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Economic viability of site-specific herbicide application

Through the use of site-specific plant protection, average costs can be reduced by a further 20 to 30 DM/ha in comparison with generally optimised overall treatment of a field. A requirement for achieving a financial advantage here is the application of an economical weed cover assessment system. From this it follows that only systems featuring sensor techniques offer economical-supportable solutions to weed assessment and site-specific plant protection.

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The appearance of weed patches in certain areas is linked principally to the properties of the soil and the weed seed banks present [1]. Years of arable cultivations have encouraged the existence of weed communities with a less incidence of the major economic weeds. These possess the ability to adjust well to the specific conditions of their surroundings . Despite this, the spread of weeds on arable fields is distinguished by great heterogeneity. The area spread and intensity of their presence is mainly dependent on cultivation practices, or on past cultivation mistakes. Site-specific weed control is based on the optimisation of herbicide utilisation in that the amount used is matched to the weed presence in each area.

Site-specific plant protection

Because of the area-specific heterogeneity it can be practical to treat a field with different amounts of herbicide. An important requirement for site-specific treatment comprises weed population assessment and a realistic estimate as to the yield loss to be expected as a result of the weed infestation. The accuracy of the estimation depends on the number of samples, the area they cover and the distance between them.

In the work recorded here, the weed assessments were carried out in spring.

This took place via a DGPS-measured screen covering 36 • 50 m (0.18 ha) on large fields of winter wheat and maize. The 36 m represented the working width of the farm's usual spraying tackle and the 50 m took account of the control period of the sprayer. The counting of the weeds according to variety and number has to take place, for example, in sampling areas of 0.5 m^2.

The time involved in the assessments represented, according to the weed density, between 0.45 and 2.5 man hours/ha. From the results, and with the help of geostatistical analyses, maps were calculated to show the dispersion of the weeds and the loss in yield [2] (*fig. 1*).

The yield loss served as a standard in the establishment of application stages. With up to 100 kg yield loss per ha, 50% of the conventional herbicide dose was applied. Where the loss was over 100 kg to 300 kg per ha, 75% of the usual amount was used and, with over 300 kg yield loss per ha, the recommended herbicide application was applied. Applying no herbicide at all on areas of the field with reduced weed infestation was, under the given trial conditions, not feasible because of the low plant population of the grain crop.

Varying application amounts between 100 and 200 l/ha is possible with conventional spraying equipment through adjusting pressure settings. The correlation of applications with weed map information and positioning on the field was possible with a chip card compatible on-board PC and DGPS.

Economy considerations

The yield loss prevented by herbicide application can be described as an economical gain from a herbicide application. The amount of the potential yield loss is dependant on the weed variatal mix and area dispersion. Economic effects of site-specific spraying occur mostly through the threshold-based optimising of herbicide applications and the exploiting of substance-dependant effect spectrums [3,4]. The optimising of site-specific weed control is also affected by further factors.

On the basis of an overall treatment, the costs of a herbicide application in winter wheat can be very variable up to a maximum of around 120 DM/ha. The choice of the herbicides which can be used, or the combination of active ingredients, is dependent of the actual mix of weed varieties. According to this, different field-related material costs can arise. In association with the material costs, the limits for the determination of application stages also alter.

The site-specific evaluation of the expected yield loss of the area presented in *fig. 1* shows that a herbicide treatment with full recommended dose only pays on a few of the field areas. Following calculations with a variety of materials, the yield loss in monetary terms for the greater majority of the field areas (77 to 95%), lay substantially under costs of input material. Decisive for treatment is the decision as to which, from the

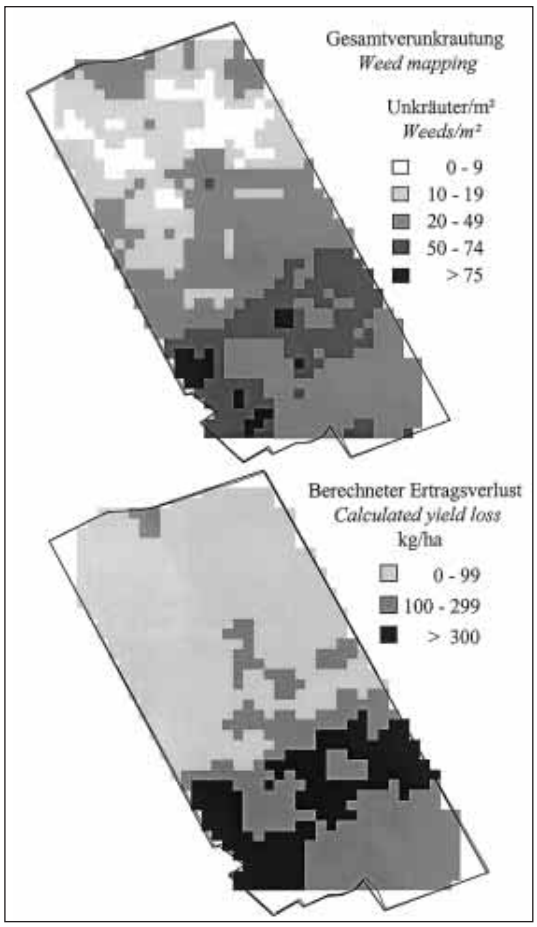

Fig. 1: Total weed infestation (above) and calculated yield loss (below) in a field of winter wheat, Landwirtschaft Golzow

economic point of view, damage threshold of residual weed population can be tolerated. On the other hand, from the crop production side it must be estimated to what extent the crop stand itself is able to depress the weed population beneath the damage threshold.

Further investigations show that with site-specific applications according to botanical-based yield loss thresholds in winter wheat and maize under alluvial site growing conditions in comparison to whole-field treatments , material savings of up to 25% are possible (*fig. 2*). The advantage of the site-specific application is subject to strong procedure-dependant and seasonal variations. The results prove that the advantageous effect of the site-specific spraying comes rather from material cost savings than from the differences in the of the field-specific weed populations.

Cost estimations

For estimation of the costs involved, an economic evaluation has to be applied to the site-specific herbicide application.

The cost saving potential for the herbicide itself lies between around 25 to 30 DM/ha. From these savings , the necessary investments in the technology and the costs of the weed sampling have to be taken account of to give a true picture of the economics. The above-described sampling process used in the trials with a labour demand of from 0.45 to 2.5 man-hours /ha is not economically viable in practice. In the future, however, there will be technical weed-mapping solutions available for the farmer. One example here is the estimation of vegetation cover on fields through aerial photography. Further possibilities include ground-level sensoric identification of weeds. Every sampling method has advantages and disadvantages – for instance in their reliability. Additionally, the information available from individual sampling methods is different [5].

In further work at the ATB, a sensor has been developed for the detection of weeds in tramlines. This development is based on the principle of the different reflection from the ground and from the green plant parts in the red and infrared area of light. With the associated simple photometer it is possible to determine an integrated signal regarding plant numbers and ground cover percentage.

The system detects the weed in the tramline. A decision is then reached by the sprayer based on the weed intensity. According to this decision, the spray application amount is dosed in real time.

The calculated costs for this type of green-sensor sampling run to around 10 DM/ha [5]. Under current conditions this variant could offer an economical way of weed cover assessment.

Summary

The possibilities for site-specific herbicide application were investigated based on a heterogeneic field-distribution of weeds. Practical experience regarding the economical viability of the procedure indicates achievable cost-saving potential of from around 25 to 30 DM/ha. The savings potential depends on the extent of weed infestation, the herbicides used and the spatial distribution of weed cover.

Comparisons of actual treatment costs and potential yield losses make it clear that, on average, with all treatments over around two-thirds of the respective field, the yield losses prevented were not enough to recompense the herbicide costs.

Weed assessment as part of the site-specific weed control procedure presents a problem that is as yet insufficiently solved There are several possible assessment procedures. First trials with a sensor-based assessment with a photodetector indicate that this method can offer an economical alternative for weed cover sampling.

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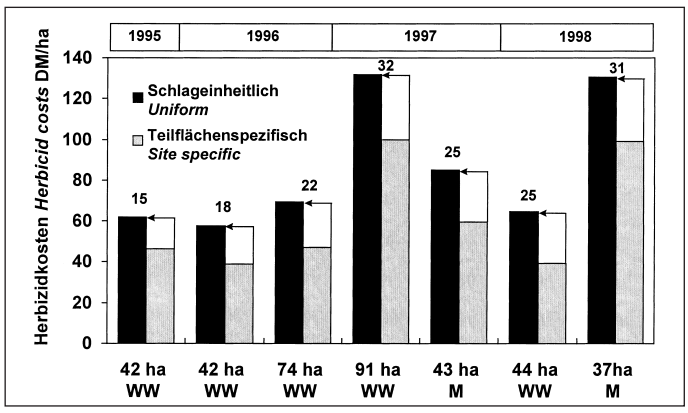

Fig. 2: Savings in herbicide costs through site-specific applications in winter wheat (WW) and grain maize (M) in a comparison over several years