The Use of Polypropylene shelters in Grapevine Establishment – a Preliminary Trial. By Graham Due.
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The use of polypropylene shelters in grapevine establishment - a preliminary trial

Graham Due

Abstract

Tubular polypropylene shelters were installed over young grapevines at four sites. Lateral growth was suppressed, and the vines grew straight, eliminating the need for summer training. Where tubes were applied before the end of summer, there were no difficulties with downy mildew or oidium. Botrytis affected old leaves which were senescent when the tubes were installed. The tubes delayed the attack of wingless grasshoppers, but when applied late they did not eliminate vine moths which were already resident. The tubes protected vines from glyphosate applied from a rotary atomiser. Tubes appear to extend the growing season, and growth was greatly increased at all except one site, where there was no effect. The growth of unirrigated Trebbiano vines, under hot, dry conditions, exceeded l2mm/day in one month. Evidence from the trial suggests that the colour of the tube could have an effect on growth.

Introduction

For several years, European foresters have been using polypropylene tubes as an aid in the establishment of trees, with about a million shelters being used in 1983/84 (Tuley, 1983, 1985). The system has obvious advantages, including protection from rabbits, protection from herbicide drift, and the easy establishment of a straight trunk. Less obvious, advantages include more rapid growth, not just height but biomass accumulation. In some cases height growth was over three times that of a control.

The system is easily adapted to viticulture, because the trellis wire can be used to support the tube. Although the cost of the tube is high, potential savings would be large if training could be simplified substantially from the usual procedures of twining vines around a string. Further savings could be possible if the establishment of weed control was facilitated, or if the installation of irrigation could be delayed or eliminated, or if vines could be planted as cuttings rather than rootlings. Accordingly, it was decided to establish a series of trials to test the practicality of the system.

Materials and methods

The tubes were triangular in shape, 90 mm on a side. They ship flat, fully assembled. The material was translucent white, U.V. stabilised polypropylene, similar in construction to corrugated cardboard. The material has been demonstrated to last more than three years under Australian conditions. Various colours were used in one of the trials to check for effects on lateral and extension growth, since growth effects due to light colour have been demonstrated in several species (Mortensen and Stromme, 1987; Casal and Alvarez, 1988). The colours used were translucent white, yellow, green, blue and fluorescent pink, orange and yellow. The fluorescent colours were chosen because they fade quickly, providing an effect of colour early, then allowing maximum light access.

Four vineyard sites were involved in the study:

Euroa

This site is located on a creek flat, with a soil of granitic sand grading into a clay subsoil at 15-45 cm. Own rooted Trebbiano and Viognier vines were used in this trial. Trebbiano is reputedly drought tolerant (Viala and Vermorel 1901-1909), and experience at Euroa suggests that Viognier is more difficult to establish under harsh conditions. Rootlings, rather below normal commercial quality, with an average cane length of about 12 cm, were planted directly into an established pasture. Spring weeds grew unchecked until the shelters were in place (December), by which time most of surface moisture was exhausted. The climate at Euroa is hot, with a mean January maximum of 36°C; temperatures of 44°C were recorded during the trial. No irrigation whatev-

Fig. 1. Weed control at Euroa. Vines were unaffected by normal rates of glyphosate.

er was applied, and in the seven months from September to March, inclusive, there was less than 100 mm of effective rainfall (calculated per Due, 1988). Evaporation over this period is typically above 1300 mm at Euroa, calculated by Lincare's (1977) method. Finally, in mid-December, there was a severe infestation of wingless grasshoppers, and any shoots they encountered were stripped of leaves and green bark. This site therefore constituted a severe test for the system.

Lyndoch

The soil at this site was a cracking black clay. The trial area was a patch in which growth had been inadequate, and the own-rooted vines had been replaced with grafts: Cabernet Franc on S04 and 5BB. The vineyard is irrigated and weed control is good. The vines already established in the neighbouring rows provided good shelter for the vines in the trial. The effectiveness of shelter from row crops is substantial (Arkin and Perrier, 1974), and the site, therefore, provided very mild conditions, although foliar symptoms of a trace element deficiency were observed. At the start of the trial, the average shoot was 71 cm long, with 28 nodes and an internode length of 2.6 cm.

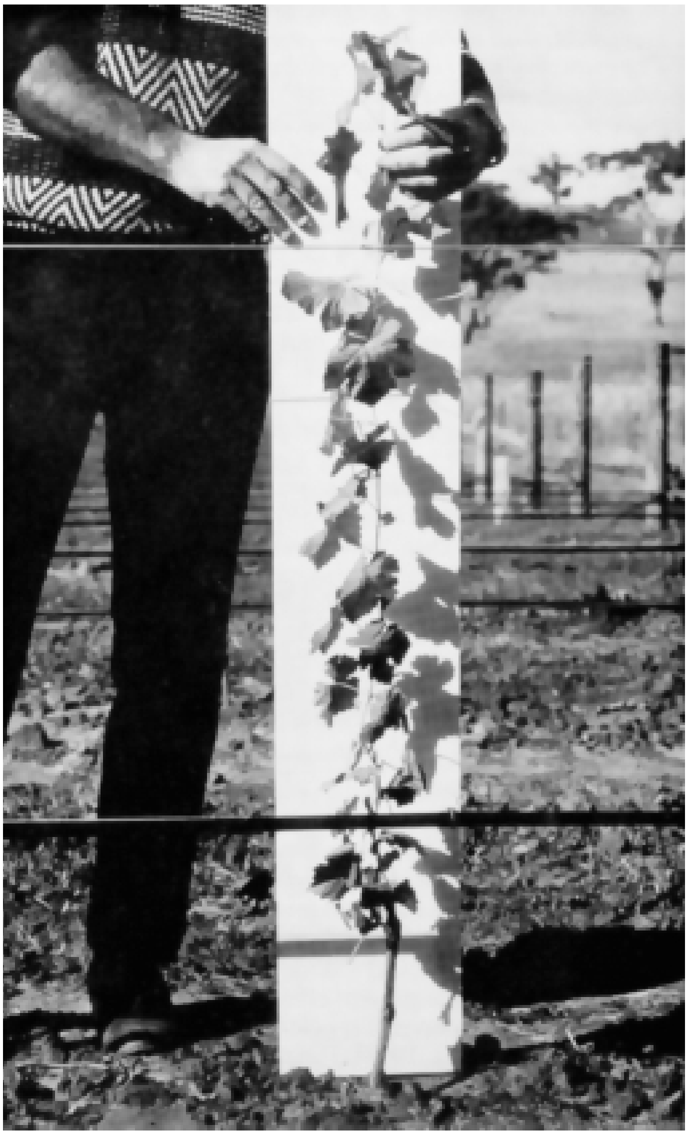

Fig. 2. Vine form at Angaston. Internodes are slightly elongated and laterals are suppressed.

Angaston

This site is on a hillside with shallow red clay loam overlaying sedimentary rock. The outermost row of the trial was close to trees, and was correspondingly poor. Some irrigation had been applied, but there was severe damage due to rabbits and moths. At the time of applying the treatment, many of the vines had suffered drought, and basal leaves had been lost. In almost all cases, the shoot top had dehisced. Limited irrigation was applied. The variety is non-clonal own-rooted Shiraz, and the average shoot was 15 cm long, with 13 nodes and an internode length of only 1.2 cm, reflecting the stressed conditions of the vines.

Lenswood

This site is also on a hillside, with a shallow clay soil overlaying sedimentary rock. Limited irrigation water was applied. The vines were small and not growing vigorously, but they were not stunted. Of the three South Australian trials, this most nearly reflected typical commercial conditions. The variety is clonal own-rooted Merlot. At the start of the trial, the average shoot was 35 cm long, with 23 nodes and an internode length of 1.5 cm.

Measurements consisted simply of shoot length, with node number also being counted at the beginning of the trial at the three South Australian sites. At Euroa, temperature-sensitive labels (Radiospares 555-392) were inserted into 20 of the tubes, each colour being represented at least once, and the effects of the various colours on lateral growth, shoot morphology and leaf colour were observed.

Tubes were installed on 29 November at Euroa, 9 March at Lyndoch and Angaston, and 23 March at Lenswood.

RESULTS

Application

Installation of the tubes was simple and quick in all cases where vines had made little growth. Larger vines were difficult to insert into the tubes, especially at Lyndoch, where the leaves were large. Normally the tube would be applied before leaves had appeared, and would be very simple. At Euroa, strong wind dislodged some of the tubes. This was remedied quickly by attaching some tie wire around the flat side of the tube and onto the trellis wire. Removal and replacement of the tube was found to be simple, except where leaves were large. Early adjustments to pruning (such as removal of excess shoots) would be easy to make. "Hilling-on" of inter-row soil onto the undervine strip did not disturb the tubes.

Some aerodynamic aspects of the tubes became clear quite early. First, the air in the tube does not mix well with the outside air, so that the vine leaves remain moist, even on hot days. In the late afternoon, as temperatures fall, tens of cm^3 of water accumulate in the tube and are returned to the soil. This appears to be a major mechanism of water conservation. Secondly, if there is a gap between the bottom of the tube and the soil, then dust and soil are sucked into the tube, coating its sides and the leaves of the vine. This would most likely occur on a windy day.

Since a large part of the effectiveness of the tubes relies on reducing air movement around the vine, care should be taken to ensure that the tubes are well inserted into the soil.

Temperatures

Temperatures were higher in tubes, and vines in shelters were- unaffected by frost late in the season. The maximum temperature recorded was 54°C for all colours, including black; an increase of 10°C over ambient. Despite these very high temperatures, there were no symptoms of damage to the vines. Experience with heat therapy shows that carbon dioxide enrichment and restricting root growth are needed to aid survival at a continuous 40°C, but in this trial temperatures would fall at night, presumably allowing recovery (Kriedeman et al, 1976). Since few other organisms can survive these temperatures, the tubes provide protection against almost all fungi and most insects, at least during the summer months.

Fungi

Since oidium and downy mildew do not survive well beyond 37°C, they would not persist after the tubes reached those temperatures (T. Wicks. pers. comm.). The first sunny day over 27°C would therefore kill these fungi, since the tubes would then reach 37°C. These conditions would occur between September and October in most Australian climates. Once eliminated, reinfection would occur only through airborne spores. Downy mildew spores would be absent in a well-managed vineyard but oidium spores can travel great distances and could be precipitated with rain (T. Wicks, pers. comms.).

Downy mildew severely damaged the vines at Lyndoch, but was not noticed at the other sites. The trial at Lyndoch was started late in the season, and the infection observed could have been present when the tubes were installed. In cases where tubes are placed on vines and hot weather is not expected, a copper spray would be advisable.

Botrytis affected basal leaves on some vines at Euroa and Lenswood, but was more common at Angaston. *Botrytis* attacks dead material, and at Angaston many of the basal leaves were severely stressed. This source of infection could be a problem in the next spring, when conditions in the tubes are warm and humid, but not hot enough to kill the fungus. Girdling of tender new shoots could occur unless a fungicide is applied (T. Wicks, pers. comm.). *Botrytis* survives in the soil, and clearly soil temperatures were not elevated enough to kill the organism, even at Euroa. *Botrytis* was not reported as a problem in Tuley (1983, 1985).

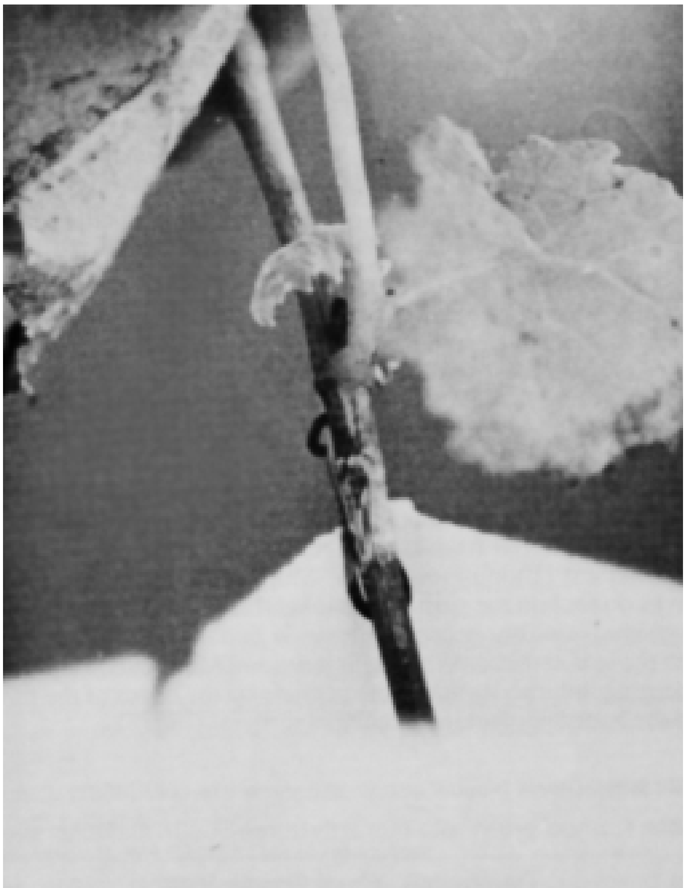

Fig. 3. Superficial damage caused by chafing on the edge of the tube.

Insects

At the South Australian sites, the tubes were installed after the hot weather, and moths already present on the vines at Angaston and Lenswood were not removed and continued browsing throughout the trial. Slugs and snails were observed in tubes at Lenswood, where some weeds had broken through the undervine herbicide.

At Euroa, wingless grasshopper infestation was intense: estimated at over $20/m^2$. Damage to vines still inside in the tubes was much less than to those which had grown out, because vines inside the tubes are only visible from above, and then only poorly for blue, green and black tubes. In late December, less than one tube in 10 had a grasshopper, and grasshoppers seemed unable to escape the tubes. No control was attempted and by the end of the season most vines had been damaged to some extent.

Vines in tubes can be protected from insects in several ways. First, as the experience with grasshoppers indicates, tubes provide some protection from adult insects, even if only because they conceal the vines. In spring, tube temperatures would reach more than 40°C, which would kill pupal stages of most insects. Summer heat would achieve temperatures of more than 50°C, which kills most insects. Soil temperatures are not raised much, and pests such as cutworm and curculio beetle could probably migrate into the tubes, unless they were inserted deeply into the soil. Those inside the tube could do considerable damage. Newly developed persistent pyrethroids, applied prior to installation of the tubes, have been suggested as a means to control these, and most other insects in tubes (P. Bailey, pers. comm.). Garden weevils can walk on plastic, but in many cases the tubes should act as a barrier to adults, and the heat inside the tubes will kill most insects, and insecticides might not prove necessary (P. Bailey, pers. comm.). Lastly, the top of the tube can be blocked completely if necessary without affecting growth (Tuley 1985).

Nutrition

Nutrition of the vines was not apparently affected by the tubes, except at Lyndoch, where the foliar deficiency symptoms already present in the control vines seemed to be worsened slightly, and nitrogen deficiency appeared. Nitrogen and potassium deficiencies can be difficult to control in glasshouse grown grapevines where humidity is high and root temperatures are low compared with the foliage (Goldspink, pers. comm.).

Weeds

At the Euroa site, weed control was easily achieved (Fig. 1.). Glyphosate was applied in still weather with 150 µm droplets from a spinning disk ULV atomiser (Fig. 1). The tube height was 900 mm and the height of the atomiser was 450 mm. There was no evidence of herbicide damage on any vine.

Weeds appeared in some tubes toward the end of the trial. The competitive effect of these weeds is unknown, but the tubes are easily detached from the trellis wire and slid upwards sufficiently to allow weeding, should it be deemed commercially justified.

The effect of different colours

The effect of different colours on growth was difficult to assess, because of the erratic nature of grasshopper attack. In broad terms, fluorescent pink, orange and yellow faded quickly and seemed to have the same effect as white tubes. Black tubes completely suppressed lateral growth, produced long, thin intemodes and the basal leaves seemed to be lost early. The remaining leaves were a healthy green. Yellow tubes produced etiolated vines, with uniformly straw yellow internodes and leaves. Basal leaves were lost early, and lateral growth suppressed.

Green and blue tubes produced leaves which were consistently more green than the other colours. Mortensen and Stromme (1987) observed a similar greening from blue light, and associated effects were a reduction in dry weight and leaf area, shortening of shoots, and promotion of lateral shoots. These effects were not observed in this trial, but might be considerable. The choice of colour for shelters therefore needs further research.

Phenology

The increase in air temperature in the tubes can be expected to extend the growing season of the vine. At Angaston, of the 13 vines described as dormant on 1 June, only two were in tubes. Conversely, eight of the nine vines which still had an actively growing shoot tip were in tubes. Differences were yet to appear at the other sites. Maturation of wood appeared to be satisfactory in the more advanced vines at Euroa.

Vine morphology

There was little lateral growth in tubes, except at Euroa, in the vines which had been damaged by grasshoppers. Of 40 vines inspected, two had laterals more than 60 mm long, and none of the remainder had laterals longer than 15 mm. Generally, however, lateral growth would be practically inconsequential for vines grown in tubes.

The shoots of vines grown in tubes were typically straight, with rather long intemodes (Fig. 2). This is expected, since these vines are sheltered from mechanical stress, and are in a humid environment (Biddington, 1986; Mortensen, 1986). Although leaves do foul on the sides of the tube, this did not seem to cause problems, possibly because internode expansion ceases earlier than the leaf at the same node (Schultz and Matthews, 1988). On emerging, internodes are prone to chafe on the edges of the tube, but the resulting damage is only superficial (Fig. 3).

Vine growth

Table.l. Shoot growth of vines at the three South Australian sites.

Site	Treatment	Shoot Growth (cm)		
		Maximum	Average	No. of Vines
Lyndoch	Control	83	40	29
	Tubes	75	33 (N.S.)	30
Angaston	Control	40	3	28
	Tubes	76	6*	29
Lenswood	Control	14	5	17
	Tubes	41	16***	17

*Note: Level of significance is indicated thus: N.S. is non-significant, * is $p<0.05$, *** is $p<0.001$.*

The growth of vines in tubes was greater at all sites except Lyndoch where soil-related factors, rather than water stress or wind, were limiting (Table 1). Growth at Angaston and Lenswood, in tubes, was more than double that of the controls. At Euroa, survival of the control vines was so bad that shelters were erected in March and April, but survival was still only 16%. By contrast, 73% of the sheltered Viognier vines survived to achieve an average shoot length of 15 cm. Trebbiano performed much better, with all the vines surviving to a final average shoot length of 58 cm. The average growth rate was more than l2 mm/day between 21 March and 14 April, despite only 20 mm of effective rainfall in the four previous months, a complete lack of weed control until December, and a severe infestation of wingless grasshoppers.

Conclusion

These preliminary results indicate that growth shelters can give excellent results if properly applied. Pest and disease damage were not sufficient to prevent a very substantial increase in growth at three of the four sites. Weed control is very greatly facilitated with the tubes, and total weed control can be achieved even when planting directly into an established pasture.

Given early application and hence weed control, it should be possible to establish vines with greatly reduced irrigation, or possibly no irrigation at all. The shelters eliminate the need to train vines to a string or remove laterals. Considerable labour savings should therefore be possible. Some modification of the shelters may be necessary to facilitate topping of the vine if it is desired to train two shoots to the wire.

The first use of the shelters in any region should be undertaken carefully. The shelters produce an environment that is unfamiliar, and the effect on pests and diseases cannot be predicted with confidence. This trial shows that, when applied late and conditions are cool, pests will survive well in tubes. Local experience and knowledge will establish whether the tubes should be applied when weather is becoming hot, or whether insecticides or fungicides are required before the installation of tubes, or whether no precautions are necessary. As demonstrated at Euroa, water use efficiency is greatly increased and irrigation should be reduced accordingly, especially if there is a danger of waterlogging. There may be some need to increase nitrogen fertilisation, and possibly potassium as well.

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