DIVERSify Factsheet no. 4

AGRONOMY

Optimising N fertilisation of plant teams in intercropping systems

ABSTRACT

Nitrogen fertilisation is one of the most important agronomic management tools for cereal crops and is important for maintaining yields and quality of harvest. We have found that mixed crops could be considered a low input approach because **N fertilisation can be reduced, compared to pure stand cereal crops, whilst delivering satisfactory results in terms of yield and grain protein content** at the same time.

Below, we present an overview of the results obtained after three years (2017-2019) of research in field trials to test plant teams in the Marche region of central Italy. The **wheat and faba bean** plant team has been found to present a real opportunity to reach sustainability targets for agriculture via its reduced N fertilisation requirements. Moreover, improved weed control was observed in the mixed crop compared to faba bean monocrop.

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PEDO-CLIMATIC ZONE

Mediterranean

CONTEXT

Durum wheat is the most important cereal crop in central and southern Italy for its use in pasta making. Whilst bread wheat is also gaining attention to meet bakery product demands. Both wheats are usually grown as pure crops in conventional farming systems in this region with the crops included in very simple crop rotations, such as wheat-sunflower. This has consequences on **soil fertility and erosion**. Furthermore, **excessive N fertilisation** is a global risk for **nitrogen pollution** in superficial and underground water[1, 2] and can stimulate **weed growth**, as outlined in DIVERSify Factsheet no. 3.

Increasing use of grain and forage legumes in the crop rotation has been identified as a promising choice for diversification in our pedo-climatic environment. Approaches that **reduce fertiliser and crop protection product use** on cereal crops and, at the same time, develop improved cropping systems that can **reduce the weed pressures on legume monocrops** are also needed.

Intercropping cereals with grain legumes could be a promising strategy to reduce nitrogen inputs in cropping systems because of the **lower cereal plant density in cereal-legume intercrops**, and the presence of a **nitrogen-fixing crop**. Therefore, we tested the effect of adjusting N fertilisation levels on the **grain yield and protein content** of a cereal (barley, durum and bread wheat) when grown in an intercrop with grain legumes (faba bean, pea) and in monocrop. N fertilisation adjustments were based on the seed density of the cereal.

WHEAT AND FABA BEAN TRIALS IN CENTRAL ITALY

UNIVPM started field trials in 2017 to evaluate the effectiveness of intercropping cereals (durum wheat, bread wheat) with faba bean in the Marche region of Italy. We wanted to test intercropping's **potential for reducing inputs** and soil erosion. Soil erosion is a huge problem in the region, particularly in the hilly landscapes. Reduction of inputs and soil erosion are considered indispensable targets for the future.

Fig. 1 DIVERSify Factsheet no. 14 considers how existing machinery can be used or adapted for drilling, managing, and harvesting plant teams

When establishing the field trials, the first question we had to face was the **choice of nitrogen (N) fertilisation levels** to apply to the mixed cereal-legume plant teams. Legumes do not require N fertilisation because these crops fix atmospheric nitrogen, whereas N fertilisers are widely used for cereals. Finally, we decided to **adjust N fertilisation of**

mixed crops based on the cereal density. For example, if wheat is included in the mixed crop at 50% of the monocrop seed density, then the N fertilisation (urea N46%) level was also halved (180 and 90 kgN ha^{-1} for wheat pure and mixed crops, respectively). We also conducted trials **without N fertilisation**, to test the level of cereal grain yield and protein content in such agronomic conditions.

LAND EQUIVALENT RATIOS

The Land Equivalent Ratio is calculated to assess the performance of intercrops versus monocrops **(LER = yield in mixed crop / yield as monocrop)**. In our trials, it was evaluated separately for each crop (wheat and faba bean) and as total LER (LERtotal = LERwheat + LERfababean). **Wheat** was mainly included at **50% of pure crop density** (expected LERwheat = 0.5) whereas **faba bean** was tested at **50%, 65% and 80% of pure crop density**.

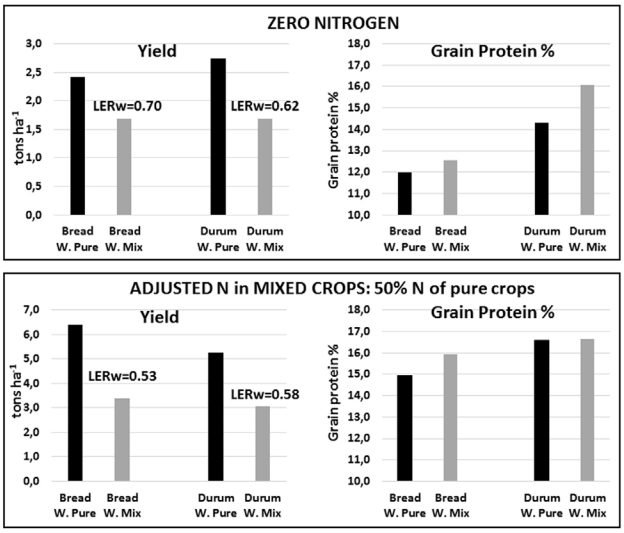

Fig. 2 Average Wheat Yield, LERwheat, protein (%) and percent increase of grain protein for durum and bread wheat when grown in monocrop and intercropped with faba bean

As expected, based on the reduced crop density, wheat yield was higher in pure than in mixed crops. In intercrops, the **LERwheat was always higher than expected**, ranging between 0.53 (durum wheat, adjusted N) and 0.70 (bread wheat, zero N) (**Figure 3**). The average **LERtotal values were always higher than 1**, ranging between 1.14 and 1.30 (not shown). **Wheat protein content was significantly higher for all wheat-faba bean intercrops** than in pure crops, except in the durum-faba bean at adjusted N level; the highest increase was found in durum wheat at zero N fertilisation (**Figure 3**).

Fig. 3 Harvesting the DIVERSify field trials in the Marche region, central Italy

The results presented are averages across varieties for each species and crop densities. **The choice of cereal and faba bean varieties included in the mix and their relative densities is important.** It will also relate to the final destination of the harvested grain (e.g., bread, pasta or animal feeding). Competitiveness and crop architecture are other important traits for consideration[3]. For faba bean, the main target is finding the best mix that maximizes weed control whilst maintaining a good legume yield level, especially in organic farming.

CONCLUSION

The risks of N fertiliser leaching, and advantages of cereal-legume intercropping are becoming well known. However, information on how to apply this practice is scarce for the Mediterranean regions and in particular for central Italy, which is characterised by extreme pedo-climatic variability whilst being an important wheat producing region.

Our results support that cereal-legume intercropping is an interesting strategy with the potential to increase the land-use efficiency of our agricultural system (LER>1). Furthermore, our research indicates that **a significant reduction of N fertiliser use could be achieved per unit area by intercropping, lowering the risk of underground water pollution due to nitric N leaching, whilst maintaining or even improving the protein content of the cereal**.

Faba bean was in general more sensitive to interspecific competition in mixed cropping, but the presence of the cereal significantly reduced the presence of annual weeds. This is an interesting effect for organic farming but also for low input conventional farming, because it means that a significant reduction of herbicide use could also be achieved. Intercropping should be considered a promising choice to reach the target of increasing the spread of grain legumes in our agricultural system that can support the development of links between local/regional/non-imported crop production and animal farming.

REFERENCES

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FURTHER INFO

> Results from other participatory farmer field trials in Italy, and other countries, are summarised on the DIVERSify project legacy website.
> Read on to discover more about plant teams for animal feed and forage in grassland systems: DIVERSify Factsheet no. 5

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