Vetch improves the productivity of irrigated cotton

By Ian Rochester, CSIRO Plant Industry, Narrabri, Australian Cotton CRC

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:

Wheat-vetch system

Vetch is sown in late January–April following wheat harvest in December. The vetch is green manured and incorporated in mid winter before cotton is sown

Continuous cotton system

Vetch is sown as soon as possible after cotton picking (and pupae busting) in May.

Commercial vetch crop being slashed at "Belapais", Merah North. It is then incorporated with power harrows.

The vetch is green manured and incorporated in late winter-early spring before cotton is sown.

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 (that is, 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 fertiliser rate for cotton is determined by applying N fertiliser at several rates between 0 and 200 kg N per hectare (as anhydrous ammonia).

Over the course of the experiment, the vetch-based systems have become more N fertile, requiring less N fertiliser 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) have been less productive than vetch.

VETCH DRY MATTER PRODUCTION AND N_2 FIXATION

Vetch is normally sown immediately after cotton picking (April–May), or after wheat (sown January–April). It grows effectively through the autumn–winter months and can produce significant biomass (four tonnes of DM per hectare), even in dry years. Normally, sufficient rain falls to grow vetch in NSW cotton-growing areas, but it will often require irrigation in northern areas.

Vetch can fix substantial quantities of atmospheric N_2 (commonly 200 kg N per

60 ▷

FIGURE 1: Response to N in the rotations

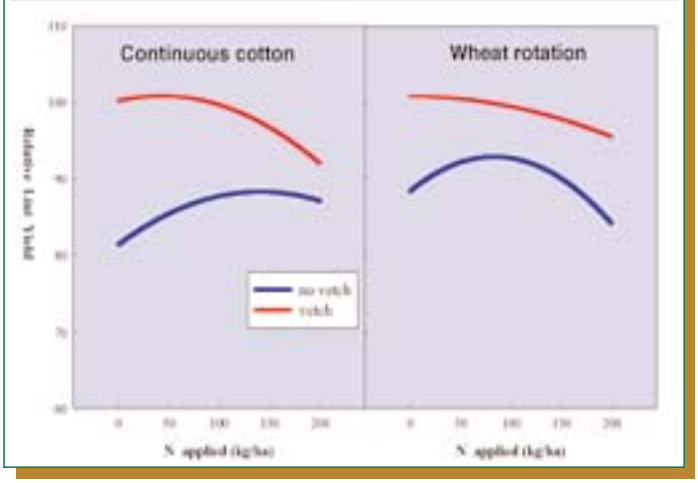
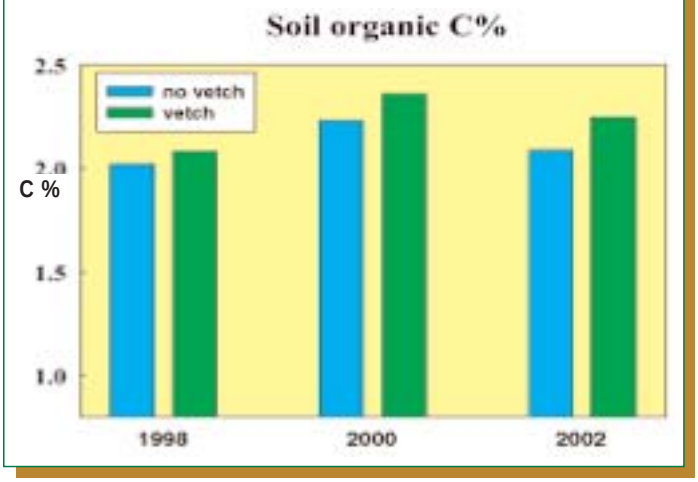


FIGURE 2: The change in soil organic carbon %



hectare). 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.

Averaged over all seasons, Namoi woolly pod vetch has produced 3.9 tonnes DM per hectare and fixed 185 kg of N per hectare — but has fixed up to 265 kg N per hectare. On average, 81 per cent 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 prior to sowing.

VETCH IN COTTON

Vetch is a winter-growing legume being increasingly grown in rotation with cotton. It provides no cash flow but substantially increases 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; and,
- Reduces black root rot incidence .

However, vetch also:

- Reduces fallow periods, requiring more timely farming operations; and,
- Is not recommended where Fusarium is present.

Namoi woolly pod vetch flowering, prior to slashing.

LINT YIELD AND N FERTILISER REQUIREMENT OF COTTON

The response of cotton to cropping history and N fertiliser is assessed in each cropping system every second year. The inherent N fertility of each system is most evident in the lint yield of cotton with zero fertiliser addition. The cropping system effects are observed at high and low lint yields. Importantly, both the vetch-based systems out-yielded the non-vetch systems irrespective of N fertiliser rate.

Cotton grown after the wheat–vetch crop sequence required no fertiliser 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 fertiliser in this experiment in 2003 and differences between the cropping systems were largely due to improvement in soil condition.

ECONOMICS OF VETCH

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

In the wheat rotation comparison, the economic optimum yield of the vetch system was 10 per cent higher (0.6 bales per hectare), with a saving of 80 kg N per hectare. This increased the cotton gross margin per hectare by $370. In the initial years, savings in N fertiliser are realised but increases in yield potential and gross margins develop more slowly, as the soil is improved. Costs directly associated with growing vetch are about $100 per hectare.

SOIL IMPROVEMENT

This research has shown that including vetch into the cropping system produces changes in the soil that are highly benefi-

FIGURE 3: The increase in total soil N (t/ha)

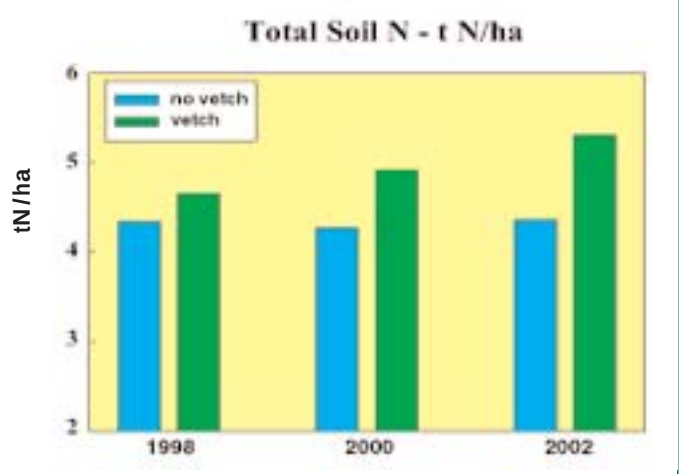
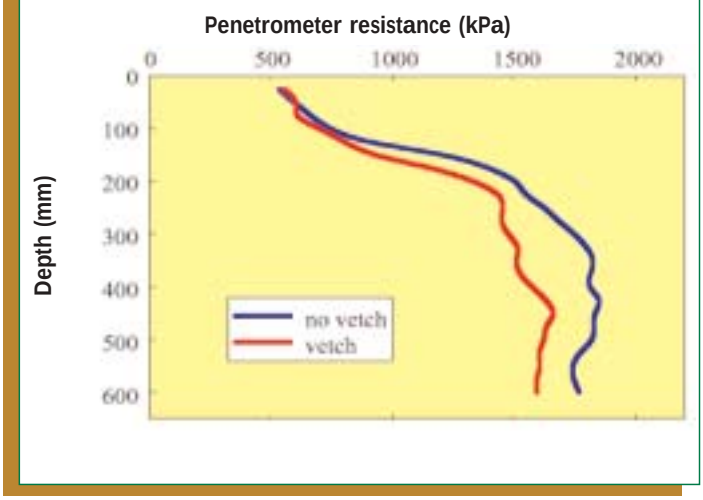


FIGURE 4: Soil strength



cial to the following cotton crops. In 2003, as in previous years, the highest yields were achieved by growing vetch after wheat, and no N fertiliser was required.

In back-to-back cotton systems, growing vetch each winter improved the yield potential of the system and also reduced the N fertiliser required for optimal yield.

The input of vetch stubble has increased the level of organic matter in the surface 30 cm of soil by five per cent over the past six years.

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 (4.0 tonnes per hectare DM) containing 1.6 tonnes organic C and 200 kg N per hectare is critical in maintaining (improving) soil fertility. Soil total N in the surface 30 cm has increased by 800 kg N per hectare over the past six years where vetch has been grown, but has remained the same in the non-vetch systems.

Nutrient uptake by cotton following vetch is also enhanced. Uptake of N, P, K, zinc and copper has increased following vetch, while sodium uptake is reduced, thus providing further evidence for elevated yield potential.

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 and making some nutrients more available to cotton.

COTTON DISEASES

Vetch cropping has been shown to reduce the incidence of black root rot in those areas where the disease occurs. There is little 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 so should be avoided in fields where Fov is present. All rotation crops tend to worsen Fov in the following cotton crops.

CONCLUSIONS

Vetch is a highly efficient N fixer — legume N can replace much of the N fertiliser 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 fertiliser 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 fertiliser 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.

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