well possible in cabbage, with conventional equipment. Intelligent intra row weeding is not particularly needed for a good result, which means such equipment is not cost-effective for cabbage growers. Hoeing with an in-row measure like finger weeders or ridging will do the job. The increased machine cost influences the **economic sustainability** of the innovative system compared with the other systems. The advanced system already has a higher labour demand, thus cost, compared with the conventional system with herbicide application. Labour demand is an important factor as farm size increases, and therefore the perceived weather risk of non-chemical measures. In general the weed control measures taken have no or limited influence on **environmental** and **social sustainability**. The increase between the advanced and innovative system can be mostly attributed to widening the crop rotation, with 50% instead of 33% cereals.*

Table 1. Results of DEXiPM calculations experiments. Comparison of conventional (CON), advanced (ADV), and innovative (INN) weed control (VL = very low, L = low, M = medium, H = high, VH = very high).

Country	System	Sustainability			
		Economic	Environmental	Social	***Overall***
The	CON	H	M	M	***M***

Netherlands					
	ADV	M	M	M	***M***
	INN	L	H	H	***M***
Denmark	CON	H	VL	L	
	ADV	M	M	H	
	INN				

INNOVATIVE METHODS"	*The two robotic weeders used in Denmark and the Netherlands have been developed from much of the expertise assembled in WP11 'Emerging technologies'. However, there have not been direct interactions between the manufactures of the robotic weeders and WP11 during the project period.*
LIMITS AND CONDITIONS OF SUCCESS, ADAPTATIONS	*Transplants of white cabbage need to be of a good quality for intelligent weeding to work properly. The stems of cabbage transplants are often bended which means that the hoe blades of the robotic weeder need to keep a safe distance from the stems, implying a less than optimal usage of the equipment. The size of this untreated zone in close proximity to the transplants determines the demand for manual weeding of residual weeds. It is essential to minimize that zone to lower the overall costs for weed control. The purchase costs for intelligent weeders are still high and need to be reduced in the future. The non-intelligent mechanical weeders can be useful but training and guidance are still required for successful employment.*
REFERENCES	*Melander B., Lattanzi B. & Pannacci E. (2015). Intelligent versus non-intelligent mechanical intra row weed control in transplanted onion and cabbage. Crop Protection (in press).* *Pure booklet 2013 – Field vegetables* *http://www.pure-ipm.eu/node/291*