Hans-R. Langner, Potsdam-Bornim

Site-specific Application of Fungicides and Herbicides

It is evident through many practical tests in the past years that the site-specific application of herbicides and fungicides can have ecological and also economical advantages. The prerequisites for the economical success are the availability of necessary sensors and application technology and the limited amount of investment costs. This article summarizes the development state of the necessary sensor technology and application equipment.

Dr.-Ing. Hans-R. Langner) is scientific member in the Department Plant Production of the Institute of Agricultural Engineering Bornim (ATB), Max-Eyth-Allee 100, 14469 Potsdam (director: Prof. Dr.-Ing. J. Zaske), e-mail: hlangner@atb-potsdam.de

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The application of fungicides is usually carried out site uniformly accordingly to plant protection recommendations. The direct registration of canopy illness before fungicide applications is a hard task, which is not to realise today. That is why today the site-specific application of fungicides is limited to site-related measurements of effect relevant parameters like the leaf area. An appropriate sensor grasps the leaf area or the biomass and the amount of fungicide is adjusted to that value.

Sensor Technology

At ATB Potsdam a biomass sensor, which is based on the mechanical principle of a pendulum, was developed and is equipped with a LBS job computer for real-time control of field sprayers. It was discovered in numerous investigations with this pendulum meter that its measuring value is well correlated with the leaf area index [1]. That is why the pendulum meter is very well suitable for the optimised, site-specific application of fungicides. The sensor was tested over 3 years on a field area of 149 ha and the results are fungicide savings up to 37,5% [2].

The site-specific application of herbicides by real time methods is possible if already sprouted weeds are to defend. The chemicals for that method are post-emergence herbicides. It is possible to detect the weed amounts by real time sensor measurements and to adjust the herbicide dose to the sensed weed amounts. The ATB Potsdam tested the sensor based herbicide application in practice over 3 years and achieved herbicide savings up to 43,4% [3]. Based on a different application method herbicide savings between 33,2% and 83,8% were achieved for six winter wheat fields [4]. A report from the US pointed out herbicide savings up to 87,5% [5].

Requirements for the site-specific application of herbicides are site related data about the real weed amount. The site related data about weeds could be achieved by manual weed counting or by automatic weed valuation with opto-electronical sensors. Suitable sensors are image processing systems with special cameras [6] or photo-optical sensors with lower costs [7]. The technical demands for an automatically real-time weed valuation are very high. As the herbicide application has to take place very soon, the germinated weeds are very small in size: around 1 mm^2 . The task is to detect the small objects by driving speeds of 10 kph (or more), which means that the measure and exposure time for the sensors are very small. Furthermore the observation conditions change due to fluctuations of the driving machine. The illumination conditions change due to the sun movement and the clouds. From the point of view of the measuring problem, the weed detection can be summarised as follows: very small objects are detectable under changing observation and illumination conditions. A significant parameter for the control of a field sprayer has to be derived from the multitude of pixels.

In the context of a BMBF-Verbundprojekt[1]) the ATB Potsdam, the Company Symacon, Magdeburg, and the University of Applied Science Osnabrück investigated camera solutions and photo-optical solutions for the weed detection problem. The investigations show that simple colour and spectral sensors are not suitable for the detection of weeds under real-time conditions. The spectral resolution is not adequate, e.g. available colour sensors have not the necessarily filter combinations [8]. Colour sensors from the company MAZeT in Jena, Germany, use the 3 spectral ranges 400 to 510nm (blue), 490 to 610nm (green), 590 to 750nm (red) [9], but that is not adequate to achieve canopy detection with high contrast and high resolution.

An automatic weed valuation in real-time is possible with modern image processing systems. Cameras with special filters are the prerequisite to achieve picture with high contrast from the weed scenes. The pictures can than be computed to binary pictures with the help of suitable calibration data. *Figure 1* shows a binary picture, which was taken with the weed detection camera of ATB Potsdam [10]. In the binary picture the ground is

1) Project ProSensoNet, sponsored by the German Ministry for Education and Research

mapped to the colour black and the weeds are mapped to the colour white. The decision level between ground (black) and weeds (white) is adapted to the changing observation conditions. The company Symacon Magdeburg developed a PC-based image processing software for the BMBF-project that meets all requirements and extracts the necessary parameters from the binary pictures. Some of these parameters are the number of weeds per size class and the soil-covering rate. The soil-covering rate is processed as the control parameter for an Amazone/BBG field sprayer.

Currently the main problems are the costs of a modern image processing system and the fact that available systems are not designed for the daily use in agriculture. The goal for the next years is the design of rugged and robust weed cameras for agriculture. This new cameras should have an internal image processing and should transfer the computed parameters directly to the application equipment. The development of such cameras will lower the sensor costs and will lead to lower investments for the transition from conventional farming to site-specific cultivation.

Application equipment

Field sprayers for the site-specific application of fungicides and herbicides need to have a wide range of dosage of the chemicals. Additionally to the compensation of different driving speeds there is the need to adjust the chemicals to the actual sensor value. A technical solution for this problem is the system VARIOSELECT of the company Lechler [11]. The system VARIOSELECT consists of up to 4 nozzles on one carrier and it is possible to switch on every combination of the 4 nozzles. Because of that the range to dose the chemicals is much wider then in systems with only one nozzle. The Amazone/BBG field sprayer of the ATB Potsdam is optimised for the range 50l/ha to 500l/ha and uses the injection nozzles in the combination 01, 015, 02, 04 [12]. The injection nozzle combination 015, 02, 03, 05 is for chemical doses up to 650l/ha.

Field sprayers for the site-specific cultivation have to follow the value from the sensor equipment adequately fast, so good control behaviour is necessary. The control behaviour of a field sprayer is determined by the amount of circulating chemicals and the capacity of the driving pump. The use of VARIOSELECT gives the opportunity to enhance the control response because of its fast switching capability between different nozzles or nozzle combinations. Another ecological advantage of VARIOSELECT in sprayer applications nearby rivers and lakes is the easy transition to a BBA approved nozzle type with low drift off.

The use of site-specific application technology in practice opens up new perspectives that high amounts of chemicals will be saved by extensive use of this new techno logy.

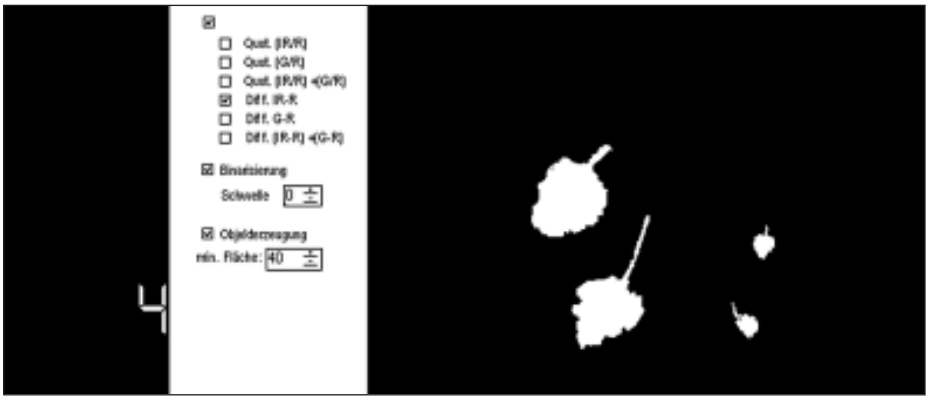

Fig.1: Determination of weed count and weed size class from the binary image (right) of a weed scene

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