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EUROPEAN PEAR BREEDING STRATEGY IN NEW ZEALAND

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ABSTRACT

The New Zealand pear breeding strategy is based around three different programmes. The first is to breed classic quality European pears with soft buttery flesh. The second is concerned with the selection of new types of fruit which combine the aroma of the European pear with the crisp juicy texture and ripening mechanism of the Japanese pear. The third programme is concerned with selection for disease and pest resistance factors.

The second and third programmes involve using interspecific hybridisations to introduce characters not commonly found in European pear cultivars. Hybridisation commenced in 1983.

KEYWORDS

Pyrus communis, Pyrus pyrifolia, interspecific hybridisation, wide crosses, fruit quality, disease resistance.

INTRODUCTION

The fruit of the cultivated pear from Europe is classically beautiful in its form and has exquisitely rich perfumed buttery flesh. It is however, generally recognised that its post harvest handling and ripening characteristics make this fruit difficult to adapt to changing marketing systems (La Rosa and Monnet, 1984). The very short shelf life and fragile nature of a ripe European pear are not suited to either pre-packaging or 'self-help' techniques used in modern outlets such as supermarkets.

There is also some evidence of a change in consumer preference, particularly amongst the young mobile urban population, away from the buttery to a crisp juicy texture (Vlandas, 1984). This trend is difficult to define because it deals with what Vlandas describes as the 'mythical fruit' in so far as the preference is a perceived one and not able to be tested.

The New Zealand pear industry is orientated to the exporting of fresh fruit, particularly to the North American and European markets in their off-season. The high cost of transport and our relatively small production (Fig. 1) means that we are not in these markets as suppliers of bulk fruit; rather New Zealand has gained, and is eager to maintain, a reputation as a supplier of high quality fruit and an innovator in the development of new cultivars.

The pear growers and marketers in this country want new cultivars with distinctive quality and appearance, well adapted to modern orchard management, transport, and marketing requirements.

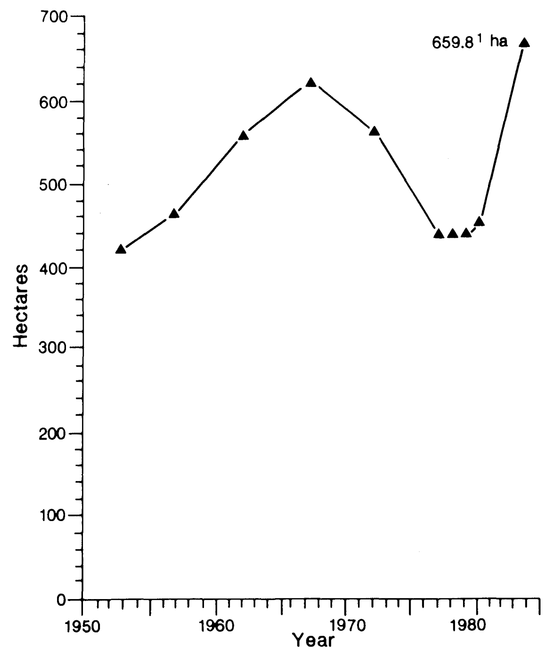

Figure 1. Areas occupied by pears (from Bollard, 1981). ([1] N.Z. Department of Statistics, 1985.)

THE INHERITANCE OF SOME IMPORTANT FRUIT CHARACTERISTICS

The current knowledge on heritability in pears has been well reviewed in recent years (Bell, 1982; Alston, 1974). The objectives of our breeding programme are in general coincident with those of most other programmes with respect to disease resistance, storage, and fruit characteristics; however there are some fruit characteristics which warrant discussion.

Flesh texture

This is a combination of a range of characters which determines the feel of the fruit in the mouth.

In crosses between *Pyrus communis* and *P. pyrifolia,* grit cells are inherited quantitiatively with additive gene effects (Thompson *et al.,* 1974). The texture of progeny resulting from crosses between Japanese cultivars (*P. pyrifolia*) is more strongly influenced by flesh firmness than the density of grit cells. Flesh firmness shows a high degree of heritability (Machida and Maeda, 1966).

Flesh texture in European cultivars (*P. communis*) is also inherited in a quantitative pattern (B. Thibault, unpub. data, 1984).

Juiciness has been reported to be inherited as a single gene with juiciness dominant over dryness (Zielinksi *et al.,* 1965).

Flavour

A complex of acids, sugars, tannins, esters, and alcohols are known to contribute to a pear cultivar's flavour but little is known about the specific components of characteristic flavours, except in the case of Williams Bon Creitien, where the ester, ethyl trans:2:cis:4-decadienoate has been identified as being responsible for its characteristic flavour (Creveling and Jennings, 1970).

Sugars and pH are inherited quantitatively with high sugar and moderate acid being the most desirable combination (Visser *et al.,* 1968).

Skin colour

Background colour appears to be a balance between green (chlorophyll) and yellow (mainly carotenoid) pigments. The various components of background colour appear to be under independent monogenic control with yellow being dominant over green (Zielinski *et al.,* 1965).

Red colour

The red pigment anthocyanin is unknown in the fruit of *P. pyrifolia* (I. Kajiura, pers. comm., 1985). It does occur to a limited extent in other species such as *P. communis* and *P. ussuriensis*, mainly due to spontaneous mutation. Max-Red Bartlett, a red mutant of Williams Bon Creitien, is heterozygous for a dominant single gene for red colour (Alston, 1974). Red sun-blush is thought to be a recessive trait (Zielinski *et al.,* 1965).

Russet

The inheritance of russet in European pears is thought to be complex (Zielinksi *et al.,* 1965). However, Kikuchi (1930) has proposed a two gene mechanism for *P. pyrifolia,* R and I genes, in which R gives russet and I partially suppresses russet formation.

Ripening

All high quality European pear cultivars are harvested immature and require varying lengths of treatment at low temperatures to be brought to eating ripeness. Breakdown after ripening is very rapid.

Amongst the quality Asian cultivars a range of ripening paterns exists. Some cultivars, particularly of *P. pyrifolia* from Japan, are non-climacteric (Kitamura *et al.,* 1981). These do not require specific pre-ripening and can be held in cool storage for many months at eating maturity (N. Lallu, unpub. data, 1984).

The inheritance of ripening characteristics is not understood at this time.

HYBRIDISATION AT THE HAVELOCK NORTH RESEARCH ORCHARD

The first known New Zealand hybridisation programme for pears commenced at the DSIR Research Orchard, Havelock North, in 1983. The European pear programme can be conveniently divided into three sections — traditional European pear breeding, interspecific crossing for quality improvement, breeding for pest and disease resistance.

Traditional European pear

Despite the problems associated with marketing this type of pear, we believe there will always be a demand for high quality, butter-fleshed pears. The common parent in the hybridisations has been Packham's Triumph, a cultivar with good quality and storage characteristics and a desirable growth habit, which is well adapted to New Zealand's requirements. The pollen parents were chosen for their high quality, late season maturity, and good storage ability, except for Max-Red Bartlett which was used for its red colour (Table 1).

Table 1. Number of seedlings produced from different crosses planted in the 1984 European pear breeding programme.

Cross	Number of seedlings
Packham's Triumph x Max Red Bartlett	194
Packham's Triumph x President Heron	239
Packham's Triumph x [1]T.N. 16-15	20
Packham's Triumph x Pierre Corneille	239
Packham's Triumph x [1]6-23-G4	49
Total	741

[1] Supplied by B. Thibault, INRA, Angers, France.

Interspecific quality

Wide crosses (Uhlinger, 1982) offer the possibility for innovation in European pear cultivar development required by the New Zealand marketing strategy. Although cultivar selection has followed markedly different objectives in various regions and spanned a wide range of species (Machida, 1979; Layne and Quamme, 1975), phenological and genetic barriers do not exist to crosses between these different types of pear.

To date, we have made crosses between high quality European (*P. communis*) and Japanese (*P. pyrifolia*)

Table 2. Interspecific breeding programme.

Cross	Number of seedlings	Date planted
Packham's Triumph[1] x Shinseiki[2]	174	1984
Shinseiki[2] x Packham's Triumph[1]	444	1984
Packham's Triumph[1] x Nijisseiki[2]	377	1984
Packham's Triumph[1] x Kosui[2]	300	1985
Nijiseiki[2] x Max Red Bartlett[1]	33	1984
Nijiseiki[2] x Doyenne Du Comice[1]	500	1985
Shinseiki[2] x Max Red Bartlett[1]	117	1984
Doyenne Du Comice[1] x Hosui[2]	100	1985
Hosui[2] x Doyenne Du Comice[1]	50	1985
Kosui[2] x Doyenne Du Comice[1]	10	1985
Total	2015	

[1] *Pyrus communis.*
[2] *Pyrus pyrifolia.*

cultivars (Table 2). An examination of both these groups shows that characters exist within the genus to overcome major impediments to the adaptation of quality European cultivars to modern marketing, and also to accommodate changes in consumer preferences.

Table 3. Disease resistance breeding programme.

Cross	Number of seedlings	Date planted
Packham's Triumph x 20-317	589	1984
Packham's Triumph x 32-238	579	1984
Packham's Triumph x N.J. 10	168	1984
Packham's Triumph x N.J. 12	370	1984
Packham's Triumph x 29-52	82	
N.J. 10 x 29-52	10	1984
	150	1985
N.J. 12 x 20-317	35	1984
	300	1985
N.J. 12 x N.J. 10	22	1984
	450	1965
N.J. 12 x MAC	74	1984
	300	1985
N.J. 12 x 29-52	44	1984
N.J. 12 x 28-264	83	1984
N.J. 2 x 19-10	122	1984
N.J. 8 x N.J. 12	103	1984
N.J. 15 x 20-317	120	1985
28-264 x 20-317	43	1984
MAC x 29-52	84	1984
13-362 x 29-52	8	1984
Shinseiki x N.J. 12	47	1984
Shinseiki x 29-52	34	1984
Nijisseiki x 20-317	113	1984
Nijisseiki x MAC	40	1984
Nijisseiki x 19-10	117	1984
Total	4088	

Our primary objective in this programme is to combine the perfumed flavour of the European cultivars with the crisp, juicy texture and maturity characteristics of the Japanese cultivars. Red fruit colour is another character of interest.

Pest and disease resistance

This programme also uses wide crosses to incorporate useful known resistances from a range of species within the *Pyrus* genus. To date, sources of resistance have all come from North America, particularly from the progrmame at Rutgers, New Jersey, from whence Dr. L.F. Hough has supplied pollen and seed (Table 3).

In many countries, a serious impediment to pear culture is the mycoplasma disease, pear decline. In New Zealand neither the disease nor its vector *Psylla pyricola* have been recorded. Although no screening is included for pyslla we have introduced sources of resistance into our programme to protect against the possibilities of its future introduction. The diseases of fireblight (*Erwinia amylovora*) and scab (*Venturia pirina*) are sufficiently significant problems to warrant consideration in the programme. Powdery mildew (*Podosphaera leucotricha*) is generally not a problem on pears in this country.

Major pests of pears in New Zealand include mealy bug (*Pseudococcus sp.*), European red mite (*Panonychus ulmi*), San Jose scale (*Quadraspidistus perniciosus*), and pear slug (*Clairoa cerasi*). Work is currently underway to identify sources of resistance to these pests.

CONCLUSION

Wide crosses have mainly been used by pear breeders to introduce characters of disease resistance (Bell, 1982) and to a limited extent for other characteristics (Alston, 1973; Braniste *et al.*, 1984). A major broadening of the genetic base for quality and handling characteristics is required to enable the European pear to overcome the problems facing this fruit in the market plae.

The development of new genetic combinations may create the opportunity to select recombinants having novel phenotypes or better adaptability.

Within the *Pyrus* genus there are no morphological or phenological barriers limiting interspecific crossing, and the little information we have on the mechanisms of inheritance of the major quality characteristics supports the possibility of successful selection from progeny of interspecific crosses. Uhlinger (1982) has suggested that psychological barriers have been the major limitation to wide crosses with herbaceous perennials. Perhaps the same is true in pear breeding.

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SYMPOSIUM DISCUSSION

Mr L. Decourtye, INRA

The European breeding programme is concerned mainly with resistance to fireblight. I understand this is not a great problem to you?

White

While we do have the disease in New Zealand, to date it has not been of great significance in our orchards. We have not been doing glasshouse screening, we will be doing field screening. The technique we will use is injection with a hyperdermic syringe of a solution of spores into the soft growing tips.

Dr F.H. Alston, East Malling Research Station

We have also been involved in our crossing programme in a small way with bringing together the Asian pear and European pear but without a lot of success. From what I have seen since I came to New Zealand that may be because we have not been using some of the later varieties from Japan.

White

Yes I think that could be correct. A brief review of the literature suggests that most of the characteristics we are looking at in terms of texture and flavour tend to be additive, and thus the selection of the highest quality cultivars for parents in a hybridisation programme is very important. The Japanese programme within the *pyrofolia* species supports this — they get improved texture by using the best textured parents in their programme. I can not see any reason why this should not occur across the species.

Dr R.D. Burdon, Forest Research Institute

Are you using the successful Japanese cultivars?

White

Yes

Burdon

Might it be more useful to go back to Japanese breeding population material for your purposes rather than just the successful cultivars?

White

That is a possibility we are considering. To a large extent our programme to date has been limited by available material — we have not always been able to have the amount or the selection of material that we would like to use.

Mr H.K. Hall, Crop Research Division, DSIR

Have you examined the variability in seedlings of the Asian pear.

White

We have, but not for a cultivar programme, we are looking at this in terms of rootstock.

Mr L. Decourtye, INRA

European pears are propagated using quince rootstocks, what will you use if you introduce the new species in your programme.

White

This is a potential problem if we wish to graft or bud our selections onto quince, because the *pyrofolia* species in general is very incompatible with quince. We would have to resort to using either an interstem if we wanted to use quince stocks, or a seedling or a clonal selection of the *pyrofolia* species, as a rootstock. At this preselection stage in our programme, we do not include a screen for compatibility with quince.

Alston

To further comment on the question of compatibility, its been our experience at East Malling with crosses between European and Asian pears that if you have the population numbers, and you want to add another selection criteria, you can select for compatibility within that population. You can get Asian pear types which carry compatibility derived from the Eruopean pear. In one case we got a very sharp segregation between compatible and incompatible.

White

In our objectives we rate fruit quality more highly than compatibility. Also we are using population sizes that are smaller than what we would prefer, so we must be selective as to those characteristics that we apply selection pressure for. We are not uncomfortable with the use of interstems in European pear production.

Alston

What about the cost of the tree? Some growers are concerned about this.

White

We have not found that to be the case in this country.

Dr C.J.A. Shelbourne, Forest Research Institute

How long have people been breeding pears and how many generations are we away from the wild pear tree? Also, do you take any cognisance of gene resources in your breeding strategy?

White

The French and the Belgians have been breeding since the early 1800s. Before that there was selection of naturally occurring seedlings or trees that suddenly appeared in the back garden. Most of the cultivars currently used in the world, perhaps with the exception of Packer's Triumph, arose from that type of selection.

The second part of your question — we have been using what material we have been able to lay our hands on. One of the basic problems we face in breeding of fruit crops in this country is the limitations that are imposed on us by quarantine. It takes a very long time to get material into this country and bulk it up to sufficient numbers so, while the answer is yes we do, in practice there are limitations.

Shelbourne

When you are talking about quarantine you are talking about quarantine of vegetative material. What about introducing seed material?

White

We are asking people to make crosses for us using available material and introducing the seed. However, we are not really going back to wild sources. I think that would be to turn our back on many generations of crosses that have produced material containing many desirable characters. A lot of the disease resistance factors, for example, come from pears which are as big as your fingernail. It takes several generations to introduce desirable characters and we are dealing with a long generation crop.