Sveriges lantbruksuniversitet
Swedish University of Agricultural Sciences

Institute of Plant Protection - NRI

18th EWRS Symposium, June 17-21, 2018, Ljubljana, Slovenia

PRODIVA Project: Crop species mixtures for weed suppression

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WP2: Crop species mixtures for weed suppression

Aim:

Assess the weed suppressive ability of crop mixtures as a function of species & densities, using a functional approach (Leaf area cover, dry matter allocation).

WP	Method	Crop Diversification	Weeds	Results
WP2	Experiments	Crop mixtures	Species, Densities LAC, DMA	Crop mixture characteristics, weed suppressive ability

WP2: Crop species mixtures for weed suppression

Crop mixtures have greater weed suppressive abilities than the sole crop due to:

- Interspecific above-ground ground interactions between component crops (enhanced light interception, canopy heat capture).
- Interspecific below-ground interactions between component crops (with interspecific facilitation and complementarity in acquisition and utilization of water, nitrogen, and nutrients).
- Better pest and disease control, which may result in over-yielding.

What to calculate?

Ability to compete (AC) or weed suppressive ability (WSA) = $100 - ((b_w/b_t)*100)$, where b_w is the weed biomass, b_t is the total plant biomass (weeds + crops)

Ability to withstand competition (AWC) or weed tolerance (WT) = $(Cb_w/Cb_{wf})*100$, where Cb_w is the crop biomass in presence of weeds and Cb_{wf} the crop biomass in absence of weeds

Possible synergistic effects of an intercrop on the weed biomass, a term denoted relative weed biomass, RWB = $Ib/(\Sigma Sb_{i...n}/n)$, here Ib is weed biomass in the intercrop, $\Sigma Sb_{i...n}$ the sum of the weed biomass in the sole component crop and *n* is the number of component crops. An RWB < 1 indicates that there might be synergistic weed suppressive effects of an intercrop

WP2 - Experiments 2015-17

Field experiments

- 3 field experiments in Poland
- 3 field experiments in Sweden

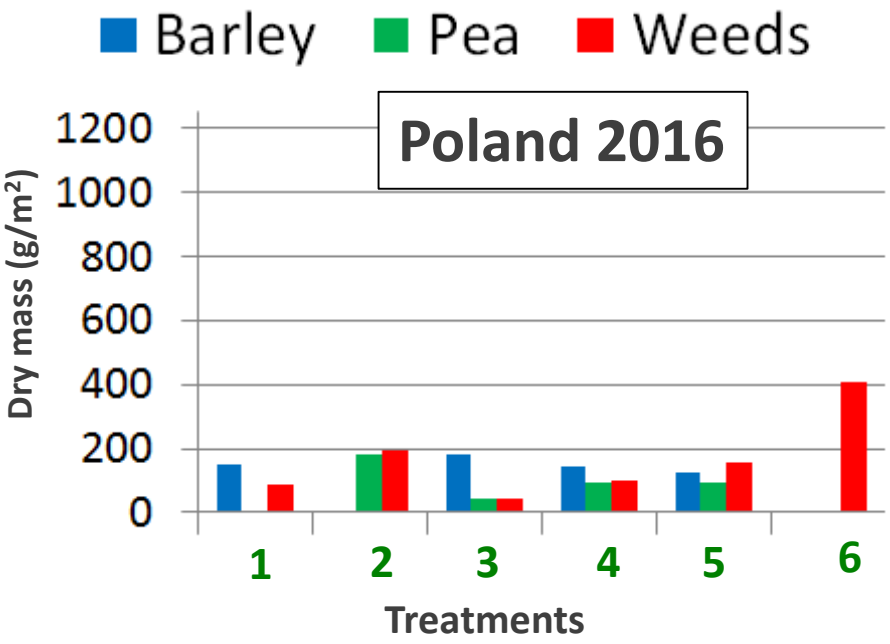
Experiments with varying proportions of spring barley/pea and natural occurring weed flora dominated by annual weeds (Poland) and *Cirsium arvense* and *Elytrigia repens* (Sweden).

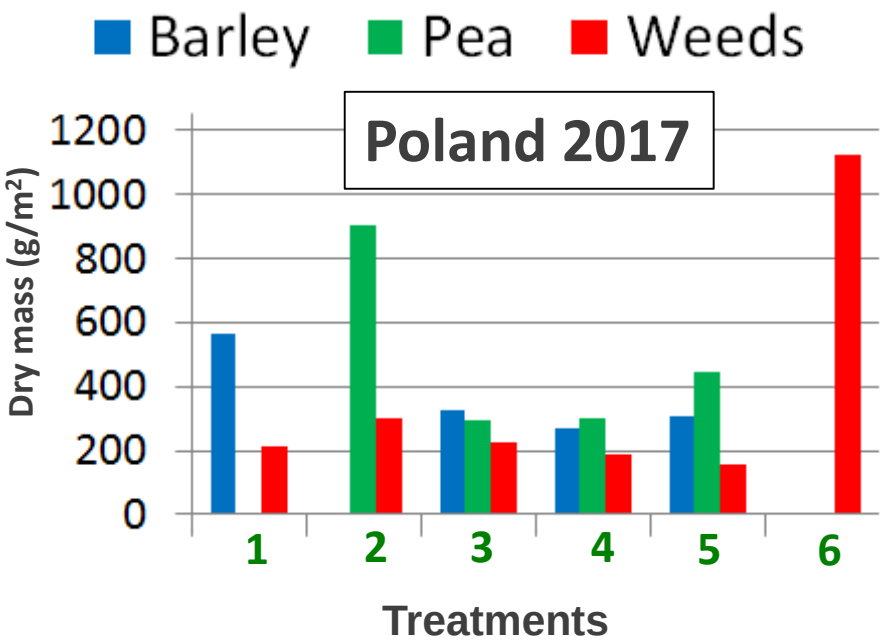
Field experiments

Experimental design

Treatments		Seed rate		
		Barley No seeds m^{-2}	Peas No seeds m^{-2}	Seed rate Barley + Peas (%)
1	Spring barley	350	-	100 + 0
2	Peas	-	110	0 + 100
3	Spring barley + Peas	245	33	70 + 30
4	Spring barley + Peas	175	55	50 + 50
5	Spring barley + Peas	105	77	30 + 70
6	Control (no crop)	-	-	-

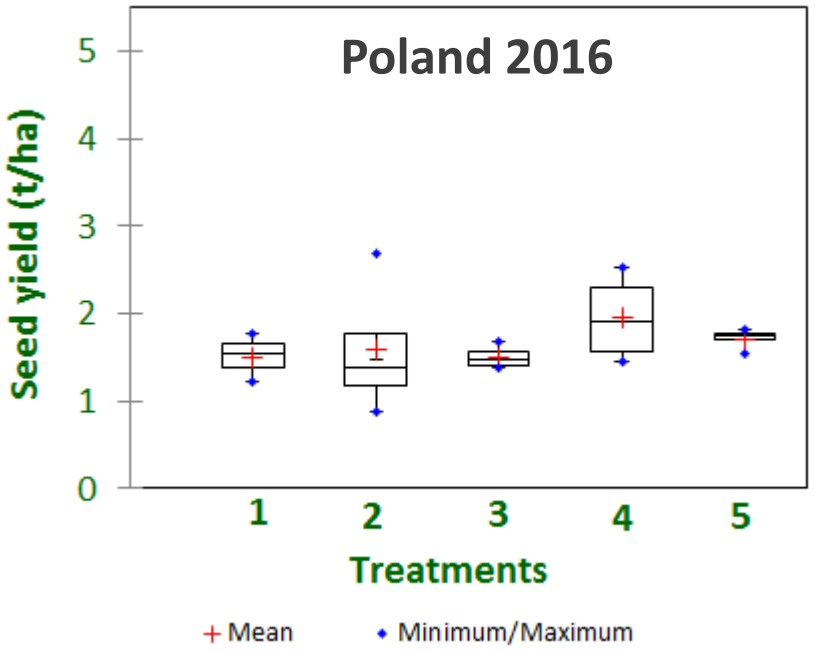
Field experiments - results

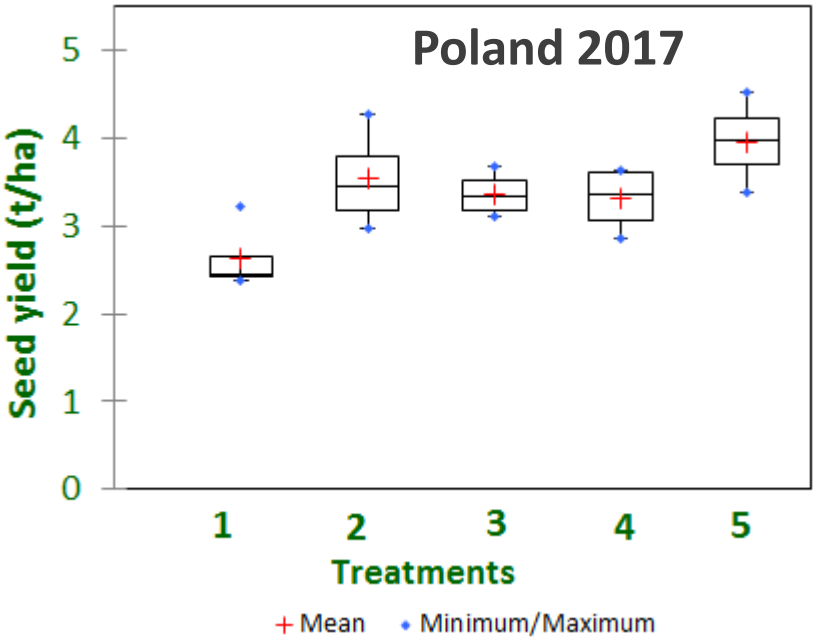




Number treatment	Farming system	Crop species (seed rate proportion)
1	Organic	Barley (100%)
2		Pea (100%)
3		Barley (70%) + Pea (30%)
4		Barley (50%) + Pea (50%)
5		Barley (30%) + Pea (70%)
6		Without crop- only natural weeds

Field experiments - results





Number tretment	Farming system	Crop species (seed rate proportion)	Seeding rates number/m^2
1	Organic	Barley (100%)	350
2		Pea (100%)	110
3		Barley (70%) + Pea (30%)	245 + 33
4		Barley (50%) + Pea (50%)	175 + 55
5		Barley (30%) + Pea (70%)	105 + 77

WP2 - Experiments 2015-17

Controlled experiments

- 3 outdoor box experiments (Sweden) (*E. repens*)
- 3 glass house experiments (Poland) (*E. repens*)
- 3 growth chamber experiments (Poland) (*E. repens, S. alba*)

Experiments with varying proportions of spring barley/pea and (i) *Elytrigia repens (L.) Desv. ex Nevski*, (ii) *Sinapis alba* L.

Controlled experiments

Experimental design

Treatments		Seed rate		
		Barley No seeds m^{-2}	Peas No seeds m^{-2}	Seed rate Barley + Peas (%)
1	*E. repens*	-	-	-
2	Spring barley	350	-	100 + 0
3	Peas	-	110	0 + 100
4	Spring barley + *E. repens*	350	-	100 + 0
5	Peas + *E. repens*	-	110	100 + 0
6	Spring barley + Peas	175	55	50 + 50
7	Spring barley + Peas + *E. repens*	175	55	50 + 50

Controlled box experiments - results

E. repens, rhizome weight (g box^{-1})

Treatment	Sweden 2015		Sweden 2016	
	Estimate	SE	Estimate	SE
1. Weeds	127.3	35.0	86.0	5.7
4. Barley + weeds	10.5	4.0	4.6	5.7
5. Peas + weeds	4.0	4.0	10.5	5.7
7. Barley + peas + weeds	5.0	4.0	3.4	5.7

2015-2016: Rhizome weight *E. repens* significantly higher in treatment 1 compared with 4, 5 and 7.

Similar results in 2017.

Controlled box experiments - results

E. repens, total weight (g box^{-1})

Treatment	Sweden 2015		Sweden 2016	
	Estimate	SE	Estimate	SE
1. Weeds	320.0	76.5	381.7	13.8
4. Barley + weeds	15.0	7.6	28.8	13.8
5. Peas + weeds	10.0	7.6	38.1	13.8
7. Barley + peas + weeds	10.0	7.6	16.9	13.8

2015-2016: Total weight *E. repens* significantly higher in treatment 1 compared with 4, 5 and 7.

Similar results in 2017.

Controlled box experiments - results

Ability to compete (AC) with *E. repens*

Treatment	Sweden 2015		Sweden 2016	
	Estimate	SE	Estimate	SE
4. Barley + weeds	98.65	0.30	97.14	0.86
5. Peas + weeds	99.19	0.14	93.37	0.86
7. Barley + peas + weeds	99.06	0.22	98.06	0.86

2015: No significant differences in AC between the treatments.
2016: AC was significantly lower in treatment 5 compared with treatments 4 and 7.

Controlled box experiments - results

Ability to withstand competition (AWC)

Treatment	Sweden 2015		Sweden 2016	
	Estimate	SE	Estimate	SE
Barley	96.45	10.29	102.89	6.19
Peas	99.19	5.17	91.70	6.19
Barley + peas	92.77	5.27	105.51	6.19

No significant differences in AWC between barley, peas and the mixture.

Conclusions of the work

- The extent to which crop mixtures suppress weeds better than the single crops depends on interactions which comprise several biotic and abiotic factors.
- Success of a crop mixture, in terms of crop DMA and WSA, depends ao on Leaf Area Durability, which - dependent on crop species - can be longer than of the single crops.

***Question*:** Can these results change weed management in organic farming? (Are the outcomes of CM predictable?)

Answer: Not in general, but feasible with additional information about cropping systems and site factors.