DIVERSify Factsheet no. 2

AGRONOMY

Disease, pest and weed management in temperate cereal-legume plant teams

ABSTRACT

Intercropping can play a role in disease, pest and weed management, contributing to the sustainability of crop protection programmes. However, adjustments are needed to fine-tune mixtures to deliver effective reductions of target disease, pests and weeds across different agro-ecological conditions.

Below, we report **beneficial effects of intercropping in reducing disease, pest and weed prevalence** in legume and cereal crops when intercropped, as demonstrated in DIVERSify field trials. The trials can be considered as case study examples to consider when wishing to apply intercropping on your farm. Further reading and examples are also provided from the scientific literature.

LEAD AUTHOR

Diego Rubiales
Institute for Sustainable Agriculture, Córdoba, Spain

CONTRIBUTING AUTHORS

Lars Pødenphant Kiær
Københavns Universitet, Denmark

Stefano Tavoletti
Università Politecnica delle Marche, Italy

Ángel Mª Villegas-Fernández
Institute for Sustainable Agriculture, Córdoba, Spain

Alison Karley
The James Hutton Institute, UK

Jennifer Banfield-Zanin
Stockbridge Technology Centre, UK

PEDO-CLIMATIC ZONE

All

CONTEXT

The beneficial effects of intercropping in crop protection are well known[1], although generally providing a degree of disease/pest/weed reduction rather than complete protection. They are also influenced by environmental factors and therefore require monitoring and case-by-case adjustments.

The **mechanisms by which intercrops affect pest and disease dynamics** include:

- alteration of wind, rain splash, and vector dispersal
- modification of microclimate, especially temperature and moisture
- changes in host plant morphology and physiology
- effects on pests interfering with host finding mechanisms and mobility of the pests, and effects on pest natural enemies.

The effect of intercropping via changes to host density is a factor underlying many of these mechanisms. In the case of weeds, **competition and inhibition by allelopathy** are factors to consider. A number of cereal-legume mixtures were tested in different countries in the context of the DIVERSify project, leading to some interesting results.

RESEARCH RESULTS FOR CONSIDERATION

DISEASES

- Multi-environment trials in southern Spain demonstrated a **reduction of rust in faba bean intercropped with cereals** and in faba bean cultivar mixtures.
- A **reduction of powdery mildew in pea intercropped with cereals** was also found (**Fig. 1**) and in pea mixtures. A barrier effect for spore movement was considered the major reason for disease reduction.
- Trials performed in northern England showed a **trend towards reductions in disease levels in wheat grown with a clover understory**, despite not achieving statistically significant reductions.
- Spanish and Danish trials also confirmed previous observations of **chocolate spot**[2] **reduction in faba bean**, and of **ascochyta blight**[3] **on pea** when intercropped with cereals.

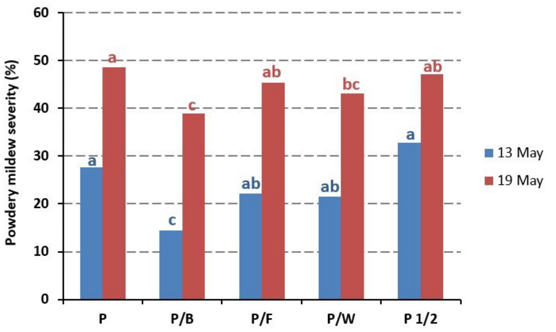

Fig. 1 Disease management: example on evolution of powdery mildew disease on pea growing in Córdoba in 2019. P= pea monocrop; P/B= pea/barley; P/F= pea/faba bean; P/W= pea/wheat; P1/2= pea at half density. Different letters per scoring date indicate significant differences (Tukey test, $p<0.05$)

There is a good range of evidence in the literature for the reduction of several other diseases, that were not tested within DIVERSify, with several cases from different countries presented at the **Intercropping for Sustainability conference** in January 2021. You can read some of the work presented by DIVERSify project partners at this conference on the project legacy website, ResearchGate or Zenodo community[4].

PESTS

Intercropping has been found to be beneficial in controlling pests, with reports on aphid reduction in barley intercropped with alfalfa and red clover; aphid reduction in faba bean intercropped with basil; leaf beetle reduction in cowpea intercropped with sorghum; seed maggot reduction in soybean intercropped with rye; fruit fly reduction in mung bean intercropped with white clover[5]. Experiments performed in DIVERSify showed:

- **reduction of pea aphid** in pea intercropped with **barley** in Scotland
- **reduction of cereal aphids** on **wheat with a clover living mulch** in northern England
- **reduced pea and bean weevil** (*Sitona lineatus*) leaf damage in **faba bean intercropped with oat or wheat** in Denmark (**Fig. 2**).

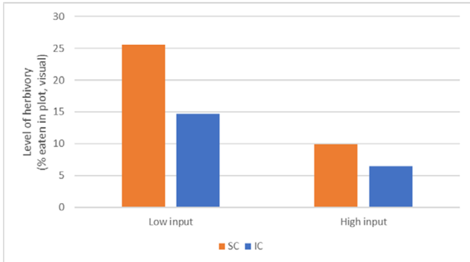

Fig. 2 Pest management: observed reductions in herbivory damage by *Sitona lineatus* to faba bean in Danish DIVERSify trials. SC: solo crop; IC: intercrop. Low input with reduced synthetic N fertiliser and no crop protection products

WEEDS

Intercropping legumes with cereals can also contribute significantly to reduction of weed biomass[6]. This is particularly relevant for **temperate legumes** which usually grow slowly in the early months of the season and are thus **poor competitors with weeds**. Some headline results from DIVERSify show weed reduction in various cereal-legume intercrops in different countries. For instance, **weeds were reduced** in:

- **faba bean** intercropped **with barley or wheat** in southern Spain (**Fig. 3**), Italy and in several on-farm trials across the UK
- **pea** intercropped **with spring barley** in Denmark, Italy and Scotland
- several different mixtures in on-farm trials including **lentil/barley** in Italy and **faba bean/oat** in Denmark
- **wheat and oat** with **clover living mulches** in northern England.

Fig. 3 Weed management: (top) faba bean grown in monocrop with an abundance of weeds; (bottom) neighbouring faba bean and barley intercrop with little weeds

DIVERSify project partners ESA and SLU discuss their wider work on intercropping for weed control, including the case of **winter white lupin and triticale** intercrops, in [DIVERSify Factsheet no. 3](). CSIC also have conducted previous research on the parasitic weed **broomrape** (Orobanche crenata) management by intercropping with **cereals**, with allelopathy identified as a major mechanism[7].

Intercropping clearly has the potential to address weed challenges on-farm, especially in organic farming where herbicides cannot be used, although context specific considerations must be taken into account. An additional aspect to consider when intercropping is the potential of a shift in weed species composition, which will be dependent on the competitive dominance of the components of the plant team.

CONCLUSION

Cereal/legume intercrops can contribute to disease, pest and weed reduction. In all cases, we should keep in mind that these reductions, although significant and beneficial, are not complete, and are influenced by environmental factors. Therefore, there remains a need for monitoring of current levels of weed, pest and disease on-farm to decide on the convenience of complementary control methods. This should be complemented in the longer term with the breeding of mixture-adapted cultivars, adjustments of optimal sowing rates and relative planting patterns.

REFERENCES

1. Hauggaard-Nielsen H. *et al.* (2008) Grain legume-cereal intercropping: the practical application of diversity, competition and facilitation in arable and organic cropping systems. doi.org/10.1017/S1742170507002025
2. Fernández-Aparicio M. *et al.* (2011) Effects of crop mixtures on chocolate spot development on faba bean grown in Mediterranean climates. doi.org/10.1016/j.cropro.2011.03.016
3. Fernández-Aparicio M. *et al.* (2010) Intercropping reduces *Mycosphaerella pinodes* severity and delays upward progress on the pea plant. doi.org/10.1016/j.cropro.2010.02.013
4. DIVERSify project ResearchGate and Zenodo community
5. Altieri M.A. *et al.* (2014) Manage insects on your farm: a guide to ecological strategies. SARE Outreach Publications, Handbook series 7.
6. Liebman M. & Dyck E. (1993) Crop rotation and intercropping strategies for weed management. doi.org/10.2307/1941795
7. Cimmino A. *et al.* (2018) Allelopathy for parasitic plant management. doi.org/10.1177/1934578X1801300307

FURTHER INFO

> Read on to discover more about intercropping and crop protection: DIVERSify Factsheet no. 3

The project has received funding from the European Union's Horizon 2020 research and innovation programme under agreement No. 727284.