

The impact of crop diversification management on weed communities in summer cereals on organic farms in Northern Europe. An introduction to the study

Zum Einfluss von Anbaudiversität auf die Unkrautartengemeinschaften im Sommergetreide ökologisch wirtschaftender Betriebe in Nord-Europa. Eine Einführung in die Untersuchungen

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Abstract

This study is a component of the CORE Organic Plus PRODIVA project, a collaboration between international weed research institutions, which aims to improve utilization of crop diversification for weed management in northern European organic arable cropping systems. The overall goal is to maintain a diversified and manageable weed flora that can support beneficial organisms. The objective of this specific research conducted by the Group Crop Health of the University Rostock is to identify challenges in weed control, to investigate the role of crop diversification management for weed management in the field and to cluster weed species into groups according to susceptibility for crop diversity management. In order to reach this objective a diversity of methods are proposed. Data collection takes place on organic arable farms in five countries (Denmark, Sweden, Finland, Latvia and Germany) over the course of two years (2015-2016). Existing information and literature on weed occurrence and control challenges from all regions are compiled into an Ex-ante database and literature review. A two year on-farm weed survey is carried out in spring-sown cereals and combined with the collection of the field history with a focus on the implementation of crop diversification measures. All data is collected at the University of Rostock for processing and analysing; the weed survey data will be compared with the Ex-ante database and analysed for interactions with the crop diversification measures. Results will both be communicated towards the stakeholders, as well as serve for scientific publications.

Keywords: Crop diversity, farmer's participation, field surveys, spring cereals, weed control, weed diversity

Zusammenfassung

Wir stellen eine Studie im Rahmen einer Projektzusammenarbeit zwischen internationalen Unkrautforschungsgruppen in CORE Organic Plus, einer europäischen Forschungsinitiative (ERA-net), vor, Acronym PRODIVA. Das Projekt zielt darauf ab, die Nutzung von Maßnahmen der Kulturvielfalt in Anbausystemen des Ökologischen Landbaus in Nordeuropa zu verbessern. Übergeordnetes Ziel ist es eine diverse, agronomisch handhabbare Unkrautflora zu erhalten, die auch nützlichen Organismen dient.

Das spezifische Arbeitspaket der Arbeitsgruppe Phytomedizin an der Universität Rostock beinhaltet: Herausforderungen für die Unkrautbekämpfung zu identifizieren, die Rolle von Kulturartenvielfalt für die Unkrautkontrolle zu erfassen und Unkrautarten nach ihrer Empfindlichkeit für Kulturartenvielfalt zu gruppieren. Verschiedene Methoden ermöglichen es, diese Ziele zu erreichen. In fünf Ländern (Dänemark, Schweden, Finnland, Lettland und Deutschland) werden Daten von ökologisch wirtschaftenden Betrieben in zwei Jahren erhoben (2015-2016). Vorhandene Informationen und Literatur zu Unkrautauftreten und Problemen in der Unkrautbekämpfung aus allen beteiligten Regionen werden in einer ex-ante Datensammlung und einer Literaturübersicht zusammengeführt. Über zwei Jahre werden Unkräuter auf Flächen mit Sommergetreide zusammen mit Bewirtschaftungsdaten unter besonderer Beachtung von Anbauvielfalt, erfasst. Die Daten fließen an der Universität Rostock zusammen und werden dort verarbeitet und analysiert. Dazu gehören der Vergleich der Daten aus der durchgeführten Artenerfassung mit der ex-ante Datensammlung und die Interaktion mit den eingesetzten Methoden der Anbauvielfalt der Kulturpflanzen. Die Ergebnisse sind sowohl geeignet für die Kommunikation mit Stakeholdern als auch für Publikation in wissenschaftliche Veröffentlichungen.

Stichwörter: Felderhebungen, Kulturartenvielfalt, Partizipation Landwirte, Sommergetreide, Unkrautbekämpfung, Unkrautdiversität

Introduction

Within organic crop production weeds remain to be the main constrain on crop productivity (PENFOLD et al., 1995; CLARK et al., 1998; TURNER et al., 2007; ALROE and HALBERG, 2008). Also in conventional crop production heavy pesticide restrictions and increased public awareness leads to the need to decrease in, and a more efficient use of, herbicides (MELANDER, 2005). This leads to a demand for weed reduction strategies that are both effective and reduce the use and necessity of herbicides in both agricultural systems. Despite the fact that many non-herbicide reduction strategies are available and utilized in organic crop production, a total eradication of the weed flora is not to be expected. This however, leads to highly diverse weed communities within organic arable fields (HALD, 1999), lacking selection pressure posed by herbicides and increasing the ecosystem services of arable fields (MARSHALL et al., 2003). Weed reduction strategies have so far focused on direct mechanical reduction methods like mechanical weeding and thermal treatments. These methods are short term solutions, based on the instant release of weed pressure, and often require a high input of time, fossil energy and can have a negative impact on the soil structure and beneficial organisms (ASCARD et al., 2007). This is currently the most wide spread method utilized in organic agriculture.

To support the direct weed intervention there are cultural measures that can be applied. These are preventative techniques adopted into cultivation such as the choice of crop cultivar, adjusted seedbed preparation, the use of mulches and the adjustments in tillage as well as fertilization and irrigation management (MORTENSON et al., 2000; BOND and GRUNDY, 2001; BARBERI, 2002; MELANDER, 2005).

Although the combination of mechanical and cultural measures frequently improves weed control on the short term, for a long term continued controlled weed population in organic agriculture the challenge should be put into a wider context and on a higher level. A strong case is made for a transformation in weed management paradigm (BARBERI, 2002) and the adoption of cropping system strategies taking into account the systematic nature of agroecosystems (IKERD, 1993). These are the long term diversity measures, integrated into the cropping system to create a more balanced and manageable weed community. The maintenance of a higher crop diversity prevents the increased abundance of a single weed species, disrupt weed communities and thus could mitigate severe weed problems on the long run (MELANDER, 2005; BLACKSHAW et al., 2007). Examples of such crop diversity measures are: A diverse crop sequence, intercropping, cover and catch crops between cash crops and the careful choice and mixture of crop varieties (MORTENSON et al., 2000; BOND and GRUNDY, 2001; BARBERI, 2002; MELANDER, 2005).

A combination of these measures, direct, cultural and systematic, would create an all-round weed control in agricultural systems with low or no herbicide input. However, many of these crop diversity based techniques are insufficiently studied for their effect on weed communities, especially noxious weed species. Long term crop diversity measures are barely adopted into agricultural practice, partly because of the lack of experience with the application of these strategies and also because of economic restrains (BOND and GRUNDY, 2001). The lack of adoption is discouraged by the gap that still persists between practical experience and scientific knowledge. For any practical application of these crop diversification strategies, farmers need to be aware of their most severe weed problems. This would require an awareness of the main noxious weed species and how they are effected by cropping system (GEROWITT et al., 2003, STORKEY, 2006). On the other side the interaction between research and practice can be more efficient and work with established experiences and methods (MANTE and GEROWITT, 2009).

The PRODIVA Project

Our study is a component of the recently started CORE Organic PRODIVA project, a collaboration between international weed research institutions, which aims to improved utilization of crop diversification for weed management in northern European organic arable cropping systems. The over-all aim is to support organic agriculture with knowledge and tools for the exploitation of crop diversification methods to improve weed management and still maintain a diverse weed flora.

Objectives of the PROVIDA project are: (I) to strengthen the scientific foundation for the employment of crop diversification, (II) to survey the weed situation in practice region-wise and link it to the agronomic measures applied (III) to bridge the information from the surveys with the scientific groundwork (IV) to disseminate important results and recommendation to extension services and growers.

It is hypothesized that crop diversification can improve weed management while ensuring a diverse weed flora by the employment of: (I) pertinent crop sequencing that mitigates noxious weed species (II) improved cover crop establishment with selected competitive cover crop species (III) crop mixtures utilizing the resources better than sole crop species resulting in more weed suppression (IV) variety mixtures exerting a stronger pressure on weed development than the sole varieties.

PRODIVA will identify the potential and strategies for diversifying arable organic crop production systems to improve the management of weeds while maintaining weed diversity and over-all crop productivity. This will be done by capitalizing on terminated and ongoing European research on crop rotation experiments with the inclusion of work packages on crop sequencing / cover crops (Finland, Latvia, Denmark), crop mixtures (Sweden, Poland), and variety mixtures (Denmark, Poland, Latvia). The dynamics of weed, crop and cover crop growth will be determined by recording weed species and densities, and leaf area coverage (LAC) and dry matter accumulation (DMA) over time for each of the three components. This will allow an assessment of their relative proportion changes over time and how that will affect the status of the weed population.

The work package 'Crop diversification and weed vegetation on farms'

Our objective of this specific research conducted by the Group Crop Health of the University Rostock (Germany) is: to identify practical weed challenges, to investigate the role of crop diversification management for weed management in the field and to cluster weed species into groups in accordance to their susceptibility for the applied crop diversification techniques.

A literature review is compiled based on existing information about weed occurrences, which includes practical grey sources. This is supported by applied sources from all international partners in their national languages. Based on existing patterns of susceptibility for crop diversification, main weed groups are formed of noxious weeds in major arable crops in organic agriculture in Northern Europe. These findings will be discussed with farmers to align these weed groups with observations in practice. This will be an ex-ante database.

On-farm weed surveys are done on 71 farms in five different regions in Northern Europe (Germany, Sweden, Denmark, Finland and Latvia) in two years (2015-2016) using a common methodology. Fields are sampled for weed density and diversity. To minimize the effect of the current crop, the surveys focus on spring sown cereals only. Three subplots of 100 m² are monitored on each field around the time of weed flowering, after all weed control measures have been finished, but while both early and late weeds are still identifiable. In these three subplots, species are recovered to density classes. Fieldwork is executed by all respective international partners in their region. Crop diversification data are collected for each field, these include rotation, inclusion of cover crops, crop varieties and crop and or variety mixtures. Data is also collected on weed control measures and local site and soil characteristics. All data is collected at the Crop health group at the University of Rostock where they will be analysed with univariate and multivariate statistics. If existing and accessible, historical, regional or national surveys of relevance will be included in the

analyses. Determining factors for weed species compositions and weed densities will be revealed with the help of mixed models and variance partitioning approaches. Revealed factors from the on-farm surveys are compared with the factors investigated in the experiments in the other divisions of the PRODIVA project. The explaining factor for analogies and differences will be identified including weed groups, crop diversification factors and socio-economic dependencies. The latter are identified and discussed at stakeholder meetings.

The perceived outcomes for this study are: scientific contributions on the effect of crop diversification factors on weed communities in organic agriculture and a cross-check of success in weed suppression between scientific knowledge and ongoing experiments and on farm implementation. Points for improved crop diversification strategies are identified and further developed into guidelines for growers and extension services in the participating regions.

Current progress

The farmers in the German region of Mecklenburg-Vorpommern were approached through adverts in the German magazines for Organic agriculture; Bioland and Biopark. Via this medium we gathered a group of 11 farmers who were interested in participating in the research. During the first experimental year 2015, 22 fields were sampled throughout the region (Fig. 1.), of which 7 were oats, 11 summer barley and 4 summer wheat fields. Only 4 of these fields were a mixed crop, with peas or clover. Of the international partners partaking in this survey, Denmark surveyed 40 fields in the first year, Sweden and Latvia 20, and Finland 22, making a total of 124 fields surveyed in the first year. The first year's data will be collected and analysed together with the farm management data in the autumn of 2015 for the preliminary results in 2016.



Fig. 1 Locations of farms involved in the weed survey 2015 in Northern Europe.

Abb. 1 Geographische Lage der landwirtschaftlichen Betriebe, die 2015 am Unkrautmonitoring in Nordeuropa teilnahmen.

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