Effect of Saline Irrigation Water on the Production of Nursery Crops on Capillary Sand Beds

Gail E. Barth
South Australian Research and Development Institute, Plant Research Centre, GPO Box 397, Adelaide, SA 5001

Kevin A. Handreck
C.S.I.R.O. Division of Soils, Private Bag No. 2, Glen Osmond, SA 5064

Data on the effects of saline water on the production of nursery stock on capillary beds are presented. Growth comparisons are made between overhead irrigation and capillary bed irrigation in a range of saline sensitive and tolerant crops. Results from salinity trials where plants were irrigated with water up to EC 3.0 dS m^{-1} are presented. Leaching of excess salts and mulching treatments are shown to be effective as management tools for handling salt build-up in pots. Control of root emergence from pots onto the capillary beds can be achieved with dichlorophen.

INTRODUCTION

Subirrigation is commonly used in Europe for the production of high quality nursery stock. One advantage over overhead irrigation is a large reduction in water use (Stackhouse, 1993). Another is the potential of the system to minimise or eliminate egress of nutrients from the site. Many Australian nurseries are considering this method of irrigation, but are concerned about the effects of water quality and disease. This paper presents information for Australian conditions on the effects of saline water on growth under subirrigation of plants with a wide range of tolerance to salinity.

EXPERIMENTAL DESIGN

Of the several systems of sub-irrigation (ebb and flood, capillary mat, capillary sand bed) we chose capillary sand beds. The beds were constructed according to the principles developed at Littlehampton, England (Handreck and Black, 1994).

Early trials established that with the majority of nursery stock tested, salinities encountered in the range of 0.8-1 dS m^{-1} presented no major growth problems in capillary bed production. This range of salinity is that encountered in the nursery industry in South and Western Australia with municipal water supplies. Yield of plants on capillary beds was consistently higher than with overhead irrigation (Fig. 1).

Herbaceous plants, roses, and the majority of woody shrub varieties also responded to doubling the recommended rates of controlled-release fertilisers in the mix by increased yields with no loss of quality. Presumably, the lack of water stress at any time during the production cycle had a marked effect on the growth efficiency of the plants. Figure 2 shows an example of growth increase with doubling the fertiliser rates on capillary beds irrigated at water EC of 0.4 and 0.8 dS m^{-1} and overhead irrigation.

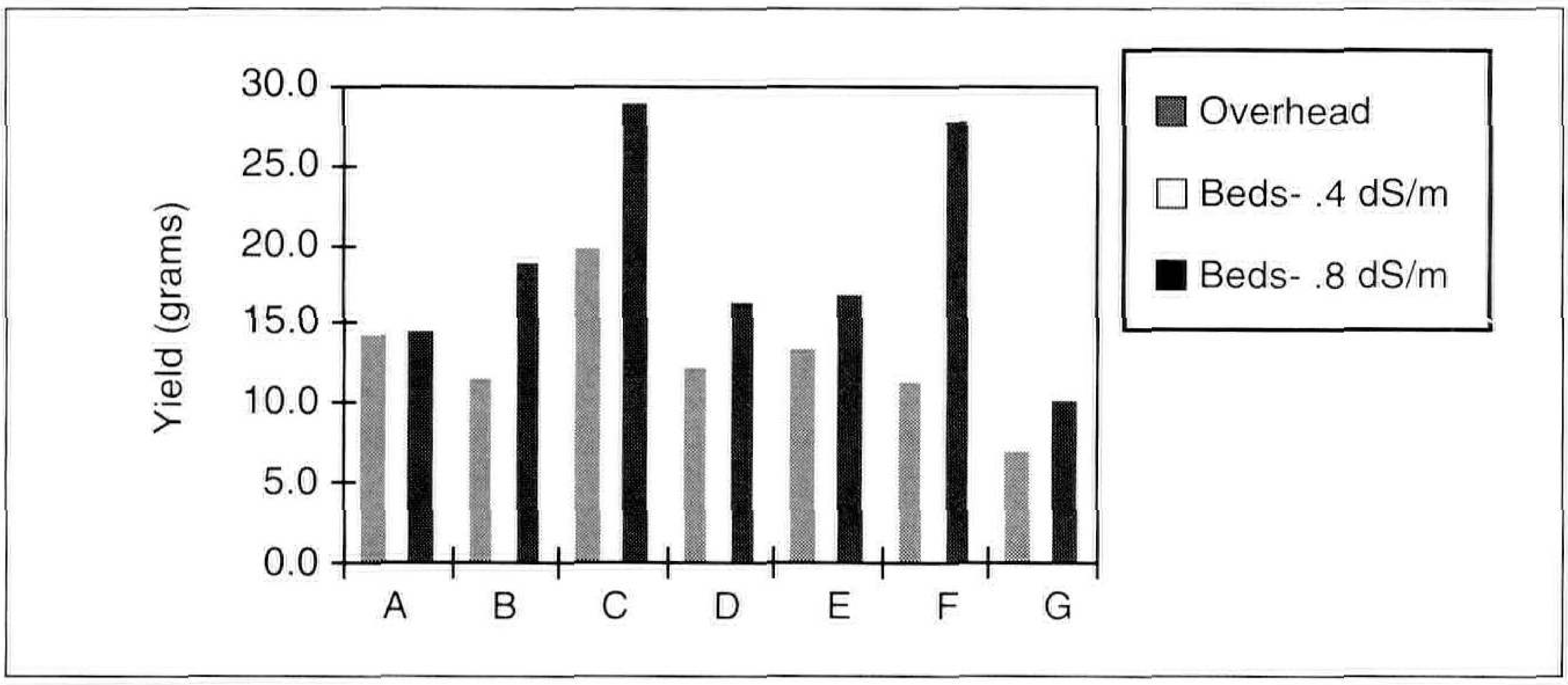

Figure 1. Dry weight yield of nursery stock grown with overhead and capillary bed irrigation. A - snapdragon, B - westringia, C - rose, D - melaleuca, E - chrysanthemum, F - marigold, G - abelia.

EFFECT OF HIGHLY SALINE WATER

The first salinity trial was conducted over the 1994 and 95 summer when the EC of Adelaide tap water was 1 dS m^{-1} at the beginning of the experiment and increased to about 1.2 dS m^{-1} during the trial. For this trial, the salinity treatments consisted of tap water, tap water diluted to about 0.6 dS m^{-1} (with RO water), and tap water to which had been added extra calcium, sodium, and magnesium chlorides and magnesium sulfate to produce ECs in the range 1.5 to 3.5 dS m^{-1}. The cation ratio of the tap water was maintained throughout, but bicarbonate was not used as part of the suite of balancing anions.

Trial plants had a wide range of sensitivity to salinity (Handreck and Black, 1994). Each was replicated 10 times on each of the 7 treatments.

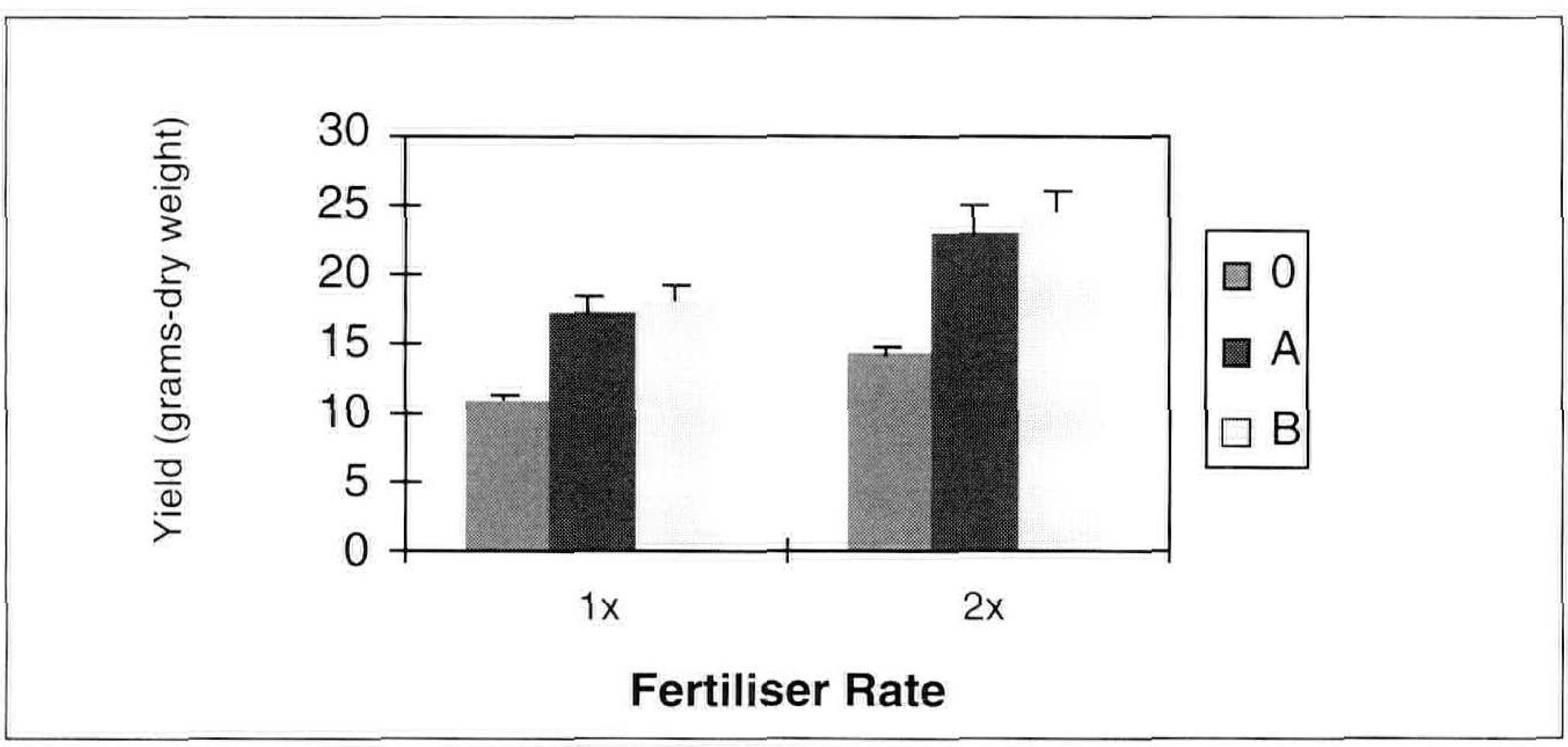

Figure 2. Comparison of growth of marigold 'Honeymoon' at recommended (1X) and double (2X) fertiliser rates with overhead (O) and capillary bed irrigation at EC 0.4 dS m^{-1} (A) and EC 0.8 dS m^{-1} (B).

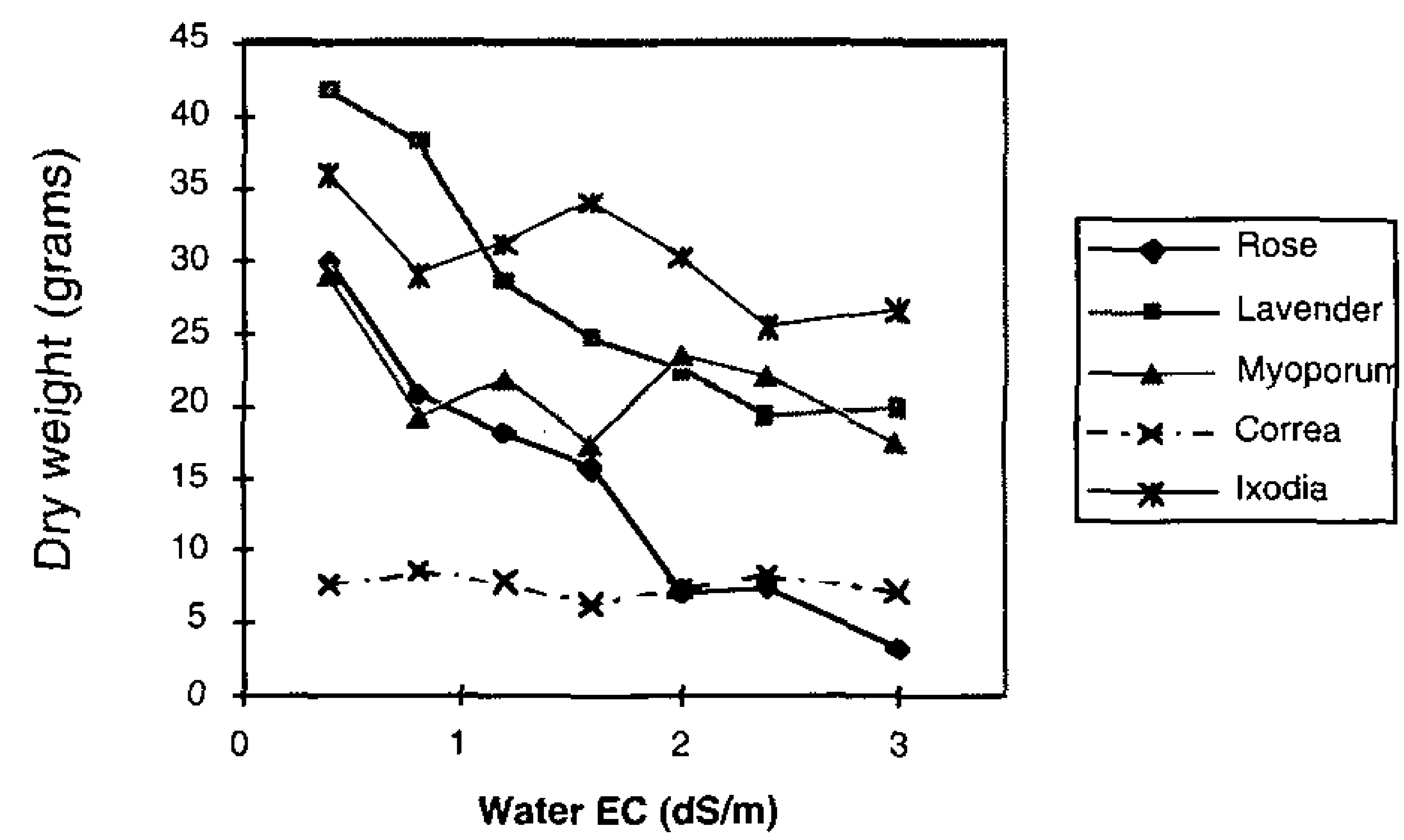

Figure 3. Yield of *Rosa* 'Meipitac' Carefree Wonder™ rose, *Lavandula ×allardii, Myoporum parvifolium, Correa alba,* and *Ixodia achillieoides* ' grown on capillary beds supplied with water of varying salinity.

There were significant responses in rose and lavender (Fig. 3) with stepwise decreases in growth from water EC of 0.35 through to 2.0. With salt tolerant *Myoporum, Ixodia,* and *Correa alba,* differences in yield were not significant and such species demonstrate that plants can be produced satisfactorily on capillary beds at water salinity levels three times that experienced by producers in Adelaide.

There was a continuous buildup of salinity in the pots during the growing period. With the saltiest irrigation waters, a crust of salt built up at mix surfaces. Typical EC readings at harvest are illustrated in Figure 4. The salts clearly concentrated in the uppermost 10 to 15 mm of the pot, where there was no root growth. While the plants remained on the capillary bed, growth and quality of the majority of species was not affected by the high salinity concentrated at the top. It would, however, be necessary to lower the salinity to acceptable levels before marketing.

LEACHING TRIALS TO LOWER SALINITY IN POTS

Figure 5 shows the result of applying 50 mm deionised water (roughly 2/3 rootball volume) to pots in which *C. schlechtendalii* had been growing. The application of this volume of water lowered the EC of the top 5 mm by 50% or greater in most cases. The leaching water had been poured onto the surface of the rootball over a period of about 3 min. Such rapid application probably did not allow enough time for salt in the surface crust to fully dissolve. It could be expected that the same amount of leaching water applied more slowly would remove a higher proportion of the total salt.

While these amounts of leaching removed much salt from the rootballs, there had been considerable redistribution of salt from the surface to lower parts of the rootball. The same effect could occur during a period of summer rainfall, where excessive levels of salinity might move into the root zone of the plants and cause injury.

One way of reducing salinity would be to remove the uppermost 5 mm of the rootball in a repotting process. The results of removal of the top of the rootball in

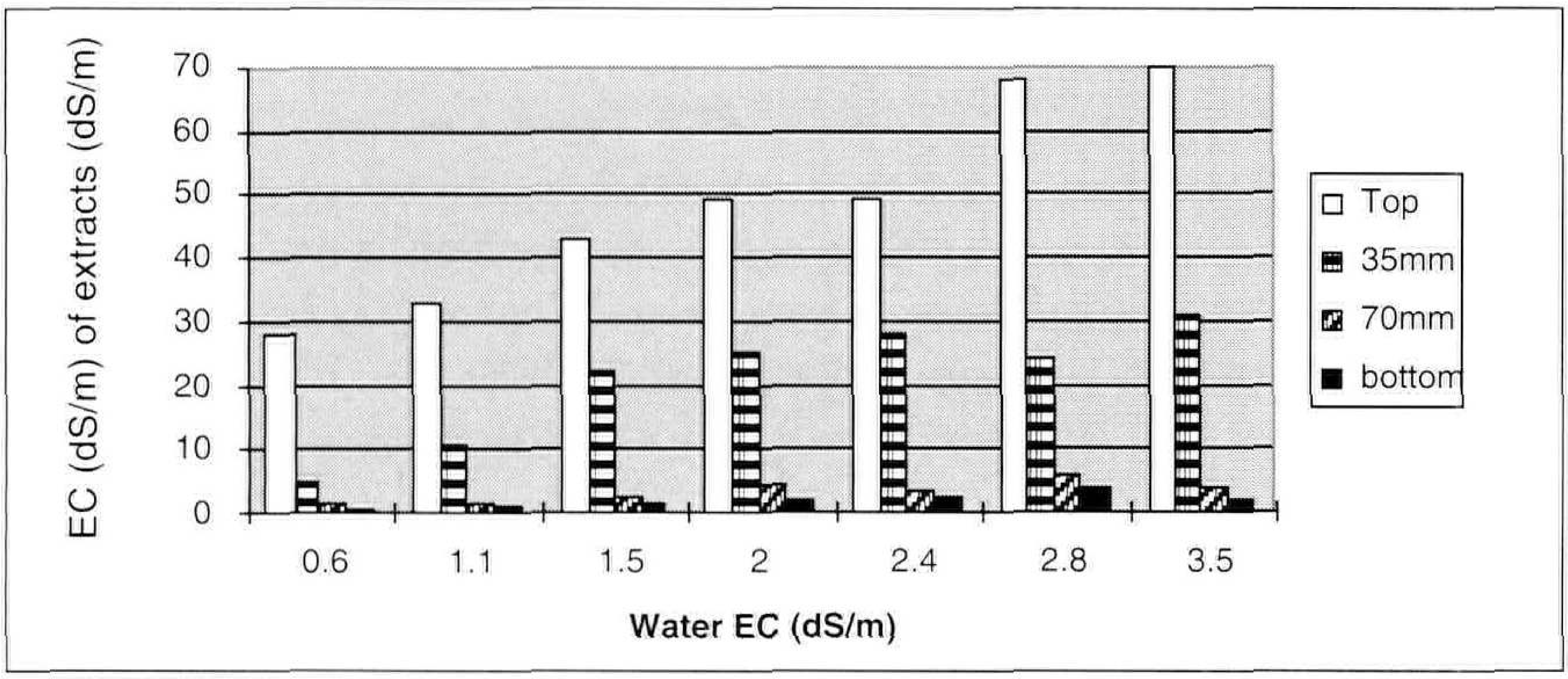

Figure 4. Electroconductivity (dS m^{-1}) of 1 : 1.5 (v/v) extracts of slices of mix removed from the pots at harvest.

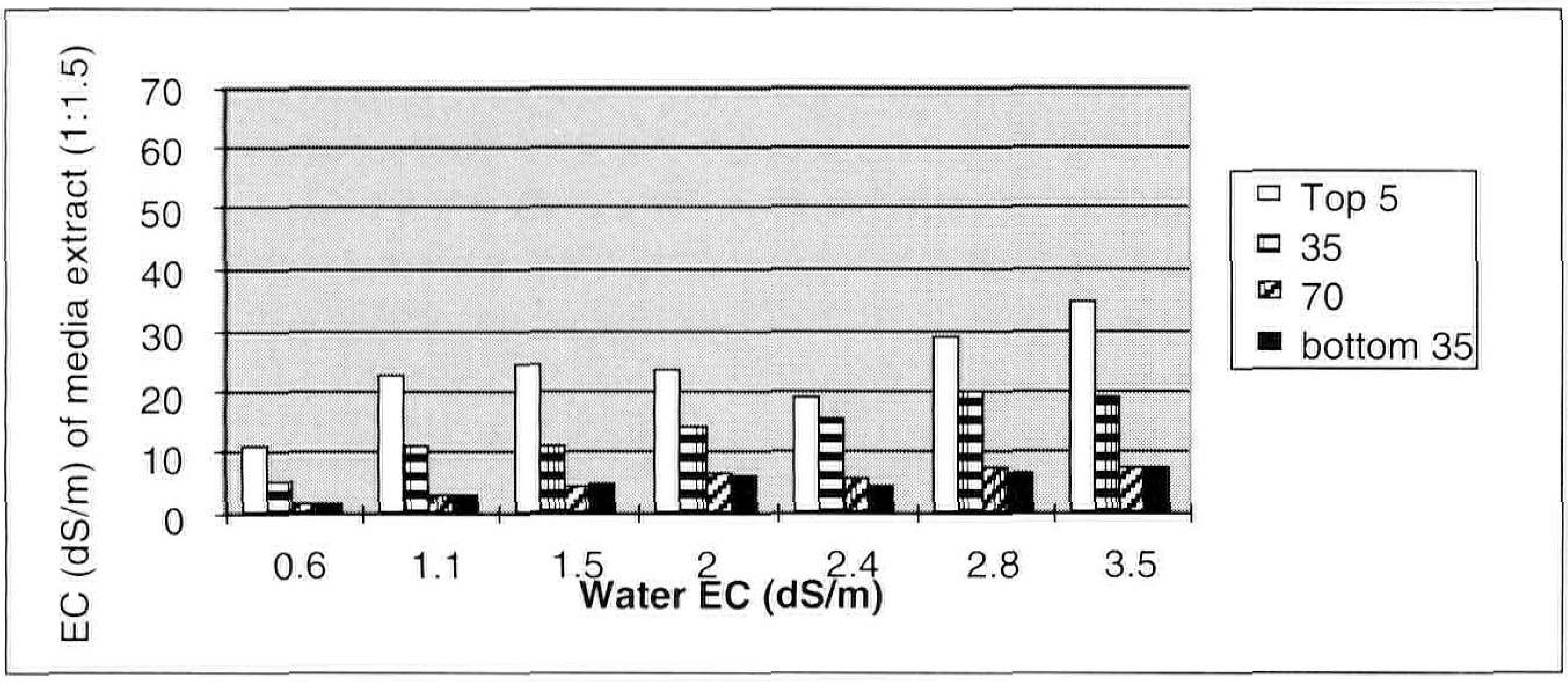

Figure 5. Effect on the EC of 1 : 1.5 (v/v) extracts of the media of leaching with 50 mm depth of water.

combination with leaching 1-pot volume of water are shown in Table 1. Leaching with 1 pot volume reduces the salinity in the top half of the mix without increasing the buildup of salt in the remainder of the pot. Further leaching would be recommended to establish safe salinity levels for marketing, however, the levels of salinity are not higher than that experienced by the pots during production. Removal of the top 5 mm prior to leaching is clearly beneficial in reducing total EC throughout the pot to acceptable levels in circumstances where extremely saline water is used for irrigation.

Table 1. Effect on the EC of 1 : 1.5 (v/v) extracts (dS m^{-1}) of various parts of a rootball of leaching with and without removal of the top 5 mm of mix.

Treatment	Top 5 mm	Next 35 mm	Next 35 mm	Bottom 35 mm
No leaching	41.3	3.9	1.9	1.7
Leaching, 1 pot volume	9	2.7	1.6	1.9
Top off, leaching 1 volume	-	1.2	0.9	0.7

We found that winter rains minimised any adverse effects on plants of saline irrigation water. Trial plants: *Camellia sinensis* 'Grace Albritton', *Rosa* 'Meidomonac' Bonica™ rose, *Viola tricolor, Dianthus barbatus*, *Grevillea* 'Scarlet Surprise', *Begonia ×carrierei* 'Olympia White', *Dietes iridioides*, *Lomandra longifolia*, *Acacia melanoxylon* experienced no adverse effects on yield or product quality as a result of irrigation with saline water up to 2 dS m^{-1} on capillary beds.

MULCHING REDUCES SALINITY BUILDUP

To control the build-up of excessively high salinity levels in the top of the pots, mulching treatments (bark, gravel, and weedmat) were incorporated into trials conducted in the winter and summer of 1996. Figure 6 presents an example of the reduction in salinity achieved in winter on a capillary bed irrigated at a salinity level of 2 dS m^{-1}.

In the unmulched controls, media extract readings of over 24 dS m^{-1} were recorded in the top 5 mm of pots of *D. iridioides* and *L. longifolia.* Significant reductions in surface salinity occurred in all mulching treatments, with coarse pinebark and gravel being more effective in reducing salinity than weedmat.

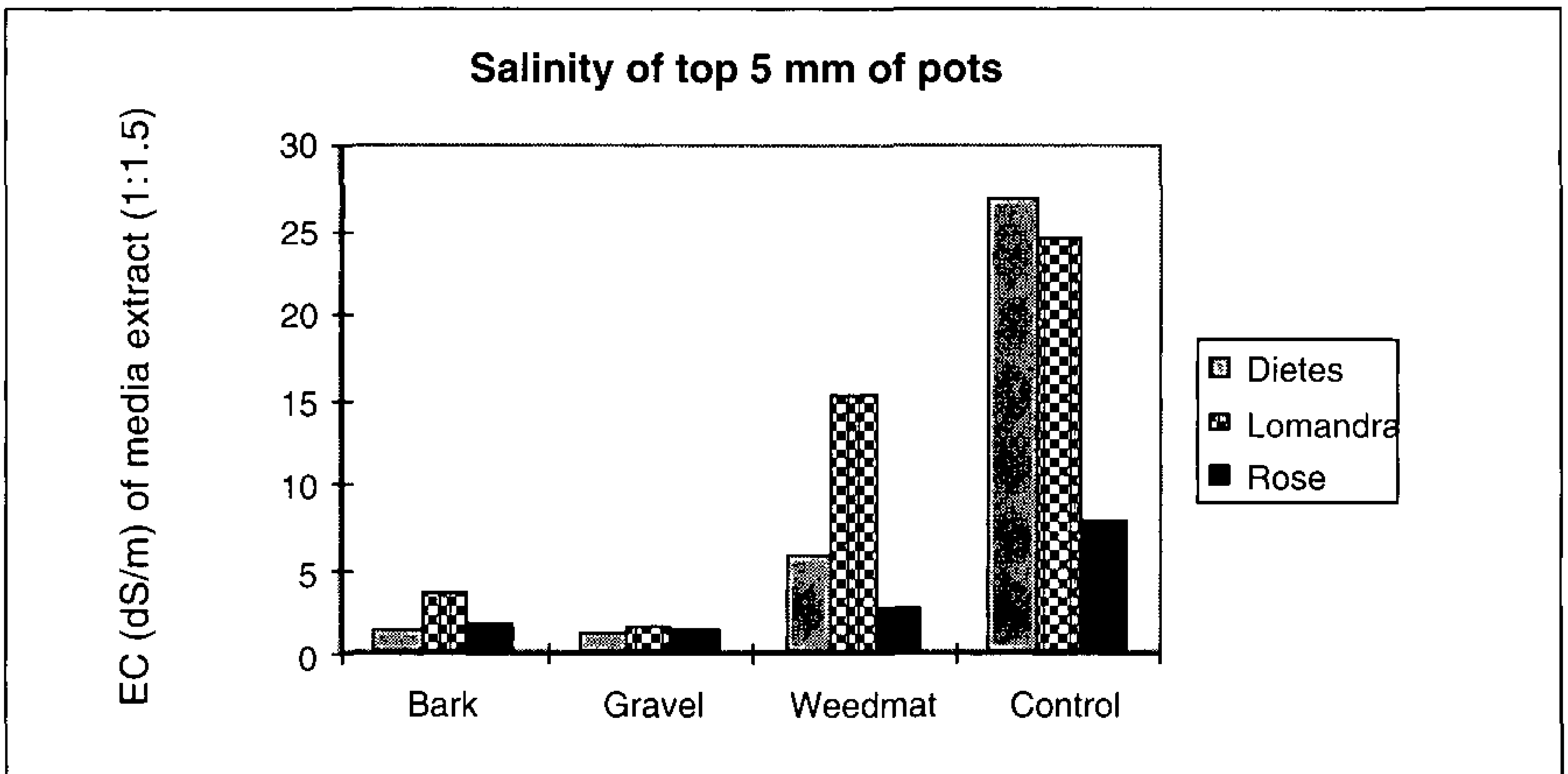

Figure 6. Effect of mulches on salinity build-up in the top 5 mm of nursery pots grown on capillary beds and irrigated with saline water (EC = 2 dS m^{-1}).

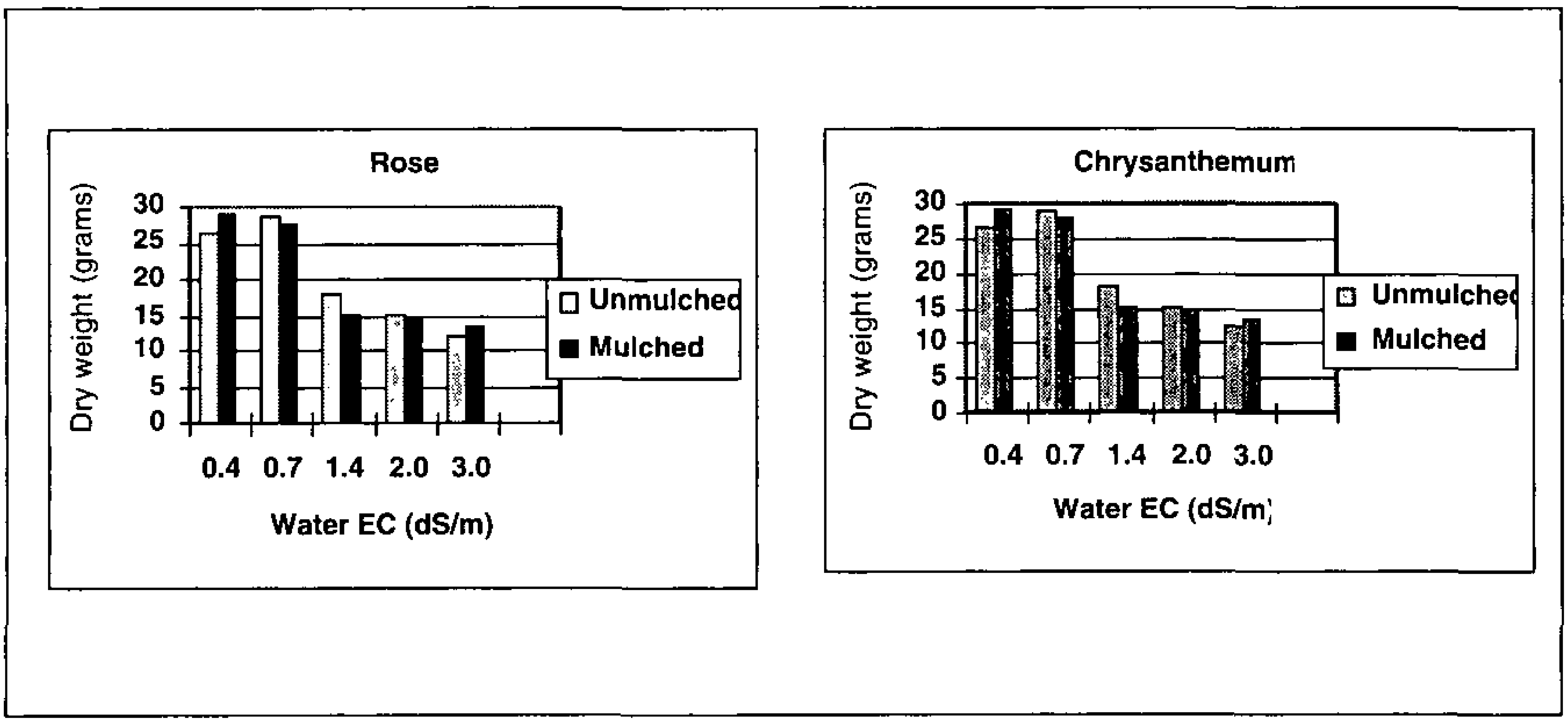

Figure 7. Effect of mulching on dry weight yield of (A) *Rosa* 'Meidomonac' Bonica^{TM} rose and (B) *Argyranthemum frutescens* 'Double White' grown on capillary beds irrigated at EC 0.4 -3.0 dS m^{-1}.

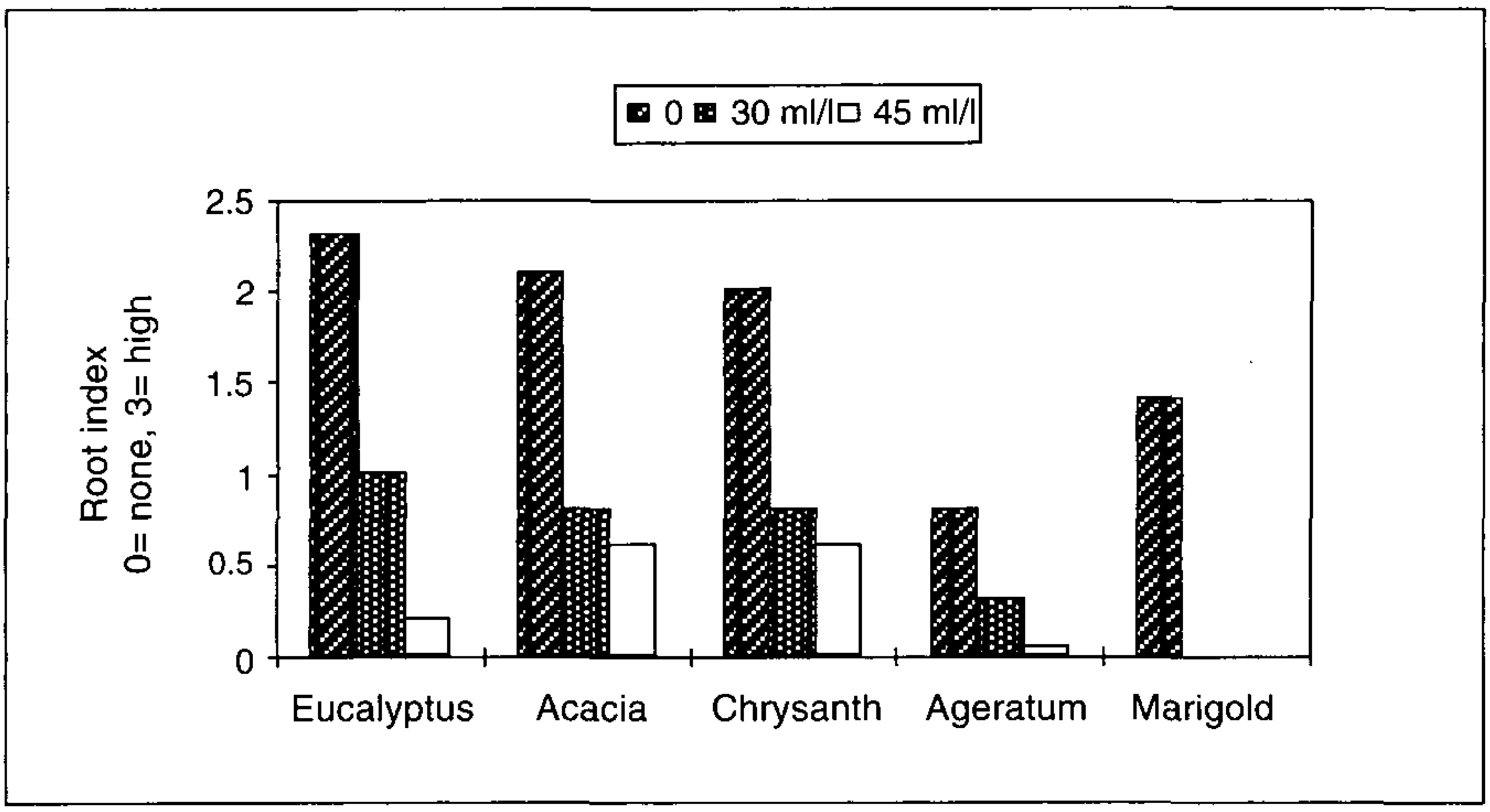

Figure 8. Effect of dichlorophen (450 g $litre^{-1}$) formulation as a root pruning chemical for capillary bed production of nursery stock.

Figure 7 shows the effects of mulching treatments on the yield of *Argyranthemum* (syn. *Chrysanthemum*) and rose grown during the summer of 1996 at six water salinities. The benefits of mulching on growth are more pronounced with chrysanthemum than with rose over the range of salinity treatments. There is, however, a pronounced beneficial effect of mulching at higher salinities in both species.

Growers who are thinking of using capillary bed irrigation with saline water in hot climates should analyse the effects of incorporating mulching into their production programs to assist in the reduction of salinity build-up.

ROOT-PRUNING CHEMICALS

The growth of roots through pots into the sand of capillary beds is a management problem which must be addressed for most species that are to be grown for longer than 2 months. This problem is particularly evident with vigorous native plants with strong taproots, such as *Eucalyptus* and *Acacia* species. In our experience, fast growing herbaceous plants like petunia and lobelia will form a dense mat of roots outside the base of the pot once the plants have reached full size, which then makes them unsuitable for retail sale.

Commercial preparations of algicides based on dichlorophen have proven in commercial experience to not only control algae on the sand surface, but also to inhibit root growth in the sand. As there are no recommended rates of this chemical for root pruning uses, we incorporated treatments at four rates into two of our 4-month trials. We used Debco's liverwort and moss control preparation (450 g $litre^{-1}$ dichlorophen). This active ingredient is also available in the formulation Kendocide® at 480 g $litre^{-1}$.

Rates of 5, 20, 60, and 100 ml of preparation were applied per m^2 in 2 litres of water. The lowest rates allowed rooting through of several species. There were no significant differences in shoot growth. The highest rates eliminated root penetration into the sand and there was no evidence of phytotoxicity. The effects of intermediate rates of 30 and 45 ml $litre^{-1}$ suggest that 45 to 60 ml of preparation per 2 litres of water be used per m^2 of capillary bed for effective pruning of escaped roots over a broad range of nursery stock.

LITERATURE CITED

Handreck, K.A. and **N.D. Black.** 1994. Growing media: For ornamental plants and turf. University of N.S.W. Press.

Stackhouse, J. 1993. Capillary watering lifts plant growth rates. Austral. Hort. 91(2):35-38

Deciduous Ornamental Trees in Australia

Wesley J. Fleming and Liz Darmody
Fleming's Nurseries P/L, PO Box 1, Monbulk, VIC 3793

Public demand for, and therefore the importation of, deciduous ornamental trees is ever-increasing. This influx has the potential to greatly enhance our environment. As professional horticulturalists and home gardeners alike, we realise the advantages that these trees offer as landscape subjects.

There are many outstanding ornamental cultivars now available in Australia. The *Acer* (maple), *Cornus* (dogwood), *Tilia* (linden), *Lagerstroemia* (crape myrtle), and ornamental *Pyrus* (pear) are a few species which we believe have potential, but these represent only a sample of what is currently available.

Consideration must be give to a whole range of criteria before a species or cultivar is selected for planting, e.g. the existence of underground sewerage; height, colour and design of surrounding buildings; power lines and other overhead obstructions; narrow streets; soil type; drainage; and aspect. People tend to place a high emphasis on what the site looks like when a tree is first planted. They want an "instant effect". Instead we need to teach people to look ahead and imagine how it will look in the future; will the perfect specimen at planting mature into a rather large and expensive problem 10 years on? The right tree needs to be chosen for the site.