

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

Merel A.J. Hofmeijer*, Henrike M. Lederer, Bärbel Gerowitt

University of Rostock, Faculty of Agricultural and Environmental Sciences - Crop Health,
18051 Rostock, Germany

*Corresponding author, merel.hofmeijer@uni-rostock.de

DOI 10.5073/jka.2018.458.008



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 m², 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 m² up to over 200 individuals per m². 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 α 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 Label	Continuous variable 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 ELSSEN (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
<i>Polygonum convolvulus</i>	17		x			
<i>Centaurea cyanus</i>	16			x		
<i>Myosotis arvensis</i>	16				x	
<i>Viola arvensis</i>	16				x	
<i>Poa trivialis</i>	16				x	
<i>Papaver rhoeas</i>	15			x		
<i>Polygonum aviculare</i>	15		x			
<i>Vicia species</i>	15				x	
<i>Veronica arvensis</i>	15				x	
<i>Cirsium arvense</i>	14				x	x
<i>Elymus repens</i>	13				x	x
<i>Stellaria media</i>	12	x				
<i>Capsella bursa-pastoris</i>	11	x				
<i>Cerastium fontanum</i>	10					
<i>Geranium pusillum</i>	10				x	
<i>Trifolium pratense</i>	10					
<i>Chenopodium album</i>	9		x			
<i>Galeopsis tetrahit</i>	8		x			
<i>Matricaria chamomilla</i>	8				x	
<i>Marchantiophyta</i>	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 α 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 α 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 α 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 α 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).

Explanatory variables	Density	Shannon index	Diversity
	Number/m ²		α –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).

References

- AGHA, J.M. and B. PALLUTT, 2006: Populationsdynamik der Unkräuter im integrierten und ökologischen Anbau am Beispiel des Getreides. Zeitschrift für Pflanzenkrankheiten und Pflanzenschutz, 385-92.
- BARNES, J.P. and A.R. PUTMAN, 1986: Evidence for Allelopathy by Residues and Aqueous Extracts of Rye (*Secale cereale*). Weed Science **34**(3), 384-390.
- BMEL – BUNDESMINISTERIUM FÜR ERNÄHRUNG UND LANDWIRTSCHAFT, 2016: Referat 516 – Ökologische Landbau, 2016. Ökologischer Landbau in Deutschland. BMEL, Bonn.
- BÖHM, H., 2014: Unkrautregulierung durch Fruchtfolge und alternative Managementverfahren. Julius-Kühn-Archiv **443**, 24-36.
- BÖHM, H. and A. VERSCHWELE, 2004: Ampfer- und Distelbekämpfung im ökologischen Landbau. Ressortforschung für den ökologischen Landbau, 39-48.
- BOND, W. and A.C. GRUNDY, 2001: Non-chemical weed management in organic farming systems. Weed Research **41**(5), 383-405.
- HANF, M., 2002: Ackerunkräuter Europas: Mit ihren Keimlingen und Samen. BVL Verlagsgesellschaft mbH, München.
- HIMSTEDT, M. and T. VAN ELSSEN, 2006: Vegetationskundliche Untersuchungen auf Äckern des ökologischen Landbaus am Beispiel ausgewählter Betriebe in Mittel- und Norddeutschland. Zeitschrift für Pflanzenkrankheiten und Pflanzenschutz, 597-604.
- HOFMEIJER, M.A.J., B. GEROWITT, J. SALONEN, T. VERWIJST, L. ZARINA and B. MELANDER, 2016: The impact of crop diversification management on weed communities in summer cereals on organic farms in Northern Europe. An introduction to the study. Julius-Kühn-Archiv **452**, 452-456.
- JÄGER, E.J. and K. WERNER, 2002: Rothmaler, Exkursionsflora von Deutschland -Gefäßpflanzen: Kritischer Band.
- LEDERER, H.M., 2016: Die Ackerunkrautvegetation ökologisch bewirtschafteter Wintergetreideflächen in Mecklenburg-Vorpommern unter dem Einfluss von Standort und Management. Bachelorarbeit, Studiengang Agrarwissenschaften, Agrar- und Umweltwissenschaftliche Fakultät, Universität Rostock.
- LFA – LANDESFORSCHUNGSANSTALT FÜR LANDWIRTSCHAFT UND FISCHEREI MECKLENBURG-VORPOMMERN, 2017: <http://www.landwirtschaft-mv.de> [September 2017].
- MARSHALL, E.J.P., V.K. BROWN, N.D. BOATMAN, P.J.W. LUTMAN, G.R. SQUIRE and L.K. WARD, 2003: The role of weeds in supporting biological diversity within crop fields. Weed Research **43**, 77-89.
- OESAU, A., 2002: Vegetationskundliche Untersuchungen im Projekt" Ökologische Bodenbewirtschaftung" in Wörrstadt-Rommersheim 1995-2004: Zwischenbericht 2000. In Bodenbearbeitung und Bodengesundheit: Zwischenergebnisse im Projekt Ökologische Bodenbewirtschaftung in Wörrstadt-Rommersheim, 47-56. Landesanstalt für Pflanzenbau und Pflanzenschutz, Mainz und Stiftung Ökologie und Landbau, Bad Dürkheim.
- PALLUTT, B.V., 1999: Einfluss von Fruchtfolge, Bodenbearbeitung und Herbizidanwendung auf Populationsdynamik und Konkurrenz von Unkräutern in Wintergetreide. Gesunde Pflanzen **51**(4), 109-120.
- PEKRUN, C., A. HÄBERLE and W. CLAUPEIN, 2003: Bedeutung von Grund- und Stoppelbearbeitung für die Kontrolle der Ackerkratzdistel (*Cirsium arvense*) im ökologischen Landbau. Landbauforschung Völknerode, 29-34.
- PENFOLD, C.M., M.S. MIYAN, T.G. REEVES and I.T. GRIERSON, 1995: Biological farming for sustainable agricultural production. Animal Production Science **35**(7), 849-856.
- TURNER, R.J., G. DAVIES, H. MOORE, A.C. GRUNDY and A. MEAD, 2007: Organic weed management: a review of the current UK farmer perspective. Crop Protection **26**, 377-382.
- ULBER, L., H.H. STEINMANN, S. KLIMEK and J. ISSELSTEIN, 2009: An on-farm approach to investigate the impact of diversified crop rotations on weed species richness and composition in winter wheat. Weed Research **49**, 534-543.
- ZWARGER, P. and H.U. AMMON (Eds), 2002: Unkraut – Ökologie und Bekämpfung. Eugen Ulmer GmbH, Stuttgart.