# Weed vegetation in organic winter cereals in the region of Mecklenburg-Vorpommern as influenced by site and management

*Ackerunkrautvegetation ökologisch bewirtschafteter Wintergetreideflächen in Mecklenburg-Vorpommern unter dem Einfluss von Standort und Management*

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## Abstract

Arable weeds are important theme in organic farming. In this study the weed densities and diversity in Mecklenburg-Vorpommern were studied. To achieve this, 17 fields of winter cereal on organic farms in the region were surveyed. Consequently the density of weeds was estimated within these fields in the months of June and July in 2016. This was combined with the management and site information of the surveyed fields. In total 69 different weed species were found. This was followed by an analysis of the effect of the soil and management variables on the weed density and diversity. From this analysis we found some significant influence of site and management variables.

**Keywords:** Autumn sown cereals, crop diversity, PRODIVA, weed diversity

## Zusammenfassung

Ackerunkräuter sind in der praktischen ökologischen Landwirtschaft ein wichtiges Thema. Wir wollen die Dimensionen und die Artenvielfalt für die Region Mecklenburg-Vorpommern aufzeigen. Dafür wurde die Ackerunkrautvegetation von neun ökologisch bewirtschafteten Landwirtschaftsbetrieben in Mecklenburg-Vorpommern näher untersucht. Die Unkrautvegetation von 17 Wintergetreideflächen wurde im Juni und Juli 2016 erfasst. Es wurde auf den Wintergetreideflächen insgesamt 69 verschiedene Unkrautarten dokumentiert. Bei der Analyse der Daten stand die Frage im Mittelpunkt, ob sich signifikante Unterschiede in der Ackerunkrautvegetation aufgrund von standortabhängigen Parametern und Managementfaktoren quantifizieren lassen. Bei den Analysen fanden sich einige signifikante Unterschiede für Standort- und Managementfaktoren.

**Stichwörter:** Kulturvielfalt, PRODIVA, Unkrautartenvielfalt, Wintergetreide

## Introduction

In organic agriculture a higher weed density and diversity is to be expected (BOND and GRUNDY, 2001), especially the increased densities can be a constrain on crop productivity (PENFOLD et al., 1995; TURNER et al., 2007). Therefore, frequently a system of weed management is implemented in organic farming, containing diverse crop rotations, ploughing and harrowing (BOND and GRUNDY, 2001). This leads to a reduction of weed density, diversity, and alteration of the weed population (AGHA and PALLUTT, 2006). Although desirable for farming purposes, this development is unfavorable for ecosystem services such as insect fauna (MARSHALL et al., 2003) and erosion control (ZWERGER and AMMON, 2002).

The PRODIVA project (HOFMEIJER et al., 2016) aims to study the effects of crop diversification strategies to improve weed management, but also still maintain a diverse weed flora. It researches the possible effects of crop diversity strategies on weed communities on farms, thus in practice and focuses on spring sown cereals in the Baltic Sea area. The region surveyed and studied in Germany is Mecklenburg-Vorpommern, which has the highest percentage of area under organic production nationwide (BMEL, 2016), and primarily produces organic cereal and beef (LFA, 2017). Like in any other organic arable system, weeds are a perpetual challenge, especially in a region with crop rotations dominated by cereals. However, while PRODIVA focuses on spring sown cereal, because it is a dominant crop in the Baltic region, in Mecklenburg-Vorpommern winter cereals are also an important crop in organic farming. Therefore, a separate survey was conducted in these

crops and constructed a more complete picture of the weed population in organic arable farming in this region (LEDERER, 2016).

The objectives of this study were to (I) survey the weed vegetation in winter cereals in the region, (II) study the effects of soil and crop management factors on the weed densities and diversity.

## Materials and Methods

The weed survey took place in winter cereals on organic farms in the region of Mecklenburg-Vorpommern in Germany. During one summer (2016) 17 autumn sown cereal fields were surveyed at the flowering stage of the crop (Stage 61-69 of BBCH scale), after all weed management measures were finished.

### Weed data

Fields were sampled for weed densities and diversity by using the method of HOFMEIJER et al. (2016) as seen in the PRODIVA project. This was done by estimating the individual density of all weed species found in a subplot of 100 $m^2$, with a triple replication in each field. These subplots were located randomly in the field, keeping at least 10 meter distance from the field boundary to avoid field edge effects. The density estimation was based on a classification scale, which included 10 density classes, exponentially increasing from 0.2 individuals per $m^2$ up to over 200 individuals per $m^2$. Some individuals could only be identified on genus level and therefore are recorded as such. Latin names are based on Rothmahler (JÄGER and WERNER, 2002).

### Statistics

The dependant variables; Density, Shannon Index and $\alpha$ diversity were tested against the explanatory variables (Tab. 1) with the use of ANOVAs. Analyses were carried out using the program IBM SPSS Statistics Version 22 (2013).

**Tab. 1** Explanatory variables.

***Tab. 1** Erklärungsvariablen.*

| **Explanatory variables** | **Catagorical variable**<br>**Label** | **Continuous variable**<br>**Unit** |
|---|---|---|
| **Soil quality ('Ackerzahl')** | | points |
| **Soil type** | 'Loamy sand' or 'sandy loam' | |
| **Rotation type** | Dominated by 'summer'- or 'winter'- crops | |
| **Rotation length** | | years |
| **Length grass clover ley** | | years |
| **Precrop** | 'Summer' or 'winter' | |
| **Date of sowing** | | date |
| **Rye** | Crop is 'rye' or 'other winter cereal' | |

## Results and discussion

### Weed species

Between 16 and 32 weed species were found on the 17 surveyed fields, the mean was 22 species. This is representative for German farms as HIMSTEDT and VAN ELSEN (2006) found similar numbers on organic arable fields in Germany. *Polygonum convolvulus* was found on all fields (Tab. 2), and fits in with the poorer conditions of the region (HANF, 2002). Further annuals were typical for organic winter wheat and the regional sandy loamy soils, such as *Centaurea cyanus* and *Papaver rhoeas*. In total 49 annual and 20 perennial species were found. The most frequent perennials were *Cirsium arvensis* and *Elytrigia repens*, which are both highly competitive with the crop and challenging to remove, and for that reason a concern to the farmer (BÖHM and VERSCHWELE, 2004).

**Tab. 2** The 20 most frequent weed species found, with their respective life cycle.

***Tab. 2** Die 20 häufigsten Unkrautarten mit ihrer Lebensform.*

| Botanical name | Frequency | Annual | Summer annual | Winter annual | Summer+ Winter annual | Perennial |
|---|---|---|---|---|---|---|
| *Polygonum convolvulus* | 17 | | x | | | |
| *Centaurea cyanus* | 16 | | | x | | |
| *Myosotis arvensis* | 16 | | | | x | |
| *Viola arvensis* | 16 | | | | x | |
| *Poa triviales* | 16 | | | | x | |
| *Papaver rhoeas* | 15 | | | x | | |
| *Polygonum aviculare* | 15 | | x | | | |
| *Vicia species* | 15 | | | | x | |
| *Veronica arvensis* | 15 | | | | x | |
| *Cirsium arvense* | 14 | | | | x | x |
| *Elymus repens* | 13 | | | | x | x |
| *Stellaria media* | 12 | x | | | | |
| *Capsella bursa-pastoris* | 11 | x | | | | |
| *Cerastium fontanum* | 10 | | | | | |
| *Geranium pusilum* | 10 | | | | x | |
| *Trifolium pratense* | 10 | | | | | |
| *Chenopodium album* | 9 | | x | | | |
| *Galeopsis tetrahit* | 8 | | x | | | |
| *Matricaria chamomilla* | 8 | | | | x | |
| *Marchantiophyta* | 8 | | | | | |

Weed density and diversity

When we study Table 3 we look for significant effects ($p<0.05$) and lesser effects or tendencies ($p<0.1$). Densities were influenced only by the precrop. Here we found that a winter precrop brought down densities in comparison to a summer precrop, possibly by already suppressing the growth of summer annuals and providing cover in winter. Rye as a crop however decreased $\alpha$ diversity possibly because of rye crops are designated to have allelopathy effects on some weed species (BARNES and PUTMAN, 1986; OESAU, 2002). A winter crop as a precrop not only decreased weed densities, but also increased $\alpha$ diversity. However, we did not observe the same effects for a winter crop dominated rotation when studying the rotation type.

Diversity was mostly influenced in the form of $\alpha$ diversity; sandy soils had a higher diversity than loamy soils. However, we do need to keep in mind that the soil types did not vary greatly between farms. When the grass clover ley period was longer, the Shannon index increased without increasing the weed density. This is positive as a longer grass clover ley could also suppress the build-up of weeds with creeping root and weed patches (PEKRUN et al., 2003). The earlier the crop was sown the higher the Shannon index proved to be. Due to the longer growing period in autumn not only the crop can get well established before winter, but also more species get the chance to 'take root'. Besides, the weed densities did not increase when there was more time for germination, possibly because the soil was left undisturbed. An increased rotation length results in a longer time for the same crop sequence to be repeated, hence, the rotation was often more diverse. In these cases the $\alpha$ diversity also increased, showing the tendency of weed species to diversify under diverse crop conditions. However, this effect was not reflected in the Shannon index.

**Tab. 3** P-value of the ANOVA (effects with tendency (< 0.10) and significance (< 0.05) in bold).

***Tab. 3** P-Werte aus der ANOVA (Effekte mit Tendenz (< 0,10) und Signifikanz (< 0,05) fett).*

| | Density | Diversity | |
|---|---|---|---|
| **Explanatory variables** | **Number/m²** | **Shannon index** | **$\alpha$ – diversity** |
| **Soil quality points** | 0.640 | 0.336 | 0.449 |
| **Soil type** | 0.350 | 0.808 | **0.027** |
| **Rotation type** | 0.918 | 0.191 | 0.191 |
| **Rotation length** | 0.230 | 0.813 | **0.088** |
| **Grass clover ley length** | 0.348 | **0.083** | 0.401 |
| **Precrop** | **0.003** | 0.733 | **0.070** |
| **Date of sowing** | 0.597 | **0.066** | 0.283 |
| **Rye** | 0.620 | 0.404 | **0.010** |

We proof that the choice for crop and precrop influences weed densities and diversity. Moreover, also other management choices proof to be important, such as the date of sowing and the length of both the rotation as well as the grass clover ley cultivated. As there was a tendency found in the rotation length, it would be interesting to go in more depth in rotation diversity, as many sources show a significant effect on the weed vegetation (PALLUTT, 1999; BOND and GRUNDY, 2001; ULBER et al., 2009) and a suppression of the density (BOND and GRUNDY, 2001; BÖHM, 2014).

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