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APPLICATION OF PRECISION FLAMING TO MAIZE AND GARLIC IN THE RHEA PROJECT

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Abstract Flame weeding is actually a well known and used physical treatment according to the increase in concerns about the effects of herbicides on human health and the environment and in the light of the new European laws. Flaming historically, was used at first as a pre-emergence treatment, both prior to planting and before crop emergence. Alternatively, flaming can be used also selectively after crop emergence or planting in tolerant species. Although inter-row weeds can be effectively controlled through mechanical cultivation, weeds that grow in the row are more difficult to control as, in some cases, cultivation is both ineffective and causes unacceptable levels of crop damage. This work aims to describe the specific machine for mechanical-thermal weed control which is being realized by the University of Pisa within the RHEA project. This machine is able to perform mechanical and thermal treatments at the same time in order to remove weeds mechanically from the inter-row space and perform in-row selective and precision flaming. The project is still on-going and the machine has not been fully realized and tested yet, thus no data is available at the moment.

1. Introduction

Flame weeding is actually a well known and used physical treatment according to the increase in concerns about the effects of herbicides on human health and the environment. Controlling weeds without the use of chemical herbicides can be problematic, and was cited as a crucial aspect involved in the transition from conventional to organic crop production (Walz, 1999). The aim of flaming is heating tissues of weeds rather than completely burning them (Leroux et al., 2001; Ulloa et al., 2011). The heat from the flame causes rupturing of the cell walls, which leads to water loss and plant death (Parish, 1990). An exposure time between 0,065 - 0,130 second at a temperature level of 800 - 900 °C in some cases could be sufficient to devitalize a weed (Thomas , 1964; Kang 2001). A large number of studies investigated the responsiveness of weeds to flaming. This factor seem to be related to the morphological characteristic of the plants, their development stage and to the amount of LPG (used to feed the burner) per unit surface (Ascard, 1995; Sivesind et al., 2009; Ulloa et al., 2010). Flaming historically, was used at first as a pre-emergence treatment, both prior to planting and before crop emergence. Alternatively, flaming can be used also selectively after crop emergence or planting in tolerant species (Sivesind et al., 2012). Although inter-row weeds can be effectively controlled through mechanical cultivation, weeds that grow in the row are more difficult to control as, in some cases, cultivation is both ineffective and causes unacceptable levels of crop damage (Melander and Rasmussen, 2001).

Moreover, the new European directives are firmly encouraging a sustainable use of pesticides as “the implementation of the principles of integrated pest management is obligatory… with priority given wherever possible to non-chemical methods of plant protection and pest and crop management (Directive 2009/128/EC)”.

This work aims to describe the specific machine for mechanical-thermal weed control which is being realized by the University of Pisa within the RHEA project. This machine is being designed in order to carry out physical treatments in maize and garlic, which are heat tolerant crops.

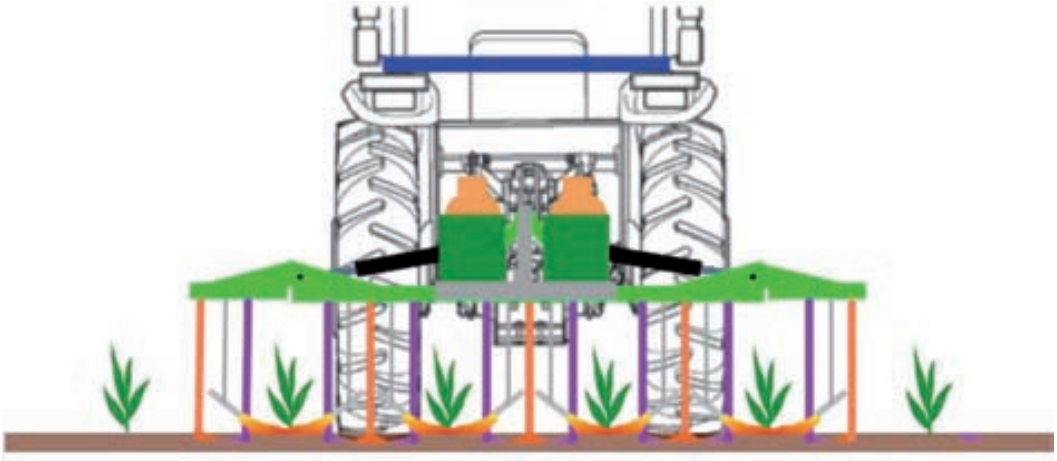
2. MATERIALS AND METHODS

The European Project RHEA (Robot fleets for Highly Effective Agriculture and forestry management) aims to create a fleet of autonomous aerial and ground mobile units for general crop protection including the application of physical weed control in maize and garlic.

This machine is able to perform mechanical and thermal treatments at the same time in order to remove weeds mechanically from the inter-row space and perform in-row selective and precision flaming. The precision of the treatment will be enhanced by a guidance system associated with a row and a weed detection system. Mechanical treatments will be always realized, ever without weed presence, as hoeing is very important from an agronomical point of view. On the contrary, flaming will be provided only if weeds have been detected in the row. Thermal treatment will be performed by means of a pair of burners per row. The pressure of the LPG, will be adjusted according to the weed cover: 0 Mpa if weed cover is equal to 0, 0.3 MPa and 0.4 MPa, according to a threshold of 25% of weed cover (Peruzzi et al., 2012).

The working width of the machine for mechanical and thermal treatments is 3 m. This covers four rows and three entire inter-row spaces of 0.75 m each and 2 half inter-row spaces of 0.375 m each. Each of the four units tills the soil between the rows using one goose-foot rigid central tine and two “L” shaped adjustable rigid side sweeps at a very shallow depth (0.03-0.05 m). Two burners per element are placed in order to hit one side of each crop row. The flame just hits the weeds growing in the “in-row” space and the lower, heat-tolerant part of the crop plants (Peruzzi et al., 2012).

a)



b)

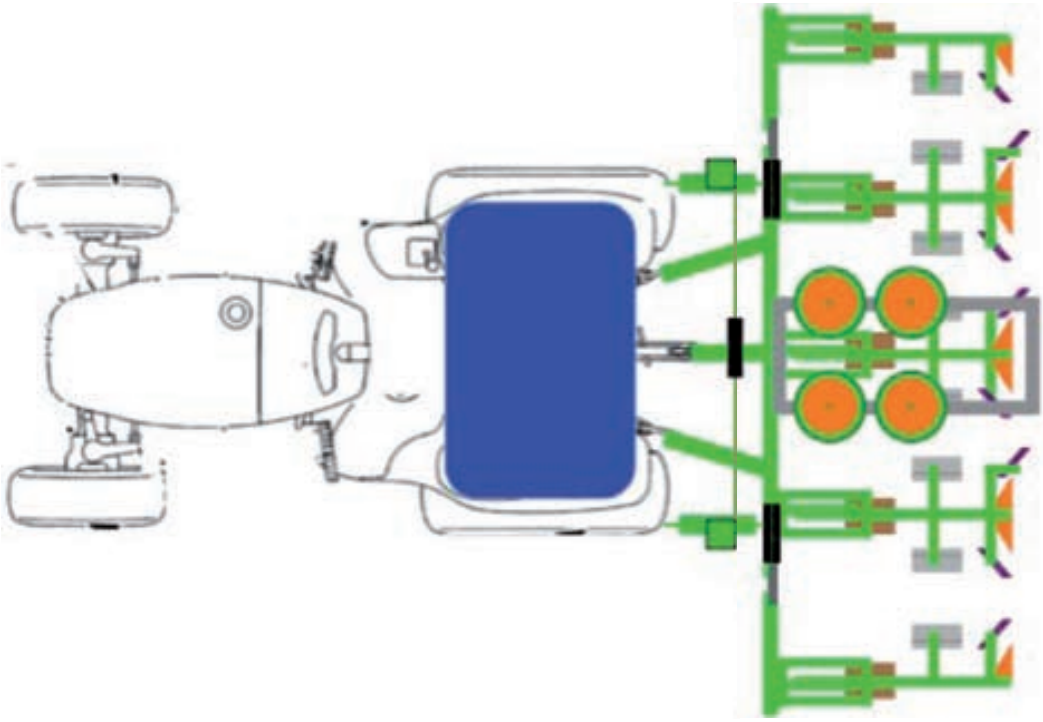


Fig. 1. Schemes of the machine for mechanical thermal weed control: side (a) and top (b) view.

3. Results/Conclusions

This very innovative application of PWC in maize represents a good opportunity for farmers in terms of reducing the use of herbicides and ensuring that their crops are of a higher quality.

Fig. 2. Pictures of the very first prototype of the machine for precision weed control.

The project is still on-going and the machine has not been completed and tested yet, thus no data is available at the moment. However, a first integration of the operative machine with the RHEA GMU was performed in 2012 (Fig.2).

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