Emerging technologies for physical weed control in row crops in Europe

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European research on physical weed control methods has largely been driven by concerns about pesticide usage in conjunction with an increasing conversion to organic farming. This paper reviews the major results with mechanical and thermal weed control in row crops (e.g. corn, sugar beet, onion, and carrot) and highlights examples of emerging technologies for improving physical weed control in row crops. Row crops present two different situations for direct physical weed control of entirely different difficulty. Interrow weeds can be removed by ordinary interrow cultivation relatively easily, now with automated guidance systems to ease the steering task. In contrast, intra-row weeds, *i.e.* those growing between the crop plants in the rows, constitute a major challenge, especially those growing in the close-to-crop area. Research has mainly aimed at replacing laborious intrarow hand weeding with mechanization, and some mechanical and thermal methods have been successful in transplanted vegetables. But apart form that, these methods generally work with low selectivity, as they do not distinguish between weed and crop plants. Therefore, the major obstacle for the development of selective and accurate intrarow weeding is the lack of automated and reliable detection and classification of crop and weeds. Some researchers are looking at systems for active shape modeling of weed seedlings to distinguish them electronically from crop plants. Others have looked on vision based perception systems to discriminate between crop and weed plants using images from real situations in the field. Attempts are made to use electronic crop seed mapping to assist subsequent computer vision for identification of crop and weed seedlings. Intelligent intrarow weeding systems appear mainly to become operational in row crops with abundant spacing between individual plants, whereas another technology based on soil steaming prior to crop establishment seems more promising for row crops developing dense crop stands in the row. The European work on physical weed control is discussed and disseminated through the working group: *Physical and Cultural Weed Control* (www.ewrs.org/pwc) under the *European Weed Research Society.*
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