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Windbreaks for horticulture on the Swan Coastal Plain

By Neil Lantzke, Development Officer, South Perth

Introduction

On the Swan Coastal Plain, high wind speeds cause problems on most horticultural properties. The dominant wind direction is from the east in the morning and from the south-west in the afternoon. In winter strong winds can also come from the north-west with the approach of cold fronts.

The establishment of well designed windbreaks will help achieve high yields and quality for most horticultural crops. Windbreaks have a number of benefits.

Reduced plant damage

Windbreaks decrease the incidence of broken stems, leaf loss and lodging of plants. The percentage of fallen and blemished fruit is reduced. Vegetable crops are protected from sandblasting.

Increased plant performance

Trials of various crops have shown that windbreaks can increase yield. Strong, hot winds increase evapo-transpiration, causing moisture stress so that more frequent irrigation is required. In winter cold, dry winds cool the soil and plants slowing growth and delaying crop maturity. Wind reduces the activity of insect pollinators.

Increased sprinkler uniformity

Windy conditions can greatly reduce the uniformity of sprinkler irrigation. Investigations by Agriculture Western Australia have shown that yield variation due to poor irrigation uniformity is common on many properties. Reducing wind speeds allows irrigation systems to function more efficiently.

Decreased wind erosion

Bare, cultivated areas such as those during fallow periods on vegetable properties are prone to erosion by wind. Windbreaks can help alleviate this problem.

Increased spray efficiency

Windbreaks reduce spray drift, this increases the efficiency of pesticide applications. Reduction of wind speeds also increases the number of days in the year when spraying is possible.

The benefits of windbreaks have to be weighed against possible disadvantages. Money and time are needed to plant the trees, and the area in which the windbreak is planted is lost to production. Windbreaks require maintenance if they are to function properly. Roots and branches may need to be pruned to prevent competition with the crop and the windbreak needs to be irrigated and possibly fertilised. In most situations on the coastal plain the advantages of a well designed and maintained windbreak outweigh the disadvantages. However, on properties where the production area is in a more protected location or where land is limited windbreaks may not be warranted.

Windbreak design

Before planting trees considerable thought must go into planning the design of the windbreak. Poorly designed and sited windbreaks interfere with farm operations and may need to be removed at a later date.

Orientation

To provide maximum protection windbreaks should be at right angles to the dominant or most damaging wind direction. Therefore on the Swan Coastal Plain wind-breaks should ideally be designed to run north-north-west to south-south-east.

Windbreaks can be placed around all sides of the production area to cover all wind directions. Windbreaks running east-west may cause shading of crops to the south of the windbreak in winter resulting in reduced production.

Other factors may affect the orientation of windbreaks, for example, the windbreak should be compatible with the overall property plan. You may have to realign roadways and other structures to gain maximum benefit.

Windbreaks on ridges increase turbulence on the down-wind side. If possible, it is better to locate the windbreak downslope from the top of the ridge so that the top of the trees are about level with the ridge top.

Permeability

An effective windbreak should filter wind rather than present a solid barrier to it. A solid barrier diverts wind over the top, creating turbulence on the leeward side.

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Ideally windbreaks should have a permeability of about 50 per cent. This means that thick, bushy windbreaks need to be trimmed. Foliage should extend to the ground or the wind will blow under the foliage creating turbulence.

Access and gaps

Gaps in a windbreak will cause the wind to tunnel and can increase plant damage. Access roads through windbreaks can be protected by planting an additional short windbreak at least twice the length of the gap to the windward side of the access road. If a tree dies another should be planted, otherwise turbulence will occur downwind from this area.

Height

The higher a windbreak the larger the area it will protect. However, windbreaks over 6 to 10 m tall often become difficult to manage and cause excessive shading of crops.

Windbreaks offer good wind protection at ground level to a distance of 4 to 6 times their height and adequate protection to a distance of about 10 times their height. For example, a 10 m high windbreak will give adequate protection at ground level for about 100 m downwind from the windbreak. The protection offered to orchard, grapevine and other taller crops will be less because of their height above the ground surface.

Set back distance from crop

To reduce shading and competition from tree roots, windbreaks should be planted at least 10 m from the cropping area. A greater buffer area is needed for tall windbreak species. Sufficient room should be left to allow ripping of the tree roots and vehicle access and turning space. A greater distance between crop and windbreak is required when trees are planted to the north of the cropping area so as to minimise shading in winter.

Frost

Cold air flowing downhill can be trapped or dammed up behind a dense windbreak causing frost damage in susceptible crops. On sloping areas a windbreak above the crop can reduce this problem by preventing cold air from flowing into the cropped area. Windbreaks in the crop should be sited on hillsides with sufficient gradient to allow the cold air to flow downhill out of the crop. The lower end of the windbreak must not be blocked, so that cold air can move away freely. Alternatively, deciduous trees can be used in frost susceptible locations.

Establishment and management of windbreaks

Ground preparation

Deep rip the soil along the line where the trees will be planted. Some trees such as casuarinas may suffer from iron chlorosis if planted on soils with shallow limestone.

Transplanting

You can propagate trees from seed or cuttings or you can buy them from a nursery. If buying transplants from a nursery check to see that the seedlings are not root bound. This can cause strangulation of roots which restricts the growth of new roots into the soil and may cause the trees to blow over in strong winds. Seedlings must not be allowed to dry out or they will suffer from transplanting shock and subsequent growth will be checked. The best time of year for planting is following the first autumn rains, but with irrigation, trees can be planted at any time of the year.

Tree spacing

Most trees should be planted in a line about 1.5 to 2.0 m apart. Eucalypts however should be planted at a 3 to 4 m spacing. If sufficient ground is available multiple row windbreaks can be planted, i.e. a second parallel, but offset, row of trees can be planted about 2.5 m from the first row. Alternatively, a small tree or shrub can be planted on the outside and a tall tree on the inside of the windbreak.

Weed control

Before the trees are planted kill weeds in the 1 or 2 m wide planting area by cultivation and/or with herbicides. A non-residual herbicide such as paraquat, diquat or glyphosate can be used. For the most effective weed control use a residual herbicide such as simazine or Flandor® as well as a knockdown herbicide. If using a residual herbicide wait at least 2 weeks before planting the trees. Black plastic or organic mulches can be laid before planting to control weeds.

Weeds in established windbreaks should be controlled as necessary by herbicides or cultivation. Grass weeds can be controlled with selective grass herbicides such as Fusilade® or Sertin®. Other weeds need to be controlled by a directed spray of glyphosate or Basta®. Care must be taken as spray drift of these herbicides can damage or kill trees in the windbreak. Always read the label before applying chemicals. Contact chemical companies for more detailed information and recommendations.

Pruning and trimming of branches

Almost all tree species require pruning and trimming to maintain a suitable windbreak shape. In some trees corrective pruning in the first year or two may be necessary to maintain a single dominant leader. After the first 2 to 3 years, side trimming of branches may be needed every second year. Side trimming is necessary to maintain about 50 per cent porosity and prevent the tree from becoming too wide. This can either be done by hand or with a pruning machine. Trees should not be lopped until they reach the final desired height.

Managing the root system

A major problem with some windbreak species is invasion of tree roots into the production area. At Medina Research Centre, roots from a casuarina windbreak were detected in the crop area about 20 m from the windbreak. For species with extensive, shallow root systems root pruning should be done at an early stage to encourage deeper rooting. Roots should be ripped to a depth of at least 1 m at a distance of about half the tree's height. On deep sandy soils it is likely that the tree roots will, with time, grow below the rip line and resurface. On these soils the roots of established trees should be ripped at 3, 6 and 10 m from the windbreak to help prevent roots

invading the crop area. Irrigation of the windbreak will reduce the extent of root invasion into the cropped area.

Irrigation

Irrigation is essential for establishment. Once established, irrigation ensures sustained growth of the trees and reduces root invasion into the production area. Drip or sprinkler irrigation can be used. Water at about 50 per cent of pan evaporation.

Fertiliser

Trees respond to fertiliser when the existing soil nutrient levels are low. On newly developed, sandy soils a light basal dressing of macro and trace elements can be applied before transplanting. About 100 g of a NPK plus trace element fertiliser per tree is sufficient. Alternatively, a slow release fertiliser with a 3 to 4 month release period can be used. To increase growth a light dressing of nitrogen can be applied annually. Apply fertiliser over the whole root zone of the plant rather than just at the base of the tree.

Pest and disease control

Some windbreak species may be damaged by specific insects and diseases. Spraying pesticides on a mature windbreak may be costly. Choose a tree species that has a low risk of being attacked and if pest or disease problems occur spray the trees as soon as possible. Stock should not have access to windbreaks at any time or they will graze the lower foliage.

Suitable tree species for the Swan Coastal Plain

Many species have been evaluated for their potential as windbreaks. No one species possesses all of the following beneficial criteria: cheap, fast growing, upright habit, retention of lower branches, immunity to pests and diseases, 50 per cent porosity to wind, non competitive or non intrusive root system, branches which don't break in strong winds, minimal suckering and easily trimmed or hedged. The following species are most suitable for use as horticultural windbreaks on the Swan Coastal Plain.

Casuarina species

Demonstrations by Agriculture Western Australia have shown casuarinas to be one of the best species for windbreaks on horticultural properties on the Swan Coastal Plain. The best performing casuarina species in most cases is *Casuarina cunninghamiana* (river sheoak).

This tree is native to eastern and northern Australia and grows to about 15 m high. River sheoaks are fast growing and have a good shape and form to reduce wind speed.

On heavier soil types *Casuarina glauca* (swamp oak) and *Casuarina obesa* (also called swamp oak) have also performed well, though they are more prone to splitting in high winds.

On white and pale grey sands *Casuarina equisetifolia* (coastal sheoak) performs well, though the tree shape is fairly open possibly allowing too much wind to pass through. All casuarina species are resistant to almost all pests and diseases (including weevils). Rabbits like to eat young casuarina seedlings and if present, should be controlled before transplanting.

Like all natural windbreaks casuarina windbreaks need to be maintained. Lack of pruning, ripping, irrigation and weed control will usually result in a poor windbreak.

Particular care must be taken when using casuarina windbreaks for drip irrigated perennial crops. If the tree's roots are not adequately pruned they will grow into the production area, seriously competing with the crop and even entering into the drippers.

With annual crops the problem is less severe as any shallow tree roots in the cropped area are destroyed by the cultivation before each crop. The setback distance from the windbreak may need to be increased when growing drip irrigated, perennial crops.

Eucalyptus species

A number of eucalyptus species have been used for windbreaks on horticultural properties. Limb breakage on mature trees during high winds can be a problem and with many taller species an additional, lower growing species is needed to fill in holes in the base. Eucalyptus are prone to attack by a range of insects. Spacing between trees should be 3 to 4 m. Species that may be suitable are listed in Table 1.

Exotic deciduous trees

The three main deciduous groups that are suitable for boundary and internal orchard windbreaks are *Populus* (poplars), *Salix* (willows) and *Alnus* (alders). All are moderate to fast growing and respond well to intensive management and side trimming.

Deciduous trees provide less wind protection during the winter months. This is a disadvantage for annual vegetable cropping and evergreen perennial crops. Poplar rust affects poplars, though some species are resistant. The Tasman poplar (*Populus x euramericana* hybrid) and *Alnus cordata* (Italian alder) have performed well on windbreak trials at Manjimup Research Station. Willows are a host for the carrot aphid, which is a pest of carrots, parsnips and celery.

Pinus radiata

This tree is fast growing and reaches a height of 15 to 20 m. Pines are suitable for planting as windbreaks on horticultural properties though they have some limitations.

Older radiata trees become too open at their base and often require an underplanting of a shade tolerant, lower growing species. This lower growing species should be planted at the same time as the pines.

Other problems with radiata trees include a canopy which is too dense when young, too wide a circumference when older and a poor ability to form a hedge. Limited side pruning just before the spring flush is useful in younger trees. *Pinus pinaster* is more suited for planting on white sands.

Cypress species

Cupressocyparis leylandii (clone Naylor's Blue) has been trialled in the south-west of Western Australia with

encouraging results. It is a hardy, fast growing species that has a narrow, columnar shape. It will grow at a rate of about 1.5 m a year and reach a maximum height of about 15 m.

Another cypress that may perform well is Leighton's Green, however, it is slower growing than Naylor's Blue.

Cypress species can be killed by the fungal disease *Seiridium*. Care should be taken so that the disease is not brought in on the trees when coming from the nursery. *Seiridium* is spread by rain splash from infected plants. If present the disease should be immediately controlled by fungicide applications.

Bana grass

Bana grass grows rapidly to about 3 m within 6 months and will reach a mature height of 4 to 5 m. It is usually planted from cuttings in spring at a spacing of 60 cm. The plant is erect growing and there is little lodging or lateral spreading.

Negative characteristics include lateral root growth, shedding of leaves, creating a fire hazard and poor wind porosity creating turbulence. As bana grass is very quick growing it is useful as a temporary windbreak. It can be removed by slashing and spraying the regrowth with glyphosate, however, some people have reported difficulties killing the plant.

Table 1. Other species that may be suitable for windbreaks on horticultural properties on the Swan Coastal Plain

Small trees	Large trees
Melaleuca nesophila	*Eucalyptus botryoides* (southern mahogany)
Melaleuca lanceolata	*Eucalyptus gomphocephala* (tuart)
Eucalyptus decipiens	*Corymbia maculata* (spotted gum)
Eucalyptus platypus (coastal moort)	*Eucalyptus grandis* (rose gum)
Eucalyptus lehmannii (bushy yate)	
Eucalyptus cladocalyx (dwarf sugar gum)	
Acacia iteaphylla	
Acacia celastrifolia	
Callitris priessii	

Large trees are generally only suitable for external windbreaks and need to be placed further from the crop area to prevent competition. Smaller trees can be used for both internal and external windbreaks.

Artificial windbreaks

Artificial windbreaks can be used on the boundary of the property but, because of cost are usually used as smaller, internal windbreaks. Farmnote 24/84 'Building a synthetic windbreak' details how to construct synthetic windbreaks.

Nursery crops of cereal rye

Nursery crops of cereal rye or other cereal species can be planted between the rows of direct seeded vegetable crops such as carrots and onions to reduce sandblasting of emerging seedlings. Cereal rye is tough and withstands sandblasting much better then other cereals. It is sown at a rate of about 50 kg per hectare. The cereal rye is killed with a selective grass herbicide once the crop is established and before the cereal rye seriously competes with the vegetable crop. Nursery crops only protect the emerging seedling and do not offer many of the other advantages of windbreaks that are listed above.

Further reading

- Farmnote No. 24/84 'Building a synthetic windbreak'.
- Farmnote No. 52/94 'Wind and bird protection of table grapes in Carnarvon'.
- Agriculture Western Australia Information Sheet No. 25 'Establishing natural shelter belts in Carnarvon'.
- Agriculture Western Australia Bulletin No. 4174 'Tree planting on farms in high rainfall areas'.
- Agriculture Western Australia Bulletin No. 4206 'Trees for farms'.

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