Development of a Crop Adapted Spray Application (CASA) sprayer for orchards

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Introduction

In the EU-FP6 ISAFRUIT project a Crop Adapted Spray Application system (CASA) for precision crop protection was developed (Doruchowski *et al*., 2009). The system ensures efficient and safe spray application in orchards according to actual needs and with respect to the environment. The developed CASA system consist of three sub-systems: Crop Health Sensor (CHS) - identifying the health status of fruit crops to apply chemicals only when necessary; Crop Identification System (CIS) - identifying the tree canopy size and density to apply spray precisely at relevant doses; Environmentally Dependent Application Systems (EDAS) - identifying environmental circumstances and navigating the sprayer to adjust application parameters accordingly so that spray drift is minimised and direct water contamination is avoided.

Sprayer development

The CIS and EDAS subsystems were finished and tested by 2008 and CHS by 2010. In 2009 CIS and EDAS were integrated on the CASA prototype sprayer.

Crop Health Sensor – CHS
To develop the CHS, spectral analysis has been used, based on the developments in crop sensing techniques for grassland and arable crop production (Schut, 2003). Crop health status, with as an example the infection of apple scab (*Venturia inequalis*) on apple leaves, has been evaluated. Assessment of leaves of the apple cultivars Elstar, Jonagold, Autento, Wellant and Rubens on the spectral reflectance showed that the apple varieties could be discriminated from each other based on spectral reflectance. Healthy parts of the leaves can be distinguished from diseased parts of the leaves on the mm^2 level. The infected leaves were discriminated with an estimation of NDVI (Normalized Difference Vegetation Index) based on identified reflectance wavelength groups. Powdery mildew and apple scab reduced the values of NDVI detectably. Detection of diseases on leaves with the CHS can be done several hours after infection, i.e. 10-12 days before manual visual detection. The CHS algorithm using a neural network analysis was developed in 2009 and the first CHS prototype software based on 3 discriminating wavelengths was developed in 2010. In 2010 the software was tested and showed more than 90% accuracy in discriminating healthy and apple scab infected leaves. The sensor-in the-box is still under development as the detected discriminating wavelengths need specific electronics and optical hardware to be designed, developed, and manufactured. Implementation of the CHS on the CASA sprayer could therefore not be realised.
The early detection of apple scab using spectral reflectance on the leaf opens new ways to develop a Crop Health Sensor (CHS) to be used for apple scab detection in the orchard and adapt the crop protection strategy as well. To translate the mm^2 information to an evaluation directly in the orchard at the leaf and tree level is still a big step to be made.

Crop Identification System – CIS

In order to enable an orchard sprayer to automatically adjust nozzles flow rate and spray vertical pattern according to the presence and to the characteristics of canopy target (size and density), ultrasonic sensors and software were developed. The sensor can acquire information on (a) distance between vegetation and sensor, (b) vegetation density. The results from field tests showed that with the CIS system a satisfactory control of diseases and pests was maintained at PPP dose rates reduced by nearly 50%. Thus the precision spray application with the CIS target identification system enables a drastical reduction of chemical input in fruit growing. For the integration of the CIS on the CASA sprayer it was configured to communicate with the EDAS sub-system according to ISOCANBUS protocol.

Environmentally Dependent Application System – EDAS

The EDAS sub-system was developed to reduce spray loss and minimize risk of environmental pollution and hence to enhance the consumers' perception and social acceptance of plant protection in fruit growing. In 2006-2009 the various elements of this innovative system were developed and tested in the field. EDAS features automatic alteration of spray quality and automatically adjustable airflow, independently on the left and right side of orchard sprayer, depending on wind velocity and direction measured with ultrasonic sensor and sprayer position in relation to the edge of orchard and sensitive areas (e.g. water bodies, wells, sensitive crops, public sites) identified by DGPS system. The spray quality is adjusted by selecting the nozzles (fine spray/coarse spray) in order to minimise the spray drift, or by shutting off the appropriate nozzles to respect the local standards for buffer zones. The supporting air jet is adjusted individually for the left and right side of the sprayer by manipulation of airflow on the inlet and outlet of the fan of innovative design and construction (European Patent application). A control unit and software were developed to control both spray emission and air discharge systems in various situations, and to integrate them with GPS and with CIS sub-system on CASA sprayer. The field tests made in 2008 and 2009 showed that during the spray application in orchards automatically set combination of coarse spray on the last two rows of trees and one-sided air flow application on those rows gave over 80% drift reduction compared to standard application (fine spray nozzles and two-sided airflow application all over the orchard) without significant decrease of in-canopy deposition on the edge rows.

Demonstrations

The sprayer performance was demonstrated at 8 locations in Europe (Denmark, Italy, the Netherlands, Germany, France, Poland and Spain) with the aim to present the advantages of the crop adapted application technique to advisers, press, extension services, sprayer manufacturers and fruit growers.

References

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