Beans and wheat intercropping: a new look at an overlooked benefit

Nearly a decade ago and after several years of R&D, ORC researchers were convinced that intercropping of beans and wheat would be a valuable approach for organic farmers. Despite clear evidence of benefit few took it up. It is now being rediscovered by researchers in other countries. ***Martin Wolfe****, one of the earliest proponents of the approach, has never doubted its value. Here he,* ***Nick Fradgley****,* ***Louisa Winkler*** *and* ***Thomas Döring*** *report on a trial last year, at Wakelyns Agroforestry, intercropping spring wheat and beans.*

Beans are an important crop, mainly used for high protein livestock feed, and wheat is a valuable cash crop. However, beans are often unreliable under organic conditions as yields can be depressed by Bruchid beetle attack, Chocolate Spot disease and weed competition. Intercropping wheat with field beans can be a practical approach to reduce these risks while making use of additional benefits.[1]

Provided that the maturation time of the two crops is similar, they can be harvested together and either separated using a seed dresser or used as a mixed livestock feed. Alternatively, the intercrop can be used for whole crop silage.[2&3] Depending on variety choice, there is the further possibility of using both crop components directly for human consumption.

There are several ways in which wheat and beans are complementary.

- Beans, being legumes, are able to fix and use atmospheric nitrogen whilst wheat only uses nitrogen already in the soil.
- Wheat plants sown at lower density (relative to their density in a monoculture) in a mixed crop may have access to more nutrients per plant than they would in a denser monoculture.
- Light competition in the intercrop is lower than in the sole crops as the two species make use of light resources in different parts of the canopy and at different times in the growing season.
- Disease incidence is also generally lower in diverse cropping systems as host plants are further apart from each other, delaying the spread of pathogens.[4] There are also several suggested mechanisms by which intercropping reduces pests; for example, beans may provide a habitat and food source for beneficial insects, thus controlling cereal aphid populations.

Intercropping – weeds and yield

A trial was carried out at Wakelyns Agroforestry in growing season 2012 to investigate the optimum drilling rates for a spring sown bi-crop of wheat and faba beans.

The wheat cultivar used was Paragon and the beans were Fuego. The replicated trial included plots of wheat- or bean-only sole crops as well as various combinations of wheat and bean intercrops sown at 75, 50 and 10% of their Recommended Density (RD) for sole cropping.

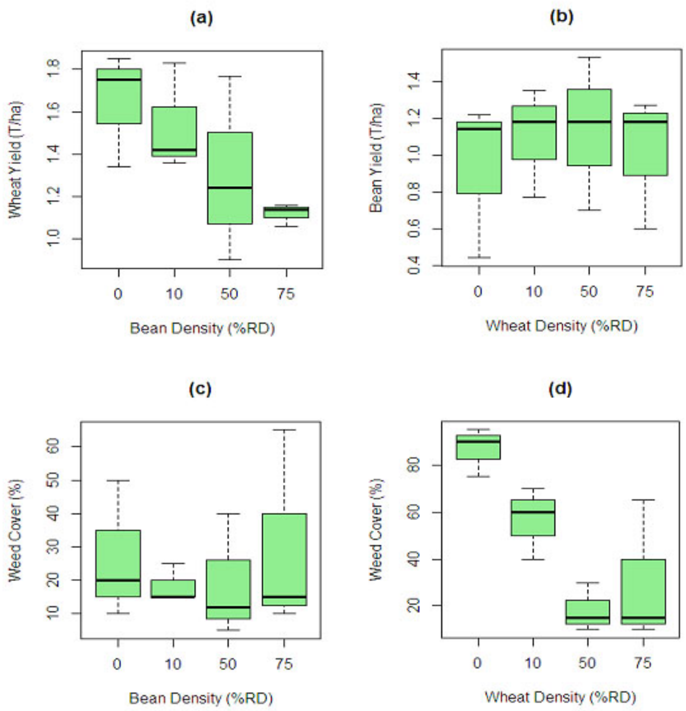

Figure 1: Yield in t/ha (panel a, b) and weed cover in % ground cover (panel c, d) depending on the density of the bean (a, c) or the wheat partner (b, d). In panel (a) wheat yield responds to the density of the accompanying bean; to keep results comparable only those plots are included in panel (a) where wheat is sown at 75% of the recommended density (RD). Conversely, panel (b) shows the response of the bean yield to the density of the wheat when the bean density is fixed at 75% RD. Similarly, weed cover (%) is shown for plots of wheat at 75% RD and varying bean density (c); and for plots of beans at 75% RD with the accompanying wheat at the variable % RD shown on the x-axis.

The results of this one year trial can be compared to a similar study by Hugh Bulson with Reading University and ORC[1].

The effects of intercropping on the yield of the intercrop components can be evaluated by observing how the yield of one crop at constant seed rate alters in response to changes in seed rate of the other (Figure 1a, 1b).

One finding in which the two studies concurred was that where wheat is drilled at 75% RD, its yield decreases as the bean density increases (Figure 1a). This may be due to the shading effect of the beans, which are tall and leafy, or to below-ground competition between the two species.

Bean yields, on the other hand, were relatively unaffected by increased wheat density (Figure 1b). Bean sole crop plots in the Wakelyns trial were very inconsistent, giving the highest and lowest bean yields in the whole trial.

In the field, we observed that the low-yielding bean plots had patchy crop growth due to high burden of both grass and broad-leafed weeds. However, bean yields were more stable in the intercropped plots, where the weed burden was also observed to be lower, particularly of grass weeds, and the amount of weed ground cover was negatively correlated with wheat sowing density (Figure 1d).

Bulson et al.[1] also observed reduced weed biomass in intercrop versus monocrop plots, a finding later confirmed by Hauggaard-Nielsen et al.[5] for a series of grain legume-barley intercrops. One hypothesis is that the bean crop is sensitive to weed pressure, and that wheat is able to out-compete weeds, grass weeds in particular, and it exerts a weaker competitive effect on beans than the weeds it replaces.

A Land Equivalent Ratio (LER) is a useful way to test the effects of intercropping on yields. It is a measure of the area of land that would be required to reproduce the yield of a bi-crop component when grown as a monocrop.

An LER of more than one indicates a beneficial yield effect, and the higher the LER, the greater the benefit. LER can be used to compare drilling densities for optimum productivity.

In the study by Bulson et al., the highest LER was 1.29, which was generated by an intercrop of beans drilled at 75% RD and wheat also drilled at 75% RD. In the Wakelyns pilot trial, an even higher LER value of 1.65 was observed in plots with beans at 75% RD and wheat at 50% RD (Figure 2).

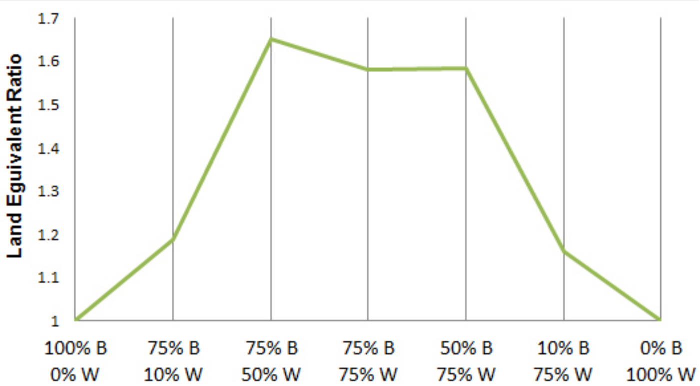

Figure 2. Land Equivalent Ratios of bi-crops relative to yields derived from monoculture plots. Seed rate of bi-crop components, wheat (W) and beans (B), is expressed as a percentage of Recommended Density (RD).

However, because the LER values are relatively similar for intercrops with RD between 50 and 75%, there is potential to adjust drilling rates to give priority to the crop that will yield a higher economic value.

Intercropping with populations and disease levels

In the Wakelyns trial, we were also interested in intercropping potential of a diversified Composite Cross Population (CCP) of wheat relative to the monoculture. We therefore included plots where the CCP and beans were both drilled at 75% RD. The CCP yielded significantly higher ($p<0.05$), on average 68.5%, than the pure line wheat at the same RD.

Although a more robust comparison would need to include multiple varieties of wheat to compare with the CCP, this result gives a positive indication that CCPs have strong potential as an adaptable intercrop component with high nutrient-use efficiency.

Another aspect of intercropping is changes in disease patterns. Bulson et al. found increased disease incidence of mildew (*Erysiphe graminis*) on wheat when intercropped with beans, which is contrary to other studies suggesting reduced disease incidence in more diverse cropping systems.[2]

Bulson et al. suggested that this may be due to an increased mildew susceptibility of the wheat crop under higher nitrogen availability in the intercrop. Although similarly, wheat grown in a monoculture with added nitrogen fertiliser would also be subject to increased mildew susceptibility.

Mildew was not present in our spring trial and other diseases only at low levels with no significant trends regarding their incidence.

It is clear that more research needs to be done to see if these results are consistent against year-to-year variations in weather, pest and disease spectrum, and weed pressure. However, our trials do provide an encouraging glimpse into the potential of intercropping beans and wheat generally and in particular, making spring beans a more attractive option for organic farmers.

References

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