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Cover crops

Can they be alternative and cheaper sources of nitrogen?

Cover crops provide many benefits: reduced soil erosion, improved soil tilth, and increased soil biological activity, to name a few. However, depending on the species, cover crops can also be important for maintaining nutrient balance in cropping systems because they can provide an alternative and cheaper source of nitrogen supply and can help take-up any residual soil nitrate-N that might otherwise leach into groundwater. In this article we review some of the information relating to how much nitrogen cover crops can supply to a following sugar beet crop.

The ability of cover crops to supply plant-available nitrogen (ammonium-N + nitrate-N) for the following sugar beet crop will depend on several factors. One of the most important factors being the choice of cover crop species. Legumes such as clovers and vetches can fix nitrogen, but other species will also take up nitrogen as they produce biomass, releasing some of this later when they are destroyed and decompose. This of course may also include nitrogen that they have absorbed and scavenged from the soil which may have otherwise been lost to groundwater.

Cover crop species selection and good biomass production are essential to providing nitrogen to the following sugar beet crop.

Biomass and nitrogen content are key

Production of sufficient cover crop biomass is key, as is the nitrogen content of the biomass. Biomass will be driven by good establishment and over-winter hardiness. Legumes can be challenging to establish in dry seed beds and when in mixes, can be out competed by other species. Some varieties such as buckwheat and phacelia are less winter hardy. Cereals are more robust across a range of conditions.

Figures 3 and 4 show some typical crop biomass values achieved in BBRO

Fig.1. Cover crop mix

Fig.2. Vetch mix

Fig.3. Fresh weight biomass of varying cover crop mixes

and BBRO/AHDB trials. Figure 3 is the fresh weight of different cover crops whereas figure 4 is the biomass dry matter (DM). To calculate the nitrogen content, the dry matter content of the biomass is required.

Species mixtures

The use of a mixture of species in cover crops can of course be a useful approach to delivering multiple cover crop functions, but can this compromise nitrogen production? A study which compared: 1) a single vetch cover crop 2) rye and vetch and 3) phacelia and vetch mix highlighted some of the challenges**. Cover crops were seeded in September or early October. Vetch was seeded at 60 kg/ha in mixtures and 70 kg/ha when solo. Seeding rates of the vetch companion crop (rye at 30 kg/ha or phacelia at 4kg/ha).

Rye was a dependable companion to vetch, establishing a good biomass at all locations. Phacelia established well in the autumn, but winter-kill in some fields resulted in partial smothering of the vetch. The total biomass was similar for solo vetch and phacelia + vetch cover crops but higher with the rye + vetch. When seeded alone, vetch accounted for 65 to 70 percent of total cover crop biomass, with weeds accounting for the balance. When seeded with rye, vetch averaged 35 percent of total biomass. Vetch biomass was more variable when seeded with phacelia.

From an available nitrogen perspective, the solo vetch mix was the most productive, highlighting the importance of having the higher % nitrogen content as opposed to higher biomass production. The lack of competitiveness of vetch with other species in mixes appears to be a challenge, especially if optimising nitrogen is the target. This indicates the need for high seed rates and good establishment conditions. Work (results not shown) also indicated that when the cover crop was mostly legume (75%) results were in line with a single stand of vetch but declined significantly when the mix ratio was less than 50%.

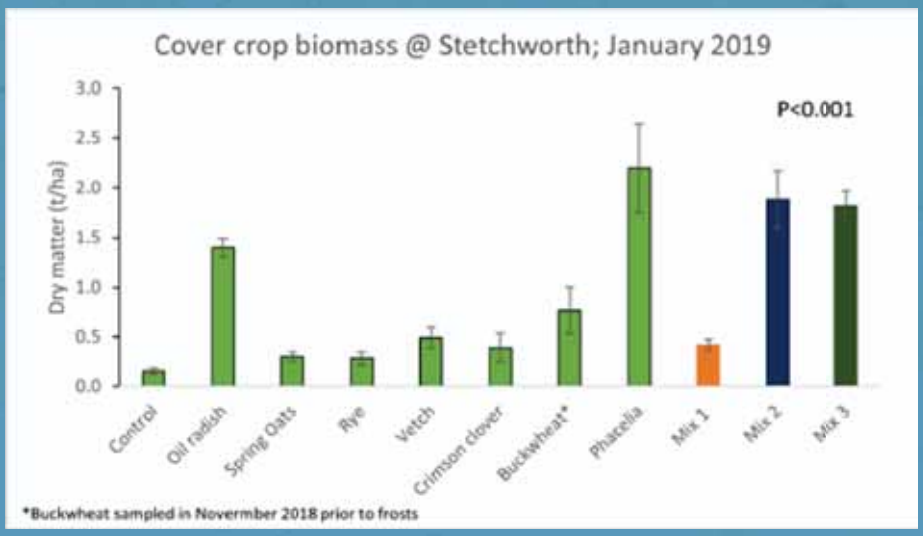

Fig.4. Dry weight biomass

Vetch

Cover crop species mix	N content (%DM)	Available nitrogen (kg N/ha)
Vetch	3	53 - 78
Rye & vetch	2.4	46 - 54
Phacelia & vetch	2.8	44 - 50

Fig.5. Cover crop performance alone or in mixes.

Nitrogen content

The nitrogen content of the cover crop biomass dry matter is important in determining how much nitrogen is available. This is influenced not just by the species but also the stage of growth. In general, green leafy plant tissues have higher N concentrations and more available nitrogen. More mature plant tissues such as woody stems, flowering and seed production growth stages have lower N concentrations. This may influence the decision about when to destroy a winter cover crop to get maximum available nitrogen benefit.

Nitrogen release following cover crop incorporation is strongly related to the nitrogen percentage in a cover crop. Research has shown of the nitrogen in the biomass, between 30-50% becomes available nitrogen within 4-10 weeks of being destroyed. The remainder is incorporated into the soil organic matter fraction. When cover crops contain a low N percentage (less than 1.5% N in DM), they provide little or no available nitrogen but cover crops containing a higher N percentage (2-4%), can provide useful amounts of available nitrogen.

Some typical values of winter cover crops are given in figure 6. These are based on BBRO trial data and additional published data.

Mustard

Radish

Cover crop species	Biomass range	DM range	N concentration range	Potentially available N in spring*
	t/ha	%	% (in DM)	Kg/ha
Cereal (oat, rye)	4-8	16-20	0.8-1.2	13-38
Legume (vetch, clover)	3-5	10-12	2.0-3.1	24-78
Phacelia	4-7	13-17	1.0-2.2	16-48
Brassica spp	3-10	15-18	1.5-2.0	18-52

*Available to sugar beet 4-10 weeks after cover crop destruction

Fig.6. Typical values of nitrogen released from different cover crop species

Legume cover crops provide up to 80kg N /ha, to maximize this available nitrogen contribution from legumes, the target should be to destroy the cover crop at flowering stage. Phacelia is sometimes used to replace cereals as a winter cover crop. Like cereals, available nitrogen from phacelia is positive in early vegetative growth but is near zero or negative at flowering. Brassicas can also provide available nitrogen when destroyed at the flowering growth stage (%N in DM is near 2%) but this can decline as the plant matures.

Cover crop essentials

Optimising the nitrogen contribution of cover crops clearly requires a bit of planning and attention to detail. The summary below brings together some of the key points and Table 2 demonstrates how this translated at Rougham into the measurement of available nitrogen, as either nitrate or ammonium using a Soil Mineral Nitrogen (SMN) test in February prior to drilling sugar beet.

Summary

- Over winter cover crops can provide a useful source of available nitrogen for following sugar beet crops. This can provide up to an additional 50-60kg N/ha compared to leaving land in stubble. This is an opportunity to reduce costly inputs of inorganic nitrogen sources and/or more expensive organic manure-sources.
- To optimise the amount of nitrogen, select legumes as key cover crop species. If using legumes in mixes target a high proportion of legume (75%).
- In mixes, ensure adequate legume seed rates are used. This will depend on species, product mixes and soil conditions but possibly may require seed rates above 50kg/ha.
- Establishing good biomass is key to target ideal soil conditions. Drilling legumes into soil moisture will ensure better establishment. Rolling mat be an option to conserve moisture in the seedbed.
- Ensuring cover crops are destroyed in the vegetative stage will help optimise the nitrogen content in the dry matter and availability to the following crop.
- Cover crops decompose rapidly and release available nitrogen rapidly. Most is released in 4 to 6 weeks after cover crop kill. Ensure sufficient period between destroying cover crops and the drilling of sugar beet to break any 'green-bridge' for pests and diseases, and also for nitrogen to become available

Fig.7. Nitrogen content of foliage and Soil Mineral Nitrogen (SMN) test result in the following February ahead of sugar beet (Rougham cover crops winter 2017/18)

**Source: Sullivan & Andrews (2012) Oregon State University publication ttps://catalog.extension.oregonstate.edu/pnw636