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The Imperial mandarin is the most widely grown mandarin cultivar in Australia. Production is expected to rise substantially over the next few years with 40% of trees currently non-bearing or less than 6 years old. The Imperial is prone to alternate bearing which can lead to problems of small fruit size in heavy crop years and increased problems with dry fruit in light crop years.

Market returns for Imperials are directly linked to fruit size and there is considerable buyer resistance to fruit of low juice content. Small fruit size is a particular problem with Imperial mandarins grown in the Sunraysia and Riverland districts of the Murray Valley and many growers believe problems with dry fruit are becoming worse. In view of expected increases in production effective strategies for improving fruit size and quality are needed.

In this project a survey of 30 Imperial mandarin growers was undertaken between 1995 and 1998 to identify key factors affecting productivity and fruit quality of mandarin orchards in Sunraysia. A questionnaire was used to obtain details of cultural practices, bearing history and packouts. Data on fruit quality and leaf nutrient levels were collected over three consecutive years. Comparative studies were also made of mandarin and orange water use patterns. In the second part of the project a series of thinning trials were conducted on commercial properties in Sunraysia and the Riverland. The objective of these trials was to assess the effectiveness of chemical and hand thinning for regulating heavy crop loads and improving fruit size and net returns.

Orchards included in the survey ranged in age from 7 to 45 years with the majority of sites between 10-20 years old. Citrange was the most widely used rootstock followed by sweet orange, Cleopatra mandarin and *P. trifoliata*. Methods of irrigation used were low level sprinklers (75% of sites), overhead sprays, drip and furrow irrigation. The median planting density was 446 trees/ha (range 204-781 trees/ha).

There was wide variation among the survey group in yield, alternate bearing tendency and fruit size distribution. Annual yields ranged from 12-67 t/ha and the proportion of fruit packed in the large size counts (64-100) from 16-49%. Alternate bearing indices ranged from 0.02 (negligible) to 0.80 (7:1 ratio). Wide seasonal and site variation were evident in juice content and maturity with seasonal factors accounting for 40-90% of the total variation. In each year, variation in juice content among sites range from less than 25 to 39%.

Key factors associated with orchard performance were:

- Irrigation scheduling. Irrigation management was identified as the key cultural practice affecting orchard performance. Low yielding sites and sites producing a high proportion of small fruit or fruit of low juice content were associated with either high sodium or high chloride levels or inadequate depth of wetting arising from under-estimation of crop water requirements. Water use was 38% higher on mandarin blocks than adjacent orange blocks and annual water requirements of Imperial mandarins may be as high as 12 ML/ha.

Mandarin blocks should be irrigated independently of other citrus and close monitoring of irrigation requirements is strongly recommended.

- Fruit size. Crop load was the dominant factor affecting fruit size distribution. All sites with above average fruit size distribution were intensively pruned (either mechanically or hand pruned) and in most instances also chemically or hand thinned. Sites carrying heavy crop loads and producing high yields of large fruit were either young orchards or sites hedged and topped annually. Although adoption of pruning among the survey group was high (88%), adoption of hand (25%) and chemical (13%) thinning was low. Further research is required on the relative merits of pruning and thinning for regulating cropping.

Leaf potassium levels among the survey group were generally low which suggests Imperial mandarins are heavy users of potassium. Sites producing the largest fruit all applied potassium annually. Given the well documented effects of potassium on citrus fruit size, annual applications of potassium and close monitoring leaf potassium levels should be considered essential management requirements with mandarins. Further research is needed on the effectiveness of potassium nitrate sprays.

- Fruit quality. Juice content was negatively correlated with fruit diameter and leaf sodium, chloride and nitrogen levels. Survey orchards were generally characterised by high to excessive leaf nitrogen levels. Sites consistently producing fruit of high juice content each year were high yielding and moderate users of nitrogen. To minimise problems with fruit dryness it is recommended that irrigation requirements during summer and autumn are closely monitored and leaf nitrogen levels reduced to 2.9-3.1%.
- Tree age. The highest producing sites in the survey were generally young orchards (13-17 years) planted at above average density and were characterised by a low alternate bearing tendency. Significantly these sites also had low sodium and chloride levels and were well-pruned. There was clear evidence of declining productivity in orchards older than 25 years which was associated with increasing problems with alternate bearing. It is recommended that tree replacement programs be initiated in orchards older than 25 years.
- Rootstock. Twenty per cent of sites planted on citrange showed varying degrees of tree decline at a young age (13-15 years). On the worst affected site 17% of trees were rated in poor health. The onset of the decline may be linked to excessive cropping which further highlights the need for crop regulation. Development of an alternative replant rootstock to citrange for mandarins should be a high priority for the national rootstock research program.

Both chemical thinning with ethephon and hand thinning were shown to be cost effective strategies for regulating cropping of Imperial mandarins under Sunraysia and Riverland conditions. Thinning reduced alternate bearing and increased net returns by 10-13%. Most of the benefits from thinning were realised from higher yields in the second year after thinning.

Based on the findings of this project achievable benchmarks for Imperial mandarins under Murray Valley conditions are average annual yields of 40 t/ha or more with minimal alternate bearing and the production of 40-45% of the crop within the count range 64-100.

Results from this project have been presented at Cirtgroup meetings and incorporated into pruning and thinning workshops. Ongoing extension will involve production of an insert on mandarin growing for the Citrus Growing Manual.