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Overlapping Double and Early Single Cropping of Low-chill Peaches in Australia[1]

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Abstract

The overlapping double cropping system occurs in low-chill feral peaches in east coastal areas of Australia. This system also occurs in recently introduced low-chill Florida bred cultivars. The overlapping double cropping system consists of partial predormancy bloom, winter fruit growth, and postdormancy harvest plus the normal postdormancy bloom and harvest with a 4 to 6 week difference between harvests. Research on enhancing this system has led to the early single cropping system which consists of total postdormancy bloom, winter fruit growth and early spring harvest. The 2 cropping systems are enhanced by timing of predormancy defoliation and bloom as regulated by water stress and nutrition.

The development of low-chill peach cultivars (1) and their production in subtropical areas has permitted testing of the biannual cropping system described in Venzuela for medium-chill Spanish-distributed peaches (14). The introduction of low-chill peach cultivars and their production in Australia (8, 10) has led to the opportunity to observe overlapping double crops and the potential for developing a unique early ripening single crop system. Times of events are presented in months rather than season so that a 6 month change is needed for northern hemisphere conversions.

The overlapping double crop system occurs naturally in the lowest chill, feral peaches in areas near Brisbane where no winter temperatures below 2°C occur. The area is at 28°S latitude with elevations up to 200 m. The coldest month averages about 14°C. Partial bloom in late April, initiated by early autumn (March to April) defoliation from leaf rust and drought stress, results in fruit set that overwinters on dormant trees where no winter frosts occur. This fruit ripens in September before pit hardening in the normal spring (November) crop. Marketing of these "off season" fruit has been practiced in the Brisbane area for more than 30 years.

The low-chill stonefruit industry is rapidly expanding in Australia and has largely replaced the locally selected

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low-chill cultivars from feral peaches. There are about 450,000 trees (1200 ha) planted (10) based on cultivars developed at the University of Florida. The industry is currently valued at $A 12 million ($ U.S. 9 million) annually (12). The earliest maturing cultivar, 'Flordaprince' ripens in late October and early November and brings high prices. Even earlier ripening fruit would extend the market season and should have equal market reception.

In the low-chill areas of eastern Australia, some autumn flowering of 'Flordaprince' and 'Flordared' cultivars, that have a short fruit development period and are rated at less than 200 chill units, can also result in an overwintering crop which matures 6 to 8 weeks earlier than the normal late October to November harvest. Methods or techniques to produce this autumn (late April) flowering fruit consistently have been developed and are described in this paper. These techniques are expected to be most useful with very low chill cultivars (< 200 chill units) in locations with no winter freezes. These techniques extend the fruit season by 6 to 8 weeks earlier, significantly increasing the value of the total low-chill Australian stonefruit industry.

Location Selection

The location must be selected with a chilling regime suitable to meet the chill unit needs of cultivars. This is usually where the mean temperature of the coldest month (July) exceeds 13°C (8). Temperatures during autumn flowering must not exceed the mean daily minimum (night temperature) of 12 to 14°C as described by Edwards (3, 5) or fruit set will be severely reduced. Temperature during the winter period when fruit are developing also must not be low enough (< 1°C) to kill or seriously hamper fruit development. Average temperatures must be sufficiently high to accumulate adequate heat units to mature the autumn-set crop 4 to 6 weeks prior to the harvest of the normal spring crop as determined by Munoz et al. (11). 'Flordaprince' in Chile and Florida requires 1190 C° days above the base 3°C from bloom to ripe fruit. For example, an average maximum of 18°C for 30 days would provide 450 C°d (18–3 x 30).

The most suitable soil types for this overlapping double crop system are ones where tree vigor can be controlled. Terminal shoot growth must be stopped prior to defoliation. Highest success in this system has been on sand or sandy loam soils where summer (January to February) water or nitrogen stress help to terminate growth.

Plant Response

Early cessation of growth is important for the accumulation of photosynthate reserves in the tree. These reserves are used for fruit development during the winter dormancy period when there are no leaves on the tree. In contrast, normal season developing fruit utilize current season photosynthesis. Autumn growth cessation can be induced by applying paclobutrazol (PP333) (7), water stress, and reducing available nitrogen. Paclobutrazol should be soil applied immediately after harvest to achieve early and uniform bud development. Rates to apply are critical and must be high enough to stop shoot extension at about 40 cm. Healthy leaves should be maintained until defoliation. If leaf loss occurs too early, the subsequent regrowth before winter will deplete stored photosynthates that could be used by the overwintering fruit.

Overlapping Double Cropping

Defoliation of trees before they enter dormancy to obtain overlapping double and early single cropping low-chill peaches is a modification of the technique used for cropping temperate zone apples and subtropical peaches and apples (2, 4, 6, 9, 14) in tropical regions. The techniques to aid the

overlapping double and single cropping in low-chill peach are presented in Table 1.

Early Single Cropping System

The single early cropping system in low-chill peach clones constitutes a shift totally to autumn bloom and fruit set. Retention of leaves and defoliation 6 weeks later (early May) than in the overlapping double crop system and just prior to dormancy, but before chill units begin accumulating, promotes a more uniform but higher percentage autumn (May) bloom. Complete defoliation can be achieved with 2 to 4% $ZnSO_4$. Alternatively, instead of $ZnSO_4$, sequential weekly sprays (up to 4) of 5% KNO_3 during the same time period (May) will give a more prolonged autumn bloom and fruit maturity period. Increasing the number of KNO_3 from 1 to 4 sprays results in more autumn bloom and fruit set and less spring bloom and fruit set. This is probably because KNO_3 has been found more effective in inducing bud break of flower than vegetative buds (3). This late defoliation with either $ZnSO_4$ or 5 KNO_3 promotes a single maximum yield (near normal) which matures about 6 to 8 weeks after July to August foliation or about 2 weeks later as compared to the autumn

Table 1. A schedule of time, technique, and response from cultural practices for aiding the overlapping double cropping system in low-chill peach in Australia.

Time	Technique	Response
Late November	Soil application of paclobutrazol	Controls terminal growth which accelerates flower bud development (7)
January	Restrict soil moisture	Controls terminal growth and conditions flower bud development (13)
Late March	Moderately prune and defoliate either chemically (2 to 5% $ZnSo_4$) or with rust disease[z]	Conditions plant for autumn flowering prior to dormancy
Late April	Increase soil moisture and apply moderate N_2 but not enough to force regrowth[y]	Promotes early flowering and fruit set
Late May	Fruit thinning to adjust crop load (one fruit per lateral)	Trees enter dormancy with autumn fruit set
July		Normal flowering occurs in low-chill clones for overlapping spring crop
Late July	Provide adequate soil moisture and nutrition	Promotes foliation and fruit growth of spring crop and improves fruit maturation in autumn set crop
Early August	Thinning spring flowers and fruit set	Increases fruit size on autumn set crop and promotes development of spring crop
Mid-August to Mid-September	Harvest autumn set crop 4 to 6 weeks after spring foliation	
Early to Mid-November	Harvest second crop from spring flowers	

[z]Gradual defoliation promotes a longer autumn flowering period that results in a longer harvest period from autumn set fruit.

[y]Critical to avoid leaf bud break and development before dormancy.

(April) set spring (August) ripened fruit in the overlapping double crop. These fruit are thinned at shuck split prior to dormancy. This maximum crop load suppresses normal (late July) bloom and fruit set in remaining flower buds.

Autumn Pruning

Autumn pruning is done just prior to entry into winter dormacy. Fruiting wood on low-chill peaches such as 'Flordaprince' can be classified in 2 types. Laterals of 2 to 4 mm base diameter produce autumn blossoms first and are not headed back. The tree is pruned to establish an even distribution of these laterals on which autumn-set fruit are usually borne on the distal third. Fruit set in this region increase flower bud and flower abscission for 15 to 25 cm basipetally. This response could be either due to utilization during winter of photosynthates by autumn-set fruit or to hormonal inhibition. Laterals of 4 to 8 mm base diameter flower in late July and produce the normal spring bloom crop in the overlapping double crop system. They can be headed back and handled in a normal dormant pruning situation.

Thinning

Thinning of autumn set fruit should leave 1 to 2 fruit per lateral depending on tree size and vigor. On mature trees, 50 to 100 fruit are left per tree in the overlapping double crop system and 150 to 200 fruit on the single early crop system. With the overlapping double crop system, the second (spring set) crop should retain slightly fewer fruit than normal because the earlier crop has utilized much of the stored reserves. Thus, while overall yield is moderately greater than a single normal crop, the price advantage for the early crop is substantially higher making overall profits greater.

Nutrition

Fertilizer rates and timing may need to be altered to achieve maximum fruit size. Foliar nutrient sprays, particularly K, may be beneficial during the winter period. Use of polyethylene mulching may also raise soil temperature and improve uptake of nutrients during the winter period.

Fruit Quality

Fruit size and color development appear to be normal in both crops of the overlapping double and in the single early cropping systems provided that trees are adequately healthy and properly thinned. Fruit sugars appear to be slightly lower compared to the normally produced fruit, but appear to be higher in fruit where the shortest dormancy (winter) occurs. In fact, sugar levels in some autumn set fruit were higher than in spring set fruit where spring leafing occurred early, air temperatures were warm, and soil moisture was low but adequate.

Discussion

The overlapping double and single cropping systems have been observed to work satisfactorily in the coastal area of eastern Australia. Refinement of the broad techniques on which the systems are based is continuing and will increase efficiency. The physiological basis is not understood, but cyanamide will be used in trying to develop techniques that would also recycle vegetative growth when temperatures become favorable for fruit set.

The success of early defoliation treatments will depend on avoiding regrowth of vegetative buds prior to dormancy, as excessive vegetative regrowth will utilize photosynthate reserves that could be channeled into autumn set fruit. In studies at Nambour, Queensland, foliar sprays of paclobutrazol during regrowth failed to stop it adequately before winter. However, other research has indicated that it may be feasible to control regrowth by high concentration sprays of paclobutrazol (1000 ppm) 2 to 3 months prior to defoliation. Refine-

ment of the regrowth control and other techniques will continue.

Techniques to aid dormancy break under similar conditions with low-chill deciduous fruits could be valuable for many areas of the world where frosts do not occur, but where temperatures are low enough to result in dormancy.

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Book Review

Chernaya Smorodina (Black Currant) by Aleksandr S. Ravkin, Moscow University Press, 1987, U.S.S.R.

A. Ravkin is acknowledged to be one of the Soviet Union's foremost authorities on black currant genetics and breeding. His paperback book in Russian language, 213 pages, summarizes 15 years of experimentation, designed to gain an understanding of taxonomy of species and their mutability under natural and cultural conditions, evaluation of parents including both phenotypic and genotypic selection, effect of inbreeding, inter-species hybrids, spontaneous and induced mutations. Many diseases and insect pests are capable of reducing black currant yield. According to A. Ravkin there are good opportunities for breeding disease-resistant black currant cultivars. American gooseberry mildew is one of the most important diseases in black currant attacking young shoots and leaves, causing stunting and distortion. Scandinavian and Finnish black currant cultivars 'Brödtorp,' 'Öjebyn' etc. show fairly high resistance and much use has been made of them in breeding as donors. Brief characterizing of 19 perspective cultivars of black currant, mainly for cutivating in Moscow district, is given.

I suggest that this book will capture the interest of the western researchers in the field of currant breeding.

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