Poor sunflower crop establishment can cause major yield losses. To assess the yield reduction expected from sub-optimal plant stands — and decide whether replanting is justified — recent research based on the Central Highlands of Queensland has provided valuable management guidelines.

Sunflower crop establishment and yield compensation

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Under conditions of high sunflower yield expectation (around two tonnes per hectare) a plant population of greater than 20,000 plants per hectare produced satisfactory grain yield. And in situations of low yield expectation (less than one tonne per hectare), a plant population of greater than 10,000 plants per hectare was also satisfactory.

The research indicated that where the plant population exceeds these densities, replanting to achieve a higher plant population would not result in higher grain yield.

But what causes poor establishment and can a sunflower crop compensate enough for low plant density to make replanting unnecessary?

CROP ESTABLISHMENT

A major field survey of summer crop establishment in the Central Highlands examined the yield losses resulting from poor establishment. Yield reduction from poor plant stand ranged from 10 to 60 per cent over all crops, averaging 31 per cent for sorghum and 43 per cent for sunflower. The causes of poor crop establishment are numerous:

Environment

High soil surface temperature may kill germinating seeds or inhibit elongation of the hypocotyl of young seedlings. High temperature also causes rapid drying of soils, reducing the window of opportunity for planting, and leading to high water demand during the summer growing period.

Tillage is the conventional method of seedbed preparation. But this makes the soil prone to slaking and dispersion of aggregates. Infiltration of rainwater into the soil is often limited by surface sealing of cracking clay soils.

Heavy rain soon after planting leads to dispersion of clay aggregates, crusting of the soil surface and increased soil strength, preventing proper emergence of seedlings. This process is exacerbated by high evaporation.

But disturbance of the soil can be minimised by using conservation tillage techniques. Suitable seedbed conditions are needed only in the planting furrow where the seed is actually placed.

This may be achieved by using powered cutting disks in front of soil openers. The use of presswheels has been recommended to improve contact between soil and seed and to improve the transfer of moisture to the seed. Presswheel pressure and shape can be varied to suit the soil type and seasonal conditions. In contrast to the benefits of presswheels, pre-soaking of seed and injection of water into the planting furrow have been ineffective in improving establishment.

Soil insects

Soil-dwelling insect pests often cause crop establishment problems — sunflower being particularly susceptible to damage. The type of damage will depend on which insect species are present and the developmental stage of the crop.

Problem species include wingless cockroaches, black sunflower scarabs, false wireworm beetle larvae, field crickets, black field earwigs and seed-harvesting ants.

These pests are usually present in the soil at the time of planting. False wireworm beetles and larvae feed directly on the germinating seed, whereas black field earwigs attack the growing points and stems below the ground. Wingless cockroach adults and nymphs feed on newly emerged seedlings, chewing the stems at ground level. Seed-harvesting ants collect newly planted seed for storage in underground granaries.

Small germinating-seed baits can be used to estimate insect populations. Baiting during fallow can reduce the necessity for insecticide control to those situations where insect populations exceed economic injury threshold levels.

The use of less susceptible crops (sorghum, wheat) in a crop rotation cycle may reduce the population of an insect pest. Populations of soil insect pests may increase where reduced tillage is practised, especially where large quantities of stubble are retained on the soil surface.

But predator populations also increase under reduced tillage conditions, and sometimes provide adequate control.

Where insecticide is necessary, baits

containing cracked grain, sunflower oil and chlorpyrifos insecticide broadcast at planting may provide effective control.

Seedling vigour

Seed and seedling vigour determines the potential for rapid, uniform emergence and establishment of the young plants. Conversely, poor seedling vigour may increase the time to emergence of sunflower. Seedling vigour affects vegetative growth but has little effect on the final grain yield of field crops.

Trial work in 1992 found that early-emerging sunflower plants had a significant yield advantage over late-emerging neighbouring plants, even when they both had adequate space.

Seedlings with poor vigour are less able to cope with high soil temperature, rapidly drying surface conditions and seedling diseases. Vigour may be improved using modified seed handling equipment and better storage facilities.

Machinery and planting equipment

Seedling emergence is often low because of inaccurate seed metering, poor depth control of planting equipment, excessive sowing speed and undulating micro-relief. Sunflower is often considered to be sensitive to spacing accuracy.

The accuracy of seed metering varies among seed meter and seed tube designs. Airseeders and combines with fluted rollers tend to be variable in seed metering performance. In contrast, finger pickup and pneumatic units in modern precision planters give much better spacing accuracy. Geometric seed tubes also improve uniformity in seed placement. The performance of precision planters depends on metering speed, with accuracy decreasing at higher speed.

In contrast, the accuracy of mass flow meters (such as combines) is not dependant on metering speed. It has been suggested that precision planters would provide little benefit over airseeders when the recommended plant population density was obtained. Precision planters were only worthwhile when the plant density obtained was lower than that recommended.

Farmers often use cereal planting equipment (such as airseeders) for planting row crops, and plant at a high speed. Excessive speed reduces the precision of seed placement at the required depth and the depth of soil cover. The recommended speed is around eight km per hour.

The depth of seed placement often varies on undulating land where rigid implement frames are used. Small variations in sowing depth can dramatically affect yield of cereal crops in which the extension of the coleoptile is limited. But sunflower is generally less susceptible than cereals to variation in sowing depth, although depth of planting is likely to affect health and vigour of seedlings.

Despite efforts to improve establishment and the adoption of better technology, situations still arise where plant stands are unacceptable. Poor crop establishment results in plant stands with a population density well below that recommended for sunflower.

YIELD COMPENSATION

To assess the reduction in yield expected from sub-optimal plant stands, three field experiments were conducted on a black

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earth cracking clay soil at Emerald during 1993. Each experiment was planted on a full moisture profile and was conducted under either fully irrigated (Experiment 1), supplementary irrigated (Experiment 2) or dryland (Experiment 3) conditions.

Experiment 1 was furrow irrigated at regular intervals. No visible signs of moisture stress were observed. Experiment 2 received one irrigation at 43 days after planting (DAP). Experiment 3 was grown under dryland conditions, receiving 34 mm rainfall during the growing period.

Sunflower (Hysun 33) was planted on February 9 at a high rate and hand-thinned two weeks after emergence. Weed control was excellent.

Treatments comprised four levels of plant population (5,000, 10,000, 20,000 and 40,000 plants per hectare).

YIELD RESULTS

- The fully irrigated experiment produced the highest average grain yield in all population density treatments (Figure 1). Grain yield increased from 1,160 to 2,720 kg per hectare between 5,000 and 20,000 plants per hectare but did not increase significantly at higher population density.
- The supplementary irrigated trials produced significantly less yield than Experiment 1 across the entire range of plant population density. Grain yield increased from 840 kg per hectare at 5,000 plants per hectare to 1,470 kg per hectare at 20,000 plants per hectare with no further increase at higher population density.
- In the dryland trial grain yield was lower than the other experiments because of severe water stress after flowering. Grain yield increased from 660 to 780 kg per hectare between 5,000 and 10,000 plants per hectare and did not change with further increase in plant population density.

SOME CONCLUSIONS

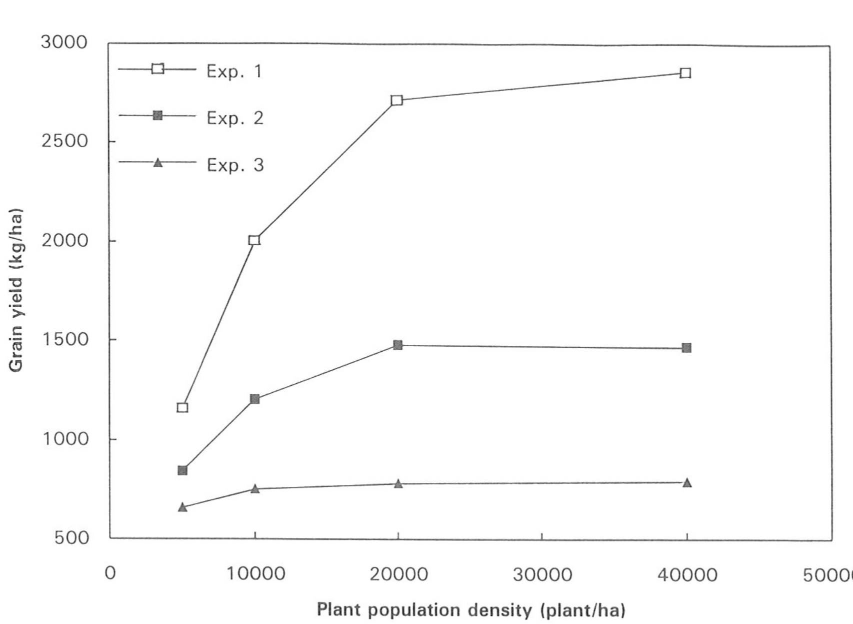
Growing conditions in Experiment 1 were optimal, and the average grain yield (2,900 kg per hectare) provided a comparison for Experiments 2 and 3. Average grain yield in Experiment 2 (1,500 kg per hectare) was similar to that produced by commercial crops under good dryland conditions.

Similarly, average grain yield in Experiment 3 (790 kg per hectare) was similar to that produced by commercial crops under average dryland conditions.

The effect of a reduction in population density depended on the level of water availability.

- Under optimal conditions (Experiment 1), yield was responsive to changes in plant population density. A plant stand of 20,000 plants per hectare produced the same yield as a plant stand of 40,000 plants, demonstrating that sunflower can fully compensate for this reduction in population density when grown under optimal conditions.
- But as population density was reduced further, plants only partially compensated for the increase in area per plant. So grain yield declined at less than 20,000 plants per hectare. In Experiment 2 and 3, grain yield also declined as population density was reduced, but the relative decline was less than in Experiment 1.
- Plants at low population density had access to a larger area per plant and were less limited by water stress. But in plant stands with a population density less than 10,000 plants per hectare, grain yield was reduced.
- Previous studies in a wide range of environments have recommended a population density of 40,000 to 60,000 plants per hectare to achieve maximum yield. Similarly, in this study, maximum yield was attained at 40,000 plants per hectare at all yield levels.

FIGURE 1: Effect of plant population density on the grain yield of sunflower in Experiments 1, 2, and 3 at Emerald, Qld.



THE REPLANTING DECISION

In a situation where poor emergence and establishment reduce the population density of the plant stand, farmers are faced with the decision of whether to replant the crop.

Firstly, farmers must know how much yield is lost in a poor plant stand. Under situations of high yield expectation (2,000 kg per hectare), a population density greater then 20,000 plants per hectare can be regarded as satisfactory.

In this study no yield benefit would be expected from replanting a plant stand greater than 20,000 plants to achieve a higher population density.

In situations of low yield expectation (less than 1,000 kg per hectare), a population density greater than 10,000 plants per hectare can be regarded as satisfactory. Replanting to achieve a higher population density would not result in increased yield.

The decision to replant an unsatisfactory plant stand also depends on factors such as the likelihood of alternative planting opportunities, the reduction in yield expectation from late-planted crops and the extra costs of replanting.

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