Organic World Congress 2020 | FRANCE

SEPTEMBER 21ST TO 27TH, 2020 IN RENNES
AT THE COUVENT DES JACOBINS • RENNES MÉTROPOLE CONFERENCE CENTRE
www.owc.ifoam.bio/2020

OWC 2020 Paper Submission - Science Forum

Topic 3 - Transition towards organic and sustainable food systems

OWC2020-SCI-1279

IMPACT OF DIFFERENT MECHANICAL WEED CONTROL METHODS ON WEED COMMUNITIES, IN ORGANIC SOYBEAN CULTIVATION, IN LUXEMBOURG.

David Richard*[1, 2], Stéphanie Zimmer[1], Christophe Naudin[2], Laura Leimbrock[1]

[1]IBLA (Institue for organic agriculture Luxembourg), Altrier, Luxembourg, [2]Ecole Supérieure d'Agricultures (ESA), Angers, France

Preferred Presentation Method: Oral or poster presentation

Full Paper Publication: No

Abstract: Knowledge gaps have been identified for legumes cultivation, especially in terms of weed control, while soybean production is still at its initial stages in Luxembourg. The project LeguTec tests different mechanical weed control methods, in organic soybean cultivation. The impact of weeding are observed from an ecological point of view in term of species number and diversity of weeds.Two experimental sites at organic farms were the basis of experiments in 2018 and 2019. Seven different weed control treatments were tested. For each, the number of weed species as well as their identification have been assessed at several times. The Shannon index has quantified the diversity of weeds. 49 weed species have been found in total for all sites. Calculated Shannon index were common values for organic fields. Weed control has shown a negative impact on weed diversity. The use of a hoe tends to lower the most the number of species and the diversity of weeds. Low abundant species were more likely to disappear while few species, 1 to 4, keep dominating.Hoeing is reducing the most weed diversity, while being the most successful method tested within the framework of the project LeguTec.

Introduction: Due to a high protein content (± 40 %), soybean is commonly used for animal feeding (Bernet et al., 2016). Most European countries are dependent on the import of soybean from oversea. The cultivation conditions and the long transport needs are not sustainable. Since Luxembourg has signed the European Soybean Declaration (2017) and with the interest of local agricultural stakeholders, IBLA has started a project called LeguTec (2017-2020). Its aim is to produce sustainable and resource-efficient proteins using various mechanical weed control methods in grain legume production, using soybean as an example. Apart from the success of the methods, weeds need to be observed in more details to identify the most problematic and the impact of the machinery on biodiversity. More knowledge about weed ecology is necessary to analyse the competition between soybean and weeds (Dordevik et al., 2019).

Material and methods: Two study sites on organic farms in Luxembourg, in Hostert and Manternach, part of the project LeguTec, designed as one-factorial-exact-trial, have been considered in the study for experimental years 2018 and 2019. Within the four field trials Hostert 2018 (H18), Hostert 2019 (H19), Manternach 2018 (M18) and Manternach 2019 (M19),

the experimental field is divided in four replicates. Each carries 7 treatments: 1) Negative control: non-weeded, 2) Positive control: weed-free, 3) Blind harrowing + Harrowing, 4) Hoeing with duck-foot shares, 5) Hoeing with duck-foot shares + Finger-weeder, 6) A combination of 3) and 5), and 7) Intercropping Soybean-Camelina + Harrowing.In 2018, only one run of the different machineries has been made, while two in H19 and in M19 only for treatment 3. In M18 and M19, the finger weeder could not be used, therefore treatments 4, 5 and 6 state for the same treatment: 4. The number of individuals and species of weeds have been assessed at different time: Before Weed Control (BWC), After Weed Control (AWC) and at FLOwering (FLO); within a score frame of a surface area of 0.5 m^2, at three different locations for each treatment. Each single weed is counted and its specie is determined by the expertise of the observers or with the help of a weed botanical book. Variations between treatments are evaluated by an ANOVA and a Tuckey tests, using the statistic software R (version 3.5.3, © The R foundation, 2019). All weed species are classified within three ecological groups: 1) Annual and biannual dicotyledonous, 2) Perennial dicotyledonous, and 3) Monocotyledonous. The frequency of occurrence of each species within a treatment is calculated as follows: $p_i = n_i / N$. *With: n_i: the number of individuals of the specie; N: the total number of individuals for the treatment.*

The Shannon index records the quantity of information carried out by individuals about the structure of the community and their distribution within species (Daget at al, 1978). Shannon index (H') calculation: $H' = -\Sigma\, pi \ln(pi)$. *With: i: a weed specie; pi: proportion of a specie i against the total number of species S; $pi = n_i / N$ where n_i is the number of individuals of the specie i and N is the total number of individuals.*

Results: In total, 49 different weed species have been counted across the experiments. More than 70 % of the species are annual or biannual dicotyledonous and stay the most abundant ecological group until flowering. Weed communities were dominated by 1 to 4 species BWC and at FLO.

Globally the number of species was homogenous across all experimental sites BWC. Mechanical weeding has tended to decrease the number of species. At FLO, the significant lowest values were visible for hoed treatments.

Shannon index values are visible in **Table 1**. BWC, they are not homogenous between treatments, except for M18, even though the variations are small (cf. mean SED). AWC, the index tend to decrease for weeded treatments. In H18, treatments 3 and 5 have significantly the lowest diversity, it is treatment 4 in H19. Shannon index are not significantly different in M18 where the values are very low. In M19, treatment 5 has significantly the lowest index. At FLO, the Shannon index have increased for H18 and M18; they are not significantly different than for treatment 1. In 2019, variations reflect the impact of weed control for each treatment. In H19, treatments 5 and 6 have significantly the lowest Shannon index. In M19, it is treatment 5.

Table 1 : Shannon index for the different treatments (1–7); BWC, AWC and FLO; for all sites. The p-value of the ANOVA for each treatment is reported and significance groups are mentioned by the small letters. The standard error of differences between two means (mean SED) is indicated.

	Hostert												Manternach											
	BWC				AWC				FLO				BWC				AWC				FLO			
	2018		2019		2018		2019		2018		2019		2018		2019		2018		2019		2018		2019	
Shannon Index																								
1	1.79	ab	1.32	ab	1.79	a	1.28	a	1.51	b	2.01	a	1.30	n.s.	1.20	ab	1.30	a	1.20	ab	1.30	a	1.49	a
2	1.75	ab	1.64	a	0.00	d	0.00	c	0.00	c	0.00	d	1.19	n.s.	1.42	ab	0.00	b	0.00	c	0.00	b	0.00	d
3	1.67	b	1.46	a	1.34	c	1.31	a	1.40	b	1.91	ab	0.98	n.s.	1.18	b	0.06	b	1.23	a	1.29	a	0.76	bc
4	1.86	ab	1.50	a	1.64	ab	0.78	b	1.56	b	1.35	bc	0.95	n.s.	1.48	ab	0.21	b	0.83	ab	1.31	a	1.12	ab
5	1.6	b	1.2	a	1.3	c	1.0	a	1.8	a	1.1	c	1.2	n.	1.3	a	0.1	b	0.6	b	1.2	a	0.5	c

	8		9	b	4		6	b	3		0		8	s.	5	b	7		7		9		5	
6	1.92	a	1.35	ab	1.58	abc	0.86	ab	1.61	ab	0.81	c	1.06	n.s.	1.62	a	0.13	b	1.06	ab	1.32	a	0.84	bc
7	1.68	b	0.96	b	1.45	bc	1.01	ab	1.43	b	1.74	ab	1.34	n.s.	1.43	ab	0.00	b	1.27	a	1.35	a	1.36	a
mean SED	0.10		0.21		0.60		0.44		0.61		0.71		0.16		0.16		0.46		0.45		0.50		0.51	
p-value	7.56 e-03		1.54 e-03		< 2.20 e-16		1.17 e-12		< 2.20 e-16		< 2.20 e-16		3.22 e-02		2.59 e-02		< 2.20 e-16		1.65 e-10		< 2.20 e-16		5.38 e-15	

Discussion: The number of weed species was balanced across the trials, except for M18. A total of 49 weed species has been counted. Several factors may impact the presence of weeds: 1) An initial low weed pressure, 2) The growing conditions, 3) Effects of a false seedbed and/or of blind harrowing, and 4) Good growing conditions for soybean. The number of species and the Shannon index tend to decrease due to mechanical weeding. Hoeing, in treatments 4, 5 and 6, lowers the most the specific richness. The dominancy of species has been amplified by weeding. Minor population are more likely to be eliminated. Dessaint et al. (2001) have shown that diversity in weed communities is mostly due to low abundant species, while generally, one or two species were dominating. In order to have more control on dominant species, weed control management is necessary to consider all along the cropping cycle. The Shannon index is a good indicator of diversity and distribution of individuals within species. Nevertheless, it considers each specie to be equivalent to each other, regardless the specific ecological traits.

Within the framework of the project LeguTec, the use of the hoe has been identified as the most successful method. Hoeing has better reduced biomass, coverage and number of weed individuals for all experimental sites. Results from the experimental year 2020 are necessary to complement the trends found.

The increased interest in regional soybean cultivation in Luxembourg due to the LeguTec project shows the need of further research on soybean cultivation to reach the long-term goal of overcoming cultivation barriers and promoting a sustainable, resource-efficient protein production in Luxembourg.

The project is funded by the Oeuvre Nationale de Secours Grande-Duchesse Charlotte and the Ministère de l'Agriculture, de la Viticulture et du Développement rural and is thankfully carried out with the support of the King Baudouin Foundation and the National Lottery. Special thanks to the sponsors and the participating organic farmers.

References: Bernet, B., Recknagel, J., Asam, L., Messmer, M., 2016. Biosoja aus Europa. FiBL Dossier 5.

Dessaint F, Chadoeuf R, Barralis G (2001): Diversité des communautés de mauvaises herbes des cultures annuelles de Côte-d'Or (France). Biotechnologie, Agronomie, Société et Environnement.

Dordevik V, Malidza G, Vidic M, Milovac Z, Seremesic S (2019): Best Practise Manual for soya bean cultivation in the Danube region. Donau Soja Vienna.

European Soya Declaration (2017). European Soya Declaration: Enhancing soya and other legumes cultivation. Council of the European Union. 10055/17. Brussels.

Disclosure of Interest: None Declared

Keywords: Soybean, weed ecology, Luxembourg, organic agriculture, LeguTec