PRODIVA - Crop diversification and weeds
Report from WP2: Crop mixtures for weed suppression

Title: Weed suppressive ability of crop mixtures

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Note: This report summarizes the preliminary results from a controlled pea/barley crop mixture experiment to assess the weed suppressive ability of crop mixtures, and is based on thesis work performed by Anna Pers-Berglund, in the framework of the PRODIVA project.

Abstract

In order to assess the weed suppressive ability of a pea/barley crop mixture and the component crops in sole cropping, a controlled outdoor experiment was performed at the Swedish University of Agricultural Sciences, Uppsala, Sweden, in the summer of 2015. A substitutive completely randomized experimental design was used with seven treatments and six replicates. The weed species planted in the experiment was *Elytrigia repens* (L.) Desv. ex Nevski. At three occasions leaf area index (LAI) was optically measured using a LAI-2200C Plant Canopy Analyzer. Two destructive harvests were taken in order to assess the biomass of different plant parts from each of the component species. At the first harvest leaf area was measured in order to calibrate the optical LAI data. The results revealed a good correlation between optically obtained LAI and LAI data from the destructive harvest; pea had the highest LAI and the intercrop was intermediate to the component crops in monoculture. Presence of a crop (sole crop or intercrop) significantly diminished the growth of *E. repens* but there were no differences between sole crops and intercrop. Sole cropped pea and barley showed ability to compete against weeds at the first and the second harvest respectively whereas the intercrop showed an ability to compete at both harvests indicating an advantage of the crop mixture in terms of weed suppression.

Keywords: Elytrigia repens (L.) Desv. ex Nevski, intercropping, LAI, LAI-2200C Plant Canopy Analyzer, leaf area index, pea, spring barley, weed, weed tolerance

Introduction

One of the goals of the PRODIVA project is to investigate the effect of crop mixtures on weed suppression in controlled experiments and field trials (http://coreorganicplus.org/research-projects/prodiva/). The objective of the work reported here is to evaluate the impact of a crop mixture on weeds compared to i) pure stands of any of the component crops and ii) to weeds in absence of crops; with a focus on leaf area index and light extinction by the crop/-s. The hypotheses to be tested are:

1) Presence of weeds suppresses crops.

2) The intercrop of pea and barley has a greater weed suppressive ability than their sole crops.

3) A crop's ability to shade is important for weed suppression.

Material and Methods

A substitutive completely randomized experimental design was used with seven treatments and six replicates. Treatments (1 to 7, respectively) consisted of pure weed (*E. repens*), spring barley, peas, spring barley + weed, peas + weed, spring barley + pea, and spring barley + peas +weed, respectively. The box experiment was performed outdoors at the Swedish University of Agricultural Sciences, Uppsala, Sweden, in the summer of 2015. The experiment was sown on 25 May 2015, with a sowing depth of 3 cm and a row spacing of 12 cm. Six rhizome pieces of the weed were planting in each of the weed-containing treatments. At three occasions, 17, 21, and 25 July, Leaf area index (LAI) was optically measured. The instrument used for the experiment was a LAI-2200C Plant Canopy Analyzer which estimates LAI of a canopy by comparing the incident light at 320- 490 nm (blue wavelength) above the canopy with the light at the bottom of the crop stand looking upwards (LI-COR Inc., 2013).

At the end of July, three of the replicates were harvested and subjected to destructive analysis in which leaf area and weight, and above-ground biomass of each of the component species was measured. The weight of the rhizome biomass was also measured. The remaining 21 boxed were subjected to harvest during late August to determine yield and weed biomass.

Analyses of data and construction of graphs (means with error plots) were done by means of the Dell Statistica Software (DELL INC., 2015). LAI calibration was performed by the Nonlinear Estimation Procedure, using an exponential zerointercept model. AWC and RWB were calculated according to Goodman (1960). Other comparisons of treatments and of treatments over time were made by the Factorial ANOVA Procedure (DELL INC., 2015).

Results

Effect of crops and crop mixtures on weeds
Leaf Area Index (LAI) and Specific Leaf Area (SLA) of *E. repens* changed significantly whencrops were present: The LAI of *E. repens* is shown with a significant (*p*-value of 0.006)

difference between treatment 1 where no crop was present and the remaining treatments containing one or two crops and *E. repens*. There were no significant differences between treatments with one or two crops, i.e. treatments 4, 5 and 7. The highest SLA of *E. repens* was found in treatment 5 (pea and *E. repens*) whereas the lowest was found in treatment 4 (barley and *E. repens*). Values from treatment 7 are in between the ones from treatment 4 and 5.

The average proportion of *E. repens* above ground weight over total weight (above/(above + below-ground)) is 0.64 ±0.019 (mean ± SE). Neither harvest time nor treatment had an effect on this proportion. The biomass of *E. repens* (aboveground and rhizomes) decreased when any component crop or intercrop was present. There was also a significant interaction between treatment and time, *p*-value 0.000007, the relative increment of *E. repens* over time being much lower in the treatments containing a crop, compared to the sole weed treatment. No significant differences were found between *E. repens'* biomass in treatments with crops, i.e. 4, 5 and 7. The same pattern of reduced biomass, harvest time x treatment interaction and lack of difference between treatment 4, 5 and 7 is valid for the rhizomes of *E. repens* as well as of production of spikes and seeds.

The ability to compete (AC) according to equation AC = 100 – ((bw/bt)*100) differs between barley, pea and the intercrop: The AC-value in the pure crops was lower than 100 for barley later in the season, while it was lower for pea early in the season. Only the AC of the intercrop was significantly below 100 during the entire season.

Effect of weeds on crop

The effect of *E. repens* on the biomass of sole cropped and intercropped pea and barley was not significant: For barley, pea and for the intercrop, the ability to withstand competition (AWC) calculated using the equation AWC = (Cbw/Cbwf)*100 did not deviate significantly from 100, meaning that none of the crops suffered from weeds. This was likely due to a low weed pressure.

Conclusions

The results from the experiment in this thesis lead to the following conclusions:

1) The presence of one or two crops suppressed the biomass production of the weeds in the experiment.
2) Production of biomass of *E. repens* was suppressed by the presence of one or two crops and therefore the reproduction of the population was diminished.
3) Competition for light was present in the experiment judging from the specific leaf area of *E. repens*: Pea shaded more than barley and their intercrop was intermediate to sole cropped pea and barley.
4) The intercrop of barley and pea had the combined ability to compete (AC) against weeds of both pea and barley and was able to suppress weeds during a longer period than either of the sole cropped component crops.
5) The LAI-2200C gives estimates of the LAI not too far from the real leaf area index measured in a destructive harvest.