Blankets for vegetables

Using frost cloth to protect plants from weather

Integrated Crop Protection
PROTECTING CROPS

Background

Cold winter temperatures are a problem for many vegetable growers. At the least, they reduce growth and yield and extend the time to harvest. However, if temperatures fall below zero the consequences can be devastating. While some crops can recover, for others even a brief period at -1°C or lower can result in total crop loss.

Frost is most likely on calm, clear nights, especially if humidity is low. Under these conditions there are no clouds to reflect heat back to the earth, and no wind to mix the descending cold air with ascending warm air. Temperature changes more quickly when humidity is low, which is why temperatures drop so quickly after sunset in desert areas.

Frost damages plants due to water turning into ice. Formation of ice crystals inside plant tissue ruptures cell membranes, causing the contents to leak out. Even if frost only settles on the surface of the leaf it can draw moisture out, so dehydrating it (Figure 2).

Young, growing foliage is the most susceptible to cold damage. The effects of a frost will be more severe if there was no cold weather to “harden off” – effectively slow down growth – of plants before the cold weather hits.

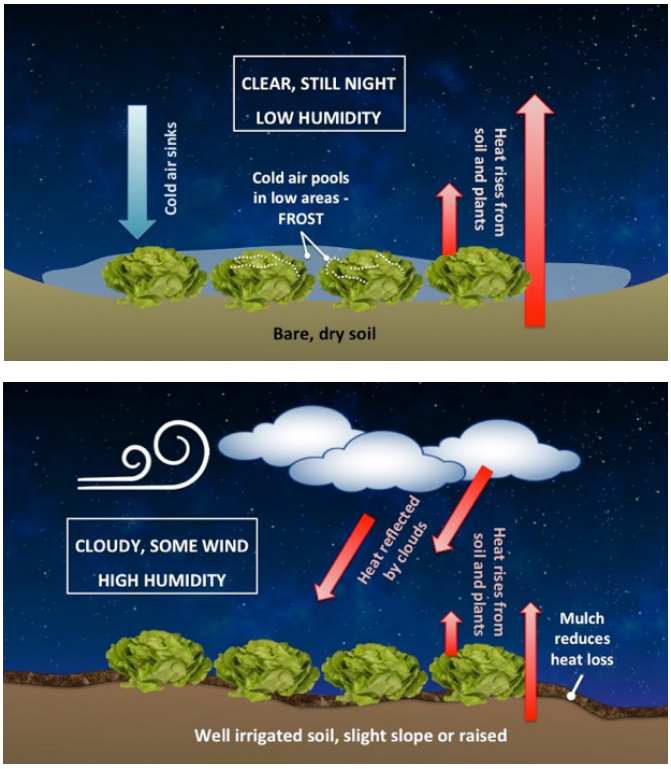

Figure 1. Conditions that make a frost likely (top) and conditions that reduce the chance of frost damaging crops (bottom).

Stopping plants freezing

The traditional way to stop frost settling was to light ‘smudge pots’. Smudge pots burn oil, giving off heat but also smoke, water vapour and other particles. Heat produces air movement by convection, while the smoke forms a kind of ‘blanket’, insulating the crop.

Orchards and vineyards in frost-susceptible areas sometimes install overhead irrigation systems or wind turbines to protect their crops. Even a small amount of air movement or warmth from irrigation water can prevent cold air pooling and forming a frost.

Another way to protect crops is by using a frost cloth. Home gardeners can use sacking or even a cotton sheet

Figure 2. Frost pulls water out of plants (left), while formation of icicles inside the plant tissue break cell membranes, allowing contents leak out (centre). This leaves dark, water-soaked areas on damaged leaves (right).

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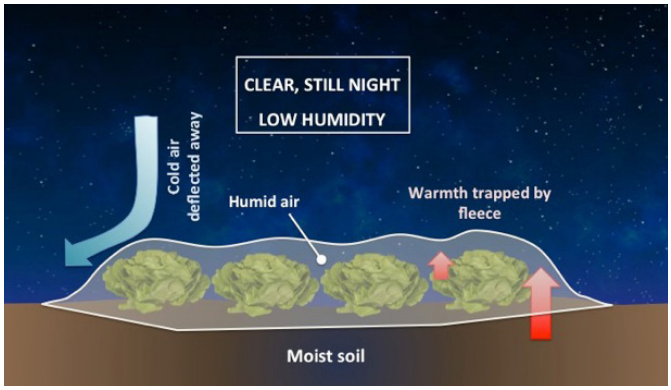

Figure 3. Fleece can prevent frost damage, acting like a blanket over crops.

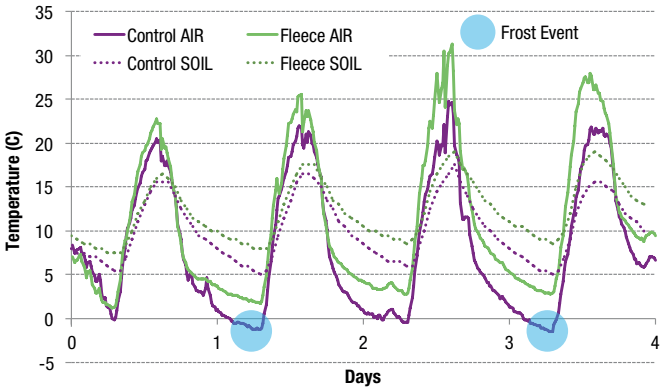

Figure 4. Air and soil temperatures recorded in a vegetable crop protected by 18gsm fleece or left uncovered (control). The fleece increased air temperature by up to 5°C, which was enough to prevent frost damage on days 1 and 3. See explanation of cloth thicknesses (gsm) below.

as a frost cloth, but these have to be removed each morning. Commercial frost cloths are called '**fleece**'. Made of spun bonded polypropylene, fleece remains in place throughout the cropping cycle.

Unlike insect netting, which is a woven material, fleece does not have holes, so presents a continuous barrier to air movement. Fleece therefore acts like a blanket, trapping warmth radiating from the soil, increasing humidity and deflecting sinking columns of cold air (Figure 3).

Keeping plants warm

Fleece can provide benefits even if temperatures stay above freezing because it can raise temperatures in both the soil and the air around plants (Figure 4). Higher temperatures – particularly in the root zone – can increase plant growth rates, especially during colder months.

Table 1 shows average temperature increases under fleece applied directly onto a bed, as it would be to lettuce or babyleaf crops; or draped over a taller crop, such as capsicum plants.

The effect of fleece is most predictable at low temperatures; at temperatures up to 10°C fleece will increase the temperature around the crop by 2–5°C and the soil temperature by 2–3°C.

Under warm conditions the effects are more variable. During a hot day the material can increase air temperatures around the plant by up to 8°C *or* decrease temperature slightly due to shading. The effects vary according to crop, sun strength and wind.

As a general guide, temperature increases under fleece are likely to be halved at particularly windy sites.

AIR TEMPERATURE (°C)	AVERAGE INCREASE UNDER FLEECE (°C)	
	LAID FLAT ON BED	DRAPED OVER PLANTS
-2 – 0	3.0 ± 0.5	ND
0 – 5	2.5 ± 0.5	4.5 ± 1.5
5 – 10	2.0 ± 0.5	4.0 ± 2.5
10 – 15	2.0 ± 1.5	3.0 ± 2.5
15 – 20	3.5 ± 1.5	2.0 ± 2.5
20 – 25	4.5 ± 1.5	2.0 ± 6.0
25 – 30	5.0 ± 2.0	1.5 ± 8.0

SOIL TEMPERATURE (°C)	AVERAGE INCREASE UNDER FLEECE (°C)	
	LAID FLAT ON BED	DRAPED OVER PLANTS
0 – 5	2.0 ± 1.5	ND
5 – 10	2.5 ± 1.5	ND
10 – 15	2.0 ± 1.5	4.0 ± 1.0
15 – 20	1.5 ± 2.0	3.0 ± 2.0
20 – 25	1.0 ± 1.5	2.0 ± 3.5
25 – 30	ND	1.0 ± 4.0

Table 1. Average increases in air and soil temperature gained using fleece laid flat on the bed, e.g. lettuce, or draped over plants, eg capsicum. The ± values indicate the range for 95% of readings.

Protecting plants from weather

Wind causes physical damage as well as pulling moisture out of plants. Fleece is an effective wind-stopper, which is another reason it increases shoot growth. For example, young capsicum plants grown under fleece were 42% larger than those grown in the open. The leaves were larger and appeared cleaner and healthier.

Decreasing air movement around plants and over the soil increases humidity and reduces evaporation (Figure 5). This effectively reduces irrigation requirements, supports even growth and lessens plant stress. If a severe frost does occur, well hydrated plants will be less susceptible to the dehydrating effects of ice crystals on the leaves than plants that are already wilting.

Keeping soil moist after seeding optimises germination, particularly for small seeded crops. Fleece has been shown to increase germination of lettuce when placed over freshly seeded beds.

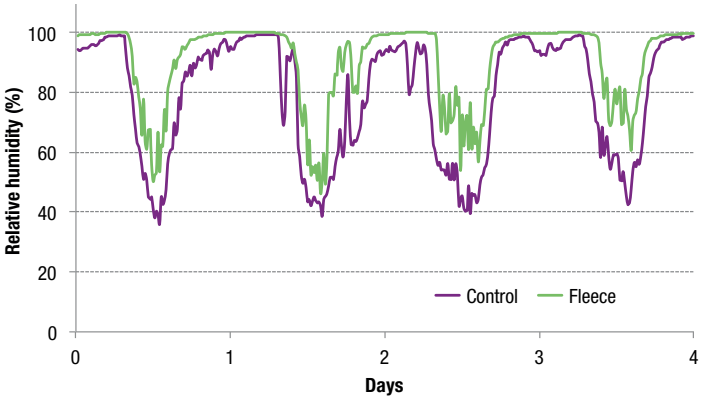

Figure 5. Relative humidity (RH) recorded in a vegetable crop protected by 18gsm fleece or left uncovered (control). During the day, average RH was 12% higher under the fleece compared to the uncovered cropping area.

Which thickness of fleece should I use?

Fleece comes in various thicknesses, ranging from 17g to 50g for 1m^2 (expressed as grams per square metre or gsm). Thinner materials are lighter, cheaper and more translucent. Although very lightweight fabrics tear easily when handled, they offer less wind resistance, so can prove surprisingly durable under windy conditions.

Thickness has little effect on the insulating properties of the material; temperature around the plants is increased due to restriction of air movement, so the thickness of the barrier itself is less important. Heavier materials may increase soil temperatures slightly compared to light materials, but the benefits of increasing the weight of the fleece are small.

When and how do I apply fleece?

Installing fleece early in the cropping cycle will optimise its effectiveness. As the material protects young plants from wind and dehydration, it helps them to establish more quickly.

In Europe, large areas are covered. These materials are rolled off large spools mounted on tractors (Figure 6). They can be retrieved using machines, which tension and roll up the material. Small areas can be installed by hand, although several sets of hands are needed.

There are a number of options for keeping the cloth in place:

- Plastic pegs are a fast way to secure fleece, but are likely to tear the material unless the site is very well protected and the peg is put through a double layer of material. They also add cost and must be retrieved after use
- Sandbags can work well if the material needs to be lifted regularly (eg for weeding), but are heavy and add significant labour
- Shovels of soil every few metres are generally the easiest and cheapest method

Figure 6. Fleece laid over direct seeded lettuce beds (L). Fleece can be laid over large areas using mechanised systems Source: Crop Solutions UK

Figure 7. Growth of babyleaf lettuce under fleece compared to the uncovered control. Crop grown during winter in south-west Sydney.

Fleeces are usually removed just before harvest. However, for some leafy crops, it may be better to remove the material a week before harvest. This allows plants to harden up, potentially increasing post-harvest storage life.

In most situations, fleece is single-use because it is too fragile to withstand multiple cropping cycles. Also, recycling fleece could infect a new crop with disease, weed seeds or pests.

The cost of disposing of used fleece therefore needs to be included in any analysis of the cost:benefit of this system.

What are the effects on yield and quality?

If growing conditions are adverse, the effects on yield of babyleaf crops can be dramatic. For example, in one trial in Camden, NSW, a number of frosts occurred during production (Figure 7).

- Germination was greatly increased under all the fleeces tested

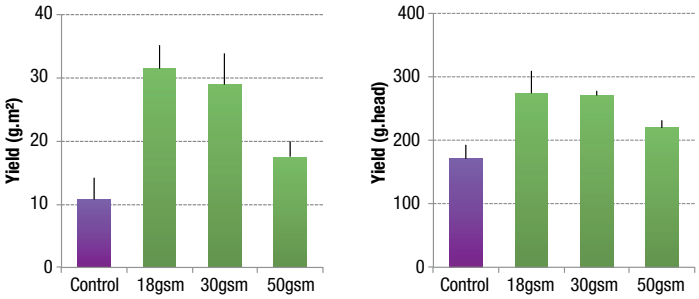

Figure 8. Differences in yield between uncovered (control) lettuce and lettuce grown under different thicknesses of fleece. Multiple frosts occurred in Camden (L), whereas temperatures in Werribee (R) did not drop below 1.6°C.

- Lettuce under the frost protection material was ready for harvest two weeks before the uncovered plots
- Total yield almost tripled

If weather is mild then the benefits of fleece will be less marked, but may still be significant. For example, yield of winter-grown head lettuce in Werribee was increased by almost 60% under fleece, even though night temperatures rarely fell below 4°C (Figure 8).

Applying 18gsm fleece to young capsicum plants in Bundaberg increased yield by 29%. Heavier materials had less effect.

One major additional benefit may be the reduction in pest and non-pest insects. Contamination with insects such as Rutherglen bug and plague soldier beetle can be major issues at certain times of year (Figure 9). A thoroughly secured fleece can exclude such pests, ensuring the harvested product is insect free.

For more information, visit the AHR website at www.ahr.com.au or contact Dr Jenny Ekman on 0407 384 285.

Figure 9. Rutherglen bug infestations can be dealt with effectively by excluding them with barriers such as fleece.

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