

Vetch improves the productivity of irrigated cotton

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Vetch is a winter-growing legume being increasingly grown in rotation with cotton. It provides no cash flow but provides substantial benefits in the productivity of the following cotton crops by improving the soil.

Vetch -

- **fixes large amounts of N in a short period**
- **improves soil quality (tilth, organic matter, structure and chemical fertility)**
- **significantly enhances cotton yields, improving the profitability of the farming system**
- **reduces black root rot incidence**

However, vetch -

- **reduces fallow periods, requiring more timely farming operations**
- **is not recommended where Fusarium is present**

Vetch has been grown on commercial cotton farms for several years in most valleys. Growers who have tried vetch are normally impressed with the results. Research has been conducted on vetch at Narrabri for eight years and continues within a legume cropping systems experiment. This article reports the most recent results from this research in relation to cotton yields and improvements to soil condition.

Growers have introduced vetch into their cropping system in three ways:

- 1) Wheat-vetch system; vetch is sown in late February – April following wheat harvest in December – vetch is green manured and incorporated in mid to late winter before cotton is sown
- 2) Continuous cotton system; vetch is sown as soon as possible after cotton picking (pupae busting) in May – vetch is green manured and incorporated in late winter-early spring before cotton is sown

- 3) Vetch rotation system; vetch is sown after cotton, green manured and then fallowed for a year before cotton is sown.

Experiments at Narrabri

The field experiment was initiated in 1997 to compare several cotton cropping systems (with and without vetch) with respect to N fertility, yield potential and economic viability. The legume cropping systems experiment at Narrabri compares the first two options i.e. the wheat–vetch and continuous cotton systems, both with and without vetch. The third option is somewhat similar to growing faba beans, although grain is normally harvested. The systems are assessed every second year when all treatments are sown to cotton. The economic optimum N fertilizer rate for cotton is determined by applying N fertilizer at several rates between 0 and 200 kg N/ha (as anhydrous ammonia).

Over the course of the experiment, the vetch-based systems have become more N fertile, requiring less N fertilizer and have produced greater lint yields than the comparative non-legume systems. The productivity and profitability of the vetch-based cotton systems now have lint yields higher than can be achieved in the respective non-legume system with high rates of N fertiliser. While vetch cropping generates no direct cash flow, economic benefits accrue from the N fixed and the improved condition of the soil. Those economic benefits more than pay for the costs of sowing and green-manuring the vetch.

Vetch cultivars

Namoi woolly pod vetch and Capello (a selection from it) have been the most productive of the vetch cultivars compared at Narrabri. The cultivars Popany, Haymaker Plus, Blanchfleur and Morava produce substantially less dry matter (DM) and fix less N. Plantings of medics and clovers (including Balansa and Berseem) were previously shown to be less productive than vetch.

Vetch Dry Matter production and N₂ fixation

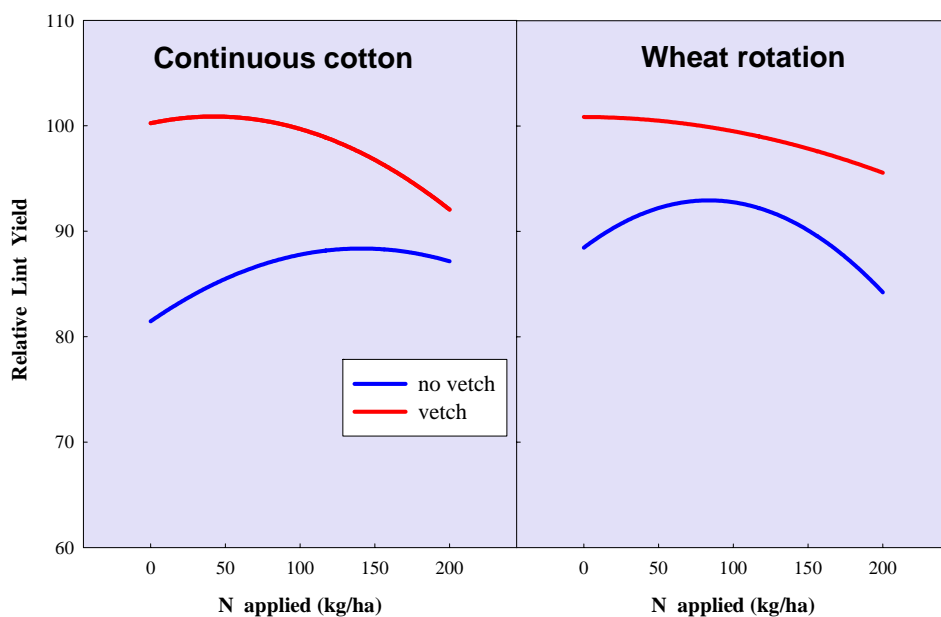
Vetch is normally sown immediately after cotton picking (April-May), or after wheat (sown Feb-March-April). It grows effectively through the autumn-winter months and can produce significant biomass (4 t DM/ha), even in dry years. Normally, sufficient rain falls to grow vetch in NSW cotton-growing areas. Vetch can fix substantial quantities of atmospheric N₂ (commonly 200 kg N/ha). Vetch is green-manured by slashing and incorporating into the soil (from July to September). This should be done at least one month prior to sowing cotton to allow some decomposition of the stubble. Herbicides have not aided destruction of vetch.

Meaned over all seasons, Namoi woolly pod vetch has produced 3.9 t DM/ha and fixed 185 kg N/ha, but has fixed up to 265 kg N/ha. On average, 81% of the vetch crop N was derived from fixation of atmospheric N. Vetch should be sown as early as possible (before mid May) to

maximise DM production and N fixation. Late sowings will not be as effective. Vetch seed should be inoculated with Group E inoculum.

Lint yield and N fertilizer requirement of cotton

The response of cotton to cropping history and N fertilizer is assessed in each cropping system every second year; data for 2003 is shown below. The inherent N fertility of each system is most evident in the lint yield of cotton with zero fertilizer addition. The cropping system effects depicted below have been observed at high and low lint yields. Importantly, both the vetch-based systems out-yielded the non-vetch systems irrespective of N fertilizer rate. Most importantly, cotton grown after the wheat-vetch crop sequence required no fertilizer N and was the highest yielding system. In fact, adding large amounts of fertiliser N to the vetch system would reduce yields. There was little response to N fertilizer and differences between the cropping systems were largely due to improvement in soil condition.



Economics of including vetch in the rotation

When vetch is included in a cotton system, there are considerable savings in N fertilizer application as well as gains in yield potential bought about by improved soil condition. Within the continuous cotton system, 140 kg N/ha was required to optimise yield without vetch, whereas only 40 kg N/ha was required following vetch. Further, the economic optimum yield of the vetch system was 18% higher (0.83 b/ha). This increased the cotton gross margin/ha by \$490.

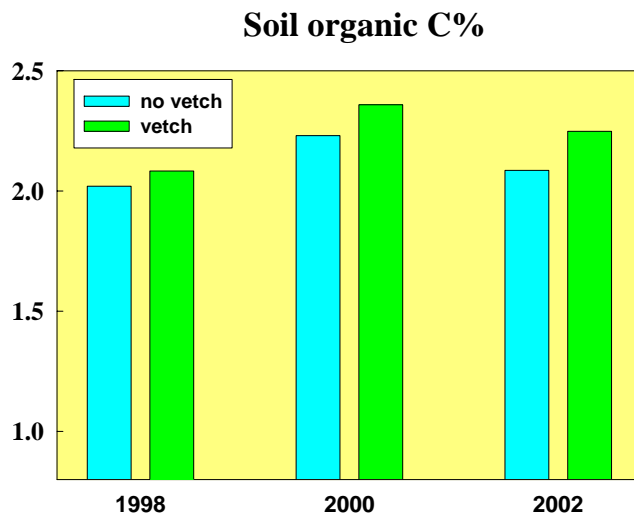
In the wheat rotation comparison, the economic optimum yield of the vetch system was 10% higher (0.6 b/ha), with a saving of 80 kg N/ha; this increased the cotton gross margin/ha by \$370.

In the initial years, savings in N fertilizer are quickly realised but improvements in yield potential and gross margin develop more slowly as the soil is improved. Costs directly associated with growing vetch are about \$100/ha.

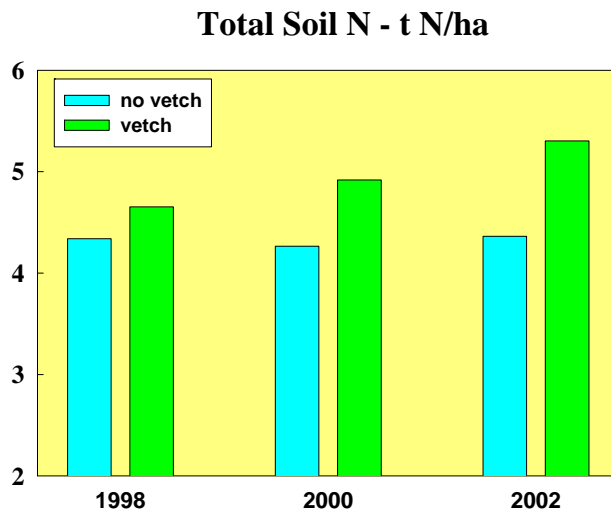
Soil improvement

This research indicates that including vetch into the cropping system produces changes in the soil that are highly beneficial to the following cotton crops. In 2003, as in previous years, the highest yields were achieved by growing vetch after wheat, where no N fertilizer was required. In back-to-back cotton systems, growing vetch each winter improved the yield potential of the system and also reduced the N fertilizer required for optimal yield.

The input of vetch stubble has increased the level of organic matter in the soil by 5% over the past six years in the surface 30 cm. This is very significant, as most cotton soils are currently suffering from declining organic matter content. By maintaining some form of crop growing in the soil, organic carbon (C) levels can be maintained or increased, relative to those systems that have regular fallows.

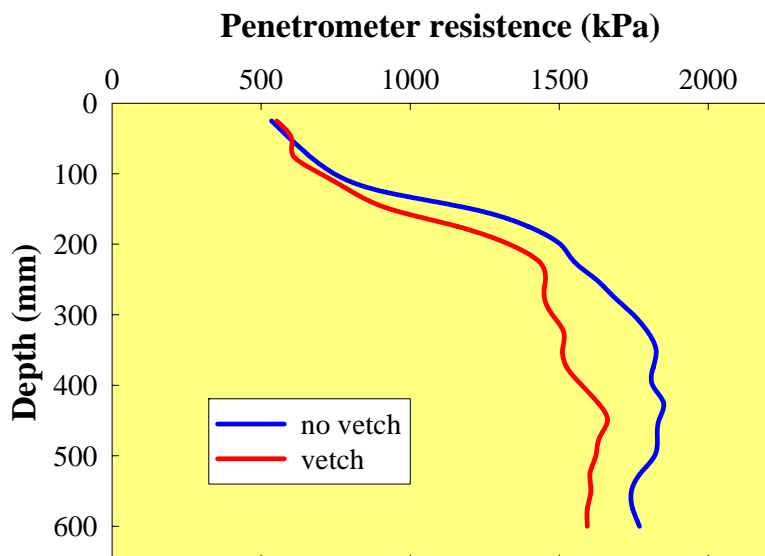


Associated with the increased organic matter is a larger pool of organic N derived from the vetch crops. The input of vetch (4 t/ha DM) containing 1.6 t organic C and 180 kg N/ha is critical in maintaining (improving) soil fertility. Soil total N in the surface 30 cm has increased by 800 kg N/ha where vetch has been grown over the past 6 years but has remained the same in the non-vetch systems.



Nutrient uptake by cotton following vetch is also enhanced. Elevated uptakes of N, P, K, Zinc and Copper, with reduction in sodium uptake provide further evidence for elevated yield potential following vetch.

Soil structure is also improved with vetch cropping. Cone penetrometer studies have shown that soil strength is reduced following vetch (and other legume crops) making it easier for cotton roots to explore the soil more thoroughly. Measurements taken during the 2003/4 season have shown that the water holding capacity of the soil and water infiltration is also improved.



Further experiments have shown that vetch and some other legumes exuded large quantities of organic acids from their roots that can dissolve naturally occurring lime and gypsum in the soil, thereby improving soil structure.

Cotton diseases

Vetch cropping has been shown to reduce the incidence of Black Root Rot in those areas where the disease occurs. There is no information on the effect of growing vetch or other winter legumes on Fusarium (Fov), although it is suspected that vetch is susceptible to Fov and hence should be avoided in fields where Fov is present.

Conclusions

Vetch is a highly efficient N fixer; legume N can replace much of the N fertilizer normally applied to cotton. Vetch cropping promotes yields above those attainable from conventional cropping systems largely through improved soil quality. Those yield increases and N fertilizer savings more than pay for the relatively small costs of sowing and green-manuring vetch.

To achieve the benefits of increased yields and reduced N fertilizer requirement, cotton growers must be prepared to adopt changes to their cropping systems over the longer term. Some growers who have grown vetch report apparent improvement to the productivity of their systems in the short term.

Including vetch into the cotton cropping system provides an environmentally friendly solution to reducing use of N fertiliser while improving soil fertility and enhancing cotton yields.

Acknowledgments

This research is continuing for the foreseeable future. It has been supported by the Cotton Research and Development Corporation and Australian Cotton CRC.



Commercial vetch crop near Wee Waa



Legume cropping systems Experiment at Narrabri.



Commercial vetch crop being slashed at Merah North



Vetch flowering, prior to slashing.