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syngenta Rapsunkräuter-Monitoring

BASF The Chemical Company

Multivariate analyses of weed survey data from German oilseed rape fields

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Introduction

Objectives - Why map weeds in oilseed rape?

WHY? WHICH SPECIES? HOW MANY? HOW? HOW OFTEN? WHERE?

- detect regional changes in weed species composition due to intensified OSR cropping
- derive predictions for (regional) weed problems
- collect uniform data to assess dynamics of weed communities at different spatial and temporal scales
- understand and rank factors that influence weed occurrence
- monitor and quantify the contribution of OSR cropping to arable weed biodiversity

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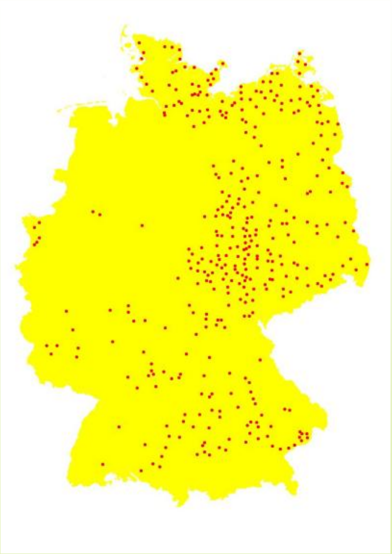
Weed mapping

Data source

- 1463 sampled oilseed rape (OSR) fields across Germany in 2005 – 2007
- Investigation of unsprayed parts of OSR fields in late autumn (mid october – mid november)
- Identification of all weed species and counting of species densities in 10 x 0.1m²
- Background information on field management and site properties



Distribution of sampled fields

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Weed mapping

Background information

Management	crop, crop rotation, years since first cropping of OSR, tillage intensity, fertilization, crop density, sowing date herbicide use in previous OSR, field history
Site conditions	soil texture and soil pH, Soil quality index
Geographical position	latitude, longitude, altitude
Climate	precipitation and temperature during growing season

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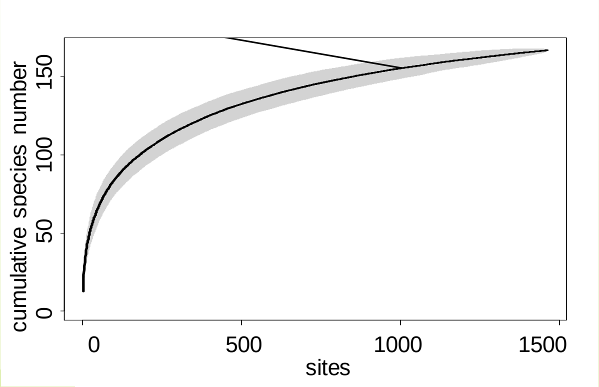
Results – weed biodiversity

Validating the adequacy of sampling effort

- Have number and choice of sites been adequate?
- How many species have been missed by sampling procedure?



sufficient

(1) Mean species-accumulation curve (standard deviation from 500 random permutations)

(2) Degree of species saturation (CHAO) : 87,1%

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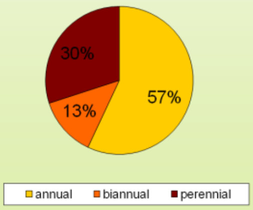
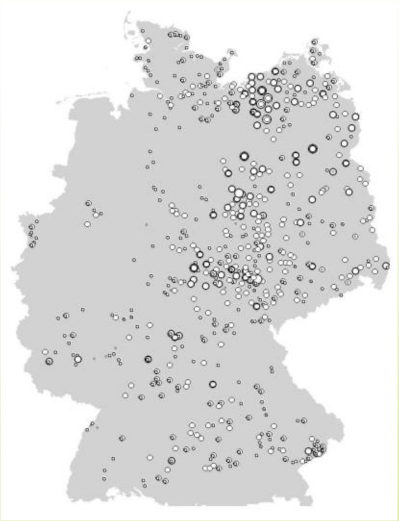
Results – weed biodiversity

Weed species richness of OSR fields

- 161 weed species from 33 plant famlilies , mostly winter annuals
- mean species number per field 11 ± 3.5 (min: 0; max:26)
- regional differences in weed species richness across Germany

Life cycle of weed species in OSR fields





Increasing size of points indicates higher weed species richness

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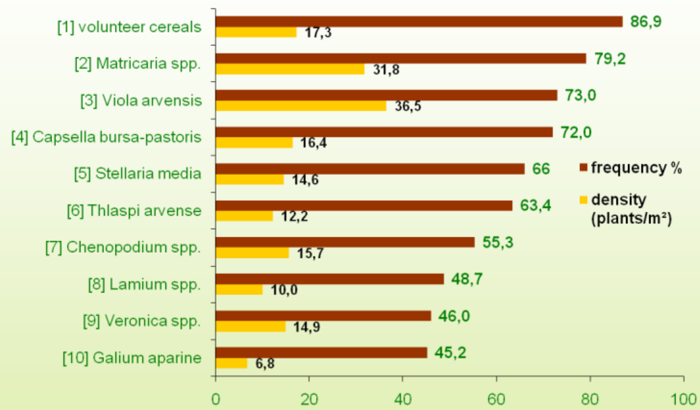
Results – weed frequencies

Most frequent weeds in OSR in Germany



- 10 most frequent weeds were the same in all 3 years and all parts of Germany
- considerable regional differences for less frequent weeds

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Results – weed species composition

Problems:

- Many less frequent weed species with limited distribution
- Annual fluctuation in weed species composition
- Large number of partly interrelated factors influence the composition of the weed community
- Very large data set

Example: German OSR weed monitoring	
Sample years	3
Sampled fields	1463
Species	161
Explanatory variables	23

Solution:

Multivariate Statistical Analysis

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Results – weed species composition

Ordination and clustering methods

(1) Which species are commonly found associated?

(2) What factors structure the community?

(3) How to extract the net effect of correlated parameters?

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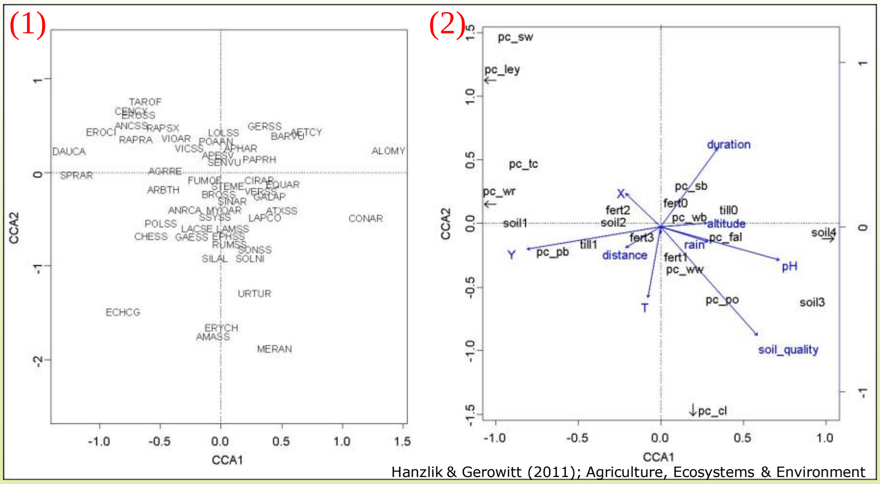
Results – weed species composition

Canonical Correspondence Analysis (CCA)

Impact of environmental and management variables on weed species composition in OSR



Hanzlik & Gerowitt (2011); Agriculture, Ecosystems & Environment

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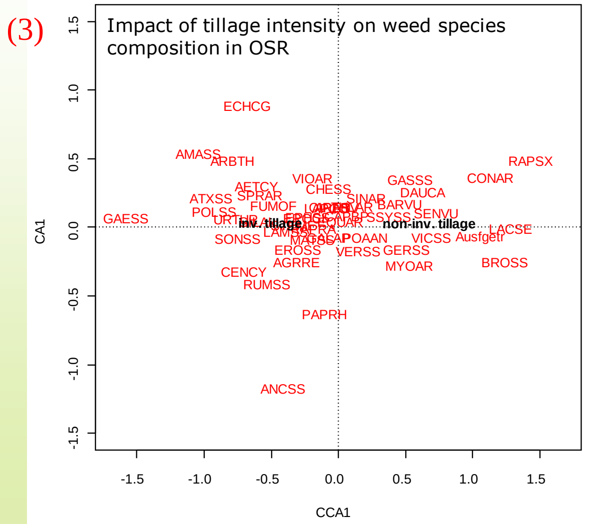
Results – weed species composition

Partial Canonical correspondence analysis (pCCA)

Unique effect of a certain variable (corrected for effects shared with other variables)



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Results – weed species composition

What factors structure the weed community of OSR fields?

Factor	Gross effect	Net effect
Crop rotation		
Previous crop	*	*
Years of OSR cropping	***	*
Spring crops in rotation %	***	
Autumn crops in rotation %	***	
OSR in rotation %	***	*
Fallow in rotation %	**	
Management		
Tillage intensity	***	***
Height of OSR variety	***	
Number OSR herbicides	***	
Crop density	***	
Fertilization source	***	
Field history		
Sowing date of OSR		

Factor	Gross effect	Net effect
Site		
Soil quality index	***	***
Soil pH	***	***
Soil structure	***	***
Climate		
Precipitation	***	***
Temperature	***	*
Geographic position		
Longitude	***	***
Latitude	***	**
Altitude	***	***
Local Environment		
Field size	***	
Distance field edge	***	***
Covariables		
Year	***	***
Sampling date	*	

Results of single CCAs (gross effect) and pCCAs (net effect),
(Significances due to permutation test n=1000,
* p<0.05; ** p<0.01; *** p<0.001)

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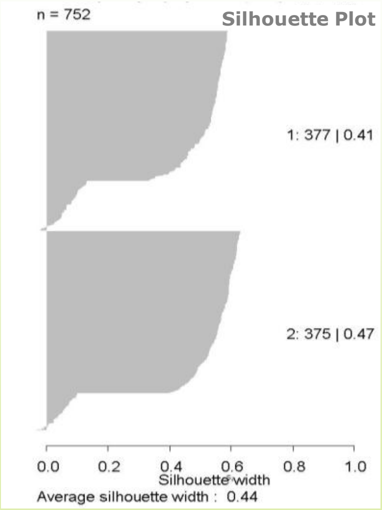
Analysis of survey data

Cluster analysis - Assigning objects to groups



Partitional Clustering

- Break data set into groups of equal rank
- produce exactly *k* different clusters of greatest possible distinction

Clustering of:

- OSR cropping intensity
- soil properties and tillage
- geoclimatic conditions

Example: Silhouette plot displaying the goodness of clustering results for 2 management systems of different OSR cropping intensity.

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Analysis of survey data

Cluster analysis - Assigning objects to groups

Verification of the Clustering results:
Are the found clusters ecologically meaningful?

Indicator species analysis *
of the clusters found by Partitioning around medoids (PAM) algorithm

(b) Weed species	Code	Group (Cluster) 1 Indval	2	p-value
Indicators of lower OSR cropping intensity (1)				
Chenopodium spp.	CHESS	42	19	**
Cirsium arvense	CIRAR	12	4	**
Silene alba	MELAL	4	0	*
Solanum nigrum	SOLNI	4	0	**
Daucus carota	DAUCA	2	0	*
Indicators of higher OSR cropping intensity (2)				
Geranium spp.	GERSS	8	28	***
Papaver rhoeas	PAPRH	9	26	**
Senecio vulgaris	SENVU	0	3	*

* Dufrene & Legendre (1997), Ecol. Monogr.

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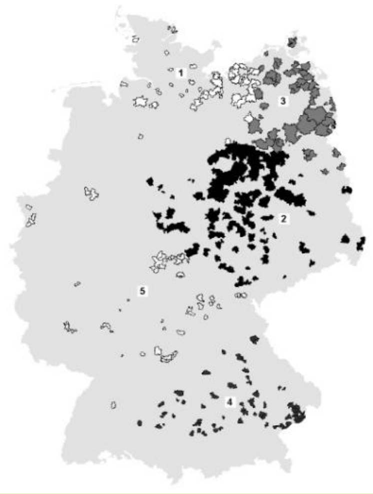
Analysis of survey data

- link weed vegetation with geographical data: verification of clustered ecoregions



Parameters for Clustering:
Geographical position data
Altitude
Mean temperature
Mean precipitation

➤ Basis for another Indicator species analysis (ISA)

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Results of Indicator species analysis displaying characteristic weed species of OSR fields within each clustered ecoregion

(c)	Weed species	Code	Group (Cluster) 1	2	3	4	5	p-value
			Indval					
Indicators of cool, maritime lowland (1)								
	Matricaria spp.	MATSS	39	8	18	10	11	***
	Stellaria media	STEME	35	9	7	12	7	***
	Apera spica-venti	APESV	28	3	3	1	4	***
	Capsella bursa-pastoris	CAPBP	24	12	15	15	11	**
	Poa annua	POAAN	23	2	4	9	1	***
	Geranium spp.	GERSS	13	2	8	4	11	*
	Vicia spp.	VICSS	5	0	0	0	0	**
Indicators of warm, dry central region (2)								
	Lamium spp.	LAMSS	6	19	5	13	8	*
	Sisymbrium spp.	SSYSS	14	18	12	0	0	***
	Euphorbia spp.	EPHSS	0	12	1	2	2	***
	Fumaria officinalis	FUMOF	0	12	1	1	6	***
	Bromus spp.	BROSS	3	10	4	0	1	**
	Mercurialis annua	MERAN	0	8	0	0	0	***
	Atriplex spp.	ATXSS	0	7	0	0	1	***
	Amaranthus spp.	AMASS	0	6	0	0	0	***
	Silene alba	MELAL	1	6	0	0	0	**
	Erysimum cheiranthoides	ERYCH	0	5	0	0	0	**
	Urtica urens	URTUR	0	5	0	0	0	**
	Daucus carota	DAUCA	0	3	0	0	0	**
Indicators of cool, dry lowland (3)								
	Anchusa spp.	ANCSS	6	0	34	0	0	***
	Chenopodium spp.	CHESS	4	18	24	15	4	***
	Viola arvensis	VIOAR	18	8	23	11	17	*
	Centaurea cyanus	CENCY	6	1	22	0	0	***
	Elytrigia repens	AGRRE	11	3	12	1	0	***
	Raphanus raphanistrum	RAPRA	0	1	3	0	0	*
Indicators of wet uplands (4)								
	Veronica spp.	VERSS	3	7	5	25	15	***
	Myosotis arvensis	MYOAR	9	2	2	15	6	**
	Sonchus spp.	SONSS	0	0	0	10	1	***
	Rumex spp.	RUMSS	1	0	0	9	0	***
	Lapsana communis	LAPCO	0	0	0	3	2	*
Indicators of warmer, moist uplands (5)								
	Alopecurus myosuroides	ALOMY	10	0	0	1	16	***
	Convolvulus arvensis	CONAR	0	1	0	1	7	**

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Summary and prospect

Results of the German weed monitoring in OSR:

- large amount of information on species responses to various management, site and geoclimatic factors
- Scientific verification of empirical field observations on the occurrence of "new" weed species
- Correlation of species spreads with changes in agricultural practice or climate
- Ranking of factors that affect the weed species composition

Possible applications:

- Exploit the potential of cultural weed control
- Understand and predict species shifts
- Use information on rare species for conservation of arable weed biodiversity

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THANK YOU FOR YOUR ATTENTION

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