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Topic 3 - Transition towards organic and sustainable food systems

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DIVERSIFICATION OF ORGANIC FARMING BY IMPLEMENTING STRIP CROPPING IN VEGETABLE FARMING OF THE NETHERLANDS

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Abstract: Organic and conventional vegetable are grown mainly in monoculture fields at most medium and large scale vegetable farms in western Europe. To develop a resilient and profitable system with increased biodiversity levels, research is done on strip cropping systems compared to monoculture systems. Strip cropping is defined as growing two or more plant species in strips that wide enough to allow mechanisation but narrow enough to facilitate ecological processes. In the Netherlands a strip cropping system was designed and examined on a medium sized organic farm. The results from 2018 show that strip cropping offers an opportunity for integrating ecology and agriculture.

Introduction: The increasing scale in agricultural system of the last decades has resulted in an abundance of food, but it is now increasingly recognised that this comes at the cost of a variety of negative effects on the environment, including emission of chemical fertilizers and pesticides, reduced soil quality, resource depletion and a decline of biodiversity. To counter the negative effects of large scale monocultures, diversification of the agriculture system is needed (IPES Food, 2016). Sirami *et al.*(2019) found that crop heterogeneity in the landscape can enhance the biodiversity without taking land out of production. Increasing crop heterogeneity without loss of efficiency is strip cropping.. Strip cropping has been reported as an effective way of increasing productivity (Nasri *et al.*, 2014) and supporting pest control (Altieri and Nicholls, 2018).

Within SUREVEG (Strip-cropping and recycling of waste for biodiverse and resource-efficient intensive vegetable production;2018-2021) 7 European countries (Belgium, Denmark, Italy, Finland, Latvia, The Netherlands, Spain) collaborate to develop strip cropping in intensive vegetable production in organic farming. The main objective is to develop profitable and resilient strip cropping systems that produce vegetables with comparable yields to conventional farming and increased biodiversity levels in the field. In the Netherlands strip cropping systems are developed at medium sized organic vegetable farms (40-60 hectares).

Material and methods: *Study site*

The strip cropping experiment in the Netherlands was carried out at an commercial, organic farm in the province Zuid-Holland (51°46’20.68” N, 4°29’14.25” E), on a clay soil (20 - 27% lutum; 3 – 3,4 % soil organic matter). In the Dutch strip

cropping experiment four different types of crops in strips alternated with strips of grass clover were examined om 2018. This mixture of grass clover consisted of: di- and tetraploïd English rye-grass (*Lolium perenne*), white clover (*Trifolium repens*), red clover (*Trifolium pratense*), alfalfa (*Medicago sativa*) and tall fescue (*Festuca arundinacea*). The crops in the experimental set-up of 2018 were pumpkin (*Cucurbita maxima* L.), parsnip (*Pastinaca* L.), white cabbage (*Brassica oleracea* L. var. *capitata*) and leek (*Allium porrum* L.). Two most promising crops from the previous year (white cabbage and leek) were chosen for the experiment in 2019.

Experimental design & sampling

The crops in strips (3 meter width) were compared with the monoculture crop in the same field as reference and the grass clover strips. A differentiation was made in the experiment for edge effects. Edge rows and middle rows were sampled separately and analysed on effects of the grass clover crop. Different parameters such as soil, biodiversity and yield were investigated. The aboveground biodiversity was monitored by 2 pitfalls and 5 yellow sticky plates in each strip in 4 months during the growing season (June, July, August, September). The fresh yield was measured by harvesting 4x 3 meter for pumpkin and 4x 6 meter for parsnip, leek and cabbage.

Data analysis

Statistical analysis in this study was conducted in R Studio 3.5.1 and in SPSS (IBM SPSS Statistics 25). The data was assessed on normality and multiple comparisons was conducted. Biodiversity was analysed with the Shannon-Wiener diversity index.

Results: *Yield*

The yield data of the 4 different crops in strips was disaggregated into edge rows and middle rows (Figure 1 and 2). Yields were compared with the reference. The data show that the yield in the edge rows of the Cabbage and Pumpkin strips was lower compared to middle rows. The yield in parsnip was not significantly different between the treatments. The yield of cabbage in the middle row was also smaller than the reference.

Figure 1 and 2: Total yield strip cropping trials 2018 for pumpkin, leek, parsnip and cabbage, divided into edge, middle and reference. Error bars = SE.

Ground beetles

Ground beetles (Carabidae) were captured most (next to spiders and rove beetles) in the pitfalls during the growing season. In total 2841 individuals of ground beetles were captured in 2018. 46,4% of these individuals were *Pterostichus melanarius*. In total 19 different species of carabids were found. The number of *P. melanarius* were compared. No significant differences in the activity density of *P. melanarius* were found for the different treatments ($p = 0,68$).

Biodiversity index

Table 1 shows the Shannon diversity index of *Carabidea*. The highest biodiversity on average in all the different crop management is found in August 2018. Comparing the different treatments the highest biodiversity overall was found in grass clover strips with adjacent strips of leek, followed by strips of leek. The lowest in ranking of biodiversity of Carabids is grass clover strips combined with pumpkin.

Table 1: Shannon Index of Carabidea genera in strip crop system (Leek for June is missing, because the leek wasn't planted yet; Pumpkin for September is missing due to the fact that the pumpkin was already harvested).

Crop	Treatment	June	July	August	Sept
Pumpkin	Mono	0.18	0.52	0.72	NA

Pumpkin strip	Strip	0.65	1.04	0.80	NA
Grass clover pumpkin	Strip	0.15	0.09	0.36	NA
Leek	Mono	NA	0.78	0.94	0.44
Leek strip	Strip	NA	0.85	1.40	1.19
Grass clover leek	Strip	NA	1.08	1.30	1.14
Parsnip	Mono	0.68	0.62	0.42	0.11
Parsnip strip	Strip	0.49	0.67	0.46	0.77
Grass clover parsnip	Strip	0.74	0.9	0.98	0.79
White Cabbage	Mono	0.48	0.69	0.64	0.32
White Cabbage strip	Strip	0.48	0.66	0.82	0.69
Grass clover white cabbage	Strip	0.76	0.88	0.09	0.60

Discussion: The growing season of 2018 was extremely dry and warm. This might have influenced the results of the strip cropping experiment. Since all grass clover strips were 2 years old, except for the grass clover strips next to the leek, which competed for moisture by their well-developed rooting systems. In combination with a different tillage system in strips (spading vs ploughing) and slightly skewed planting of cabbages and pumpkins this led difficulties in weeding and many cabbage plants were lost. The results of the experiment in white cabbage were further distorted due to the fact that a organically approved pesticide was used against the caterpillars. Finally the farmer noticed that the contractor made a fertilization error in our reference plot by fertilizing it double. In the Parsnip additional cultivation was done to construct the ridges and now differences between edges, middle or reference were found. In contrast in the leek- first year grass clover intercrop edges and middle were doing significantly better. In 2019 a more robust result will show the influence of strip cropping system with white cabbage and grass clover.

Ground beetles activity is influenced by species, habitat, temperature, food availability, mating behaviour. Thus, it is only possible to compare the total numbers of individual ground beetle species when using the pitfall method in the same habitat (Muilwijk *et.al*, 2015). For example *Pterotichus* of adult beetles emerge from pupae from the centre of cultivated fields rather than from natural uncultivated areas (Turin & van Alebeek 2007) so this species is unlike to profit from strip cropping as others. From the results of 2018 it can be concluded that different species of ground beetles prefer different crop types. The Shannon Diversity Index is utilized for comparing the strips of crops and grass clover with the mono fields. During the whole growing season all the strips with different crops score higher on the biodiversity index than the

monoculture. Results from the 2019 season will possibly confirm results from the first-year experiment. To conclude strip cropping offers an opportunity for integrating ecology and agriculture in industrial farming systems. Challenges remain in management and finding good crop combinations.

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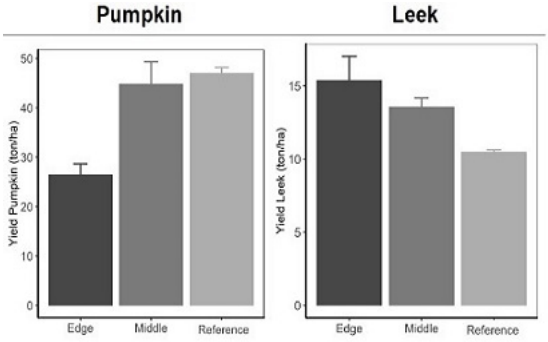
Image:



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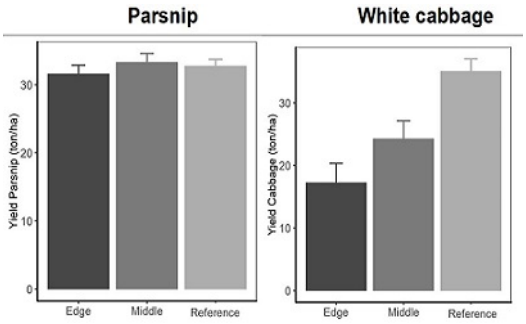

Disclosure of Interest: None Declared

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