

Crop-Weed interactions determined by sensor techniques (COMSENS)

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Background

It is wellknown that growth dynamics in the early growth stages are important characteristics for the outcome of the competition for light, water and nutrients, resulting in a certain yield loss of the crop due to presence of weeds.

If possible, an early and precise prediction of the growth dynamics of both crop and weeds could give at more precise assessment of the need for weed control. This could lead to a better confidence to point out sites in the field, where weed control can be reduced or even eliminated, if the competitive relationship between crop and weeds is in favour to the crop, and the costs to weed control would be less than the potential yield loss.

Due to that fact, that weed control is done mechanically under organic growing conditions, often by weed harrowing, there are risks for crop damages by soil coverage or other mechanical damages of the crop leaves. These damages are increasing with increasing weed control intensity, and are resulting in reduced crop growth, and possibly the yield too, immediate after weed harrowing. Taking this aspect into consideration, a further motivation to optimize the intensity of the weed control is given.

Several studies of the competition between crop and weeds have shown that the quota of weed leaf area to the total leaf area (crop+weed) gives a more accurate prediction of the yield reduction caused by weeds, than the weed density (plants m⁻²) (Kropff and Spitters 1991; Lotz et al. 1996). In other words; several but small weed plants have approximately the same yield reducing effect as a few but large plants. In relation to use automatic measurements of the competition between crop and weed, i.e. if a site-specific optimization of weed control intensity is wanted, it is obvious to use this relative leaf area model. However, the leaf area is not possible to measure exact automatically, yet. But it is possible to measure soil coverage of crop and weeds automatically, using digital image analysis. The coverage estimation is most accurate in the early growth stages, due to less overlapping leaves and no elongation growth, because the coverage is estimated as the vertical projected area of the plants. Before it is possible to use the existing competition models, which is based on the relative leaf area, it is necessary to determine the correlation between coverage and leaf area.

If there is a robust correlation between coverage and leaf area, (and competitive ability), then it could be possible to optimize weed control site-specifically, to assess damages by weed harrowing or selecting varieties with strong competitive ability, automatically.

Objective

The central aim of the PhD-project, COMSENS, is to provide new knowledge about competition between crop and weeds, aiming at predicting the outcome of the competition (the reduction of the crop yield) with a certainty, which equals the prediction from the relative leaf area model (Kropff & Spitters, 1991; Lotz et al., 1996).

COMSENS is planned to cover following issues:

- to examine if the competition between spring barley and weeds can be described with the relative leaf area model
- to estimate the relation between Leaf Area Index (LAI) and soil coverage
- to model growth in soil coverage of 3-6 spring barley varieties and 8-12 weed species under semi field conditions
- to examine interactions between varietal differences in competitiveness and tolerance to mechanical weed control
- to examine and test if sensor based methods (reflectance measurement and digital image analysis) can improve the estimation of competition between spring barley and weeds, if the methods are used in these growth stages, where weed control usually takes place.

COMSENS is closely linked to the Work Package “Crop-Weed interactions” (WP2) in the DARCOF-project “Characteristics of spring barley varieties for organic farming, BAR-OF”. For instance is the field experiment common for both COMSENS and WP2, and data is shared between the two projects. Further description of the field experiment and the planned measurements can be found in Hansen & Rasmussen, (2003).

References

- Hansen, P.K. & Rasmussen, I.A. (2003) Design og sortvalg i specialforsøg BAROF-WP2 – Ukrudtskonkurrence. Report, Dept. of Crop Protection, Danish Institute of Agricultural Sciences. 7 pp.
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Progress 1.10 2003 31.9 2004

The field experiment in 2004 at Research Centre Flakkebjerg, has been conducted, and all data, except the results from the harvest has been gained.

An informal cooperation has been started with the part of the project ACROSS (Autonomous spatial-temporal crop and soil surveying), which is dealing with outdoor computer vision for assessment of vegetation. At the 7th of June 2004 the autonomous vehicle, called the API-platform, visited the field experiment to collect images with a High Dynamic Range video camera, which is used by PhD-student Kristian Kirk at Aalborg University. The aim of the measurements was to use analyses of the images from the advanced camera to estimate the gap-fractions of the canopy, which is an important parameter in crop competitiveness. The results of the image analysis will be correlated with measurements with the instrument LICOR-2000 Plant Canopy Analyser, which was done on the same date and on at the same sites in the plots.

The SOAR summer school 2003 with the theme “Values, ideologies and organic agriculture” as well as the netbased KVL course on “Mixed Linear Models,” has been passed resulting in 4+5 ETCS points.

PKH participated and gave a presentation of COMSENS at the SOAR-autumn seminar held at Research Centre Flakkebjerg. Further PKH attended the SOAR Spring seminar, which was held at Research Centre Foulum, and enjoyed participating in the short course on retrorics.

In December 2003 PKH gave a lecture in the Weed course on KVL entitled “Præcisionsjordbrug og alternative bekæmpelse”

At Research Centre Flakkebjerg PKH gave a presentation entitled ”Planlægning og registrering i forsøg” to technicians medio March 2004.

PKH gave a lecture about crop-weed competition, and varietal differences in tolerance to mechanical weed control, at a course for organic agricultural advisors (“Økologiske feltdage”) This course was arranged by The Danish Advisory Service, and Danish Institute of Agricultural Sciences, Department of Crop Protection.

Ultimo June PKH attended the first meeting in the newly started COST-Action (COST860-Susvar) (<http://www.cost860.dk>) . The Danish results on the competitive index on spring barley and winter wheat (Hansen, 2003) was offered a great deal of attention from the other participants, as no other countries in EU yet have a system where alle varieties are ranked due to their competitiveness against weeds. The index is estimated from measurements conducted in the Danish observation-plots and some field trials from BAR-OF.

PKH has attended a course on Computer Vision arranged by DANET, at Aalborg University Centre. This course has an extent on 5 ETCS points. The course are split in two parts and the second part are done at the same time as the SOAR Summer school, therefore PKH have decided to wait to attend the SOAR Summer school until 2005.

PKH planned to have a short stay at spring (April-May 2004) with Dr. Roland Gerhards, Bonn University. However due to intense measurements in the field experiment at Research Centre Flakkebjerg at the same time, and the fact that Dr. Roland Gerhards have moved to another university, the stay has been postponed for an unspecified period.

PKH had applied for one-month leave, because he was asked to write a chapter in a new edition of the book entitled “Ukrudtsbekæmpelse i landbruget” published by Danish Institute of Agricultural Sciences, Department of Crop Protection. The leave has been approved by KVL and is running from 13 September until 13 October 2004.

Plans – 1.10 2004 31.9.2005

In 2005, the common field experiment for with COMSENS and WP2 will be conducted using the same design as in 2004.

It is further planned to attend an internet-based theoretical course on multivariate data analysis followed up by a course in applied statistics. Both courses are held at KVL.

Before Christmas 2004 a manuscript about varietal differences in tolerance to mechanical weed control will be submitted to Weed Research.

Before March 2005 a manuscript about the improvement and validation of the index of competitiveness will be submitted to Weed Research.

Finally a manuscript about the correlation between coverage of crop and weeds estimated by image analysis, and yield loss will be submitted Weed Research.

PKH will attend the SOAR autumn seminar that will be held at KVL-Tåstrup, as well as the SOAR summer school in 2005.

In the autumn PKH will give a lecture at the Weed course on KVL.

Publications

- Hansen, Preben Klarskov (2004) [Important values in the PhD-project "Crop-Weed interaction deter-mined by sensor techniques \(COMSENS\)" and the project "Charac-teristics of spring barley varieties for organic farming \(BAR-OF\)".](#) Report, Department for Crop Protection, Danisk institute og Agricultural Sciences.
- Hansen, Preben Klarskov (2003) [Beregning af Konkurrenceindeks \(KI\)](#) [Calculation of competitive index (KI)], in Deneken, Gerhard and Pedersen, Jon Birger, Eds. *Sortsforsøg 2003. Korn bælg-sæd og olieplanter*. Report, page 7. Danmarks JordbrugsForskning og Dansk Landbrugsrådgvning, Landcentret, Planteavl.
- Hansen, Preben Klarskov and Kristensen, Kristian and Rasmussen, Ilse A. (2004) [Forsøgsbeskrivelse af specialforsøg BAR-OF WP2 2004](#). Report, Afdeling for Plantebeskyttelse, Danmarks JordbrugsForskning.
- Hansen, Preben Klarskov and Rasmussen, Ilse A. (2003) [Design og sortsvalg i specialforsøg BAROF-WP2 – Ukrudtskonkurrence](#). Report, Dept. of Crop Protection, Danish Institute of Agricultural Sciences.
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- Olesen, Jørgen E. and Hansen, Preben Klarskov and Berntsen, Jørgen and Christensen, Svend (2004) [Simulation of Above-Ground Suppression of Competing Species and Competition Tolerance in Winter Wheat Varieties](#). *Field Crop Research* 89:263-280.
- Rasmussen, Ilse A. and Østergård, Hanne and Willas, Jakob and Nielsen, Niels Erik and Hansen, Preben Klarskov and Hovmøller, Mogens and Backes, Gunter Rasmussen, Ilse A., Eds. (2004) [Hvad er en god vårbyg til økologisk jordbrug?](#). Report, Dept. of Crop Protection, Danish Institute of Agricultural Sciences.
- Rasmussen, Ilse A. and Melander, Bo and Hansen, Preben Klarskov and Holst, Niels (2004) [Langsigtet balance i ukrudtsbestanden](#) [Long-Term balance in the weed population]. Paper presented at Seminar om planteværn, Landbrugsafgrøder, Januar 2004; Published in *Seminar om Planteværn 2004, Landbrugsafgrøder*, page 12-15. Dansk Landbrugsrådgivning, Landcentret, Planteavl.**

Other products (Oral presentations, public meetings, field days, etc.)

- Hansen, Preben Klarskov** (2003). Crop-weed competition with presentation of BAROF experiments. Presentation at a meeting with Martin Wolfe, Elm Farm Research Centre, UK at Research Centre Flakkebjerg 18.March 2003.
- Hansen, Preben Klarskov** (2003). Præcisionsjordbrug og alternativ ukrudtsbekæmpelse. Lecture at the Weed course at the Royal Veterinary and Agricultural University, 2 December 2003
- Hansen, Preben Klarskov** (2004) Konkurrenceevne overfor ukrudt. De vigtigste parametre, effekt af ukrudtsharvning. Lecture at "Økologiske Feltdage" Research Centre Flakkebjerg, 16.June 2004.
- Hansen, Preben Klarskov** (2004). Langsigtet balance i ukrudtsbestanden. Presentation at a meeting with swedish farmers and advisors at Research Centre Flakkebjerg 9 June 2004.

- Hansen, Preben Klarskov** (2004). Konkurrence mellem afgrøde og ukrudt. Lecture at the course "Ukrudsbibliologi og integreret ukrudtsbekæmpelse," arranged by Landscentret 11 September 2003
- Hansen, Preben Klarskov** (2004). COMSENS. Oral presentation at the SOAR Autumn seminar at Research Centre Flakkebjerg 14 November 2003
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