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PEA CULTIVAR DEVELOPMENT IN NEW ZEALAND

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INTRODUCTION

Peas have been cropped in New Zealand since the commencement of arable agriculture, predominantly in Canterbury and Marlborough. Agricultural statistics show a combined area of peas and beans for threshing in the early 1900s of around 4,000 ha.

Seed of common English garden pea varieties was grown for export, in addition to field peas of various types for stock feed and export. English varieties of blue boiling peas, yellow cotyledoned peas for splitting or meal production, and maple peas for export to England for feeding pigeons were grown extensively. The latter type formed the bulk of the exported produce.

Peas are still predominantly an export crop. The types, uses and export markets of field peas have altered little since pea cropping began. The area has steadily increased to a current level of 21,000-23,000 ha, producing about 60,000 tonnes per annum. Canterbury accounts for approximately 75 per cent of the area cropped, and North Island and Marlborough production has steadily declined.

Green pea production for processing by canning or freezing in Hawke's Bay and Canterbury expanded rapidly in the 1950s and 1960s, up to approximately 10,000 ha currently, with freezing using the greater part of production towards the present time.

EARLY INTRODUCTIONS AND SELECTIONS

Pea breeding was well established in the early 1900s in the UK, Netherlands and the USA, most work being carried out by private firms. Early introductions into New Zealand were made by seed firms interested in the re-export trade. Most cultivars came from the UK and USA.

Investigation into the performance of cultivars of all pea types commenced in New Zealand at the Government Experimental Farm in Ashburton in 1928. This work was continued at the Plant Research Bureau, Palmerston North, with the closure of the Ashburton station in 1932.

Selection for purity of established lines also commenced in 1928. Pea cultivars are prone to loss of purity through accidental mixing of seed and by mutation. Since varietal purity was an important prerequisite in garden pea seed stocks for export, a scheme was evolved where, by 1933, pure seed stocks of a number of commercial varieties were available for distribution to merchants.

From the cultivar performance trials it was established that the varieties best suited to local conditions were:

- Garden peas: William Massey, Little Marvel, Greenfeast (Lincoln), Greatcrop, Onward and Stratogem.
- Marrowfats: Harrison's Glory.
- Field Peas: Blue Prussian, White Ivory and Partridge.

Although there was a ready export market for field peas during the 1930s, production did not develop appreciably because of major quality problems with New Zealand grown Blue Prussian peas (variable hardness, slow absorption of water, small size and inconsistent colour). The available white pea cultivar (White Ivory) yielded poorly.

EARLY CROSSING PROGRAMMES

In 1932 it was decided that improved types of blue pea should be selected from crosses between Blue Prussian and a number of garden peas. Several lines from four crosses were tested at Lincoln from 1937 to 1939, and in 1940-41 a line from a cross between Blue Prussian and Harrison's Glory was increased and named Mammoth Blue. It was released in 1943. It was said to have higher yield, and produced a larger seed of equivalent cooking quality to Blue Prussian, but there were still problems with variable hardiness, inconsistent colour and slow water absorption.

Crosses to develop a white pea with improved yield were made in 1933. Single plant selection was practised in early generations until field trials were commenced in 1937 to compare seven advanced lines. From these trials, one line from a cross between Blue Prussian and Greenfeast demonstrated superior yield to White Ivory, but seed quality was slightly inferior. This line was named White Prolific and released through the Department of Agriculture in 1943.

The advent of World War II curtailed pea breeding activities after the release of Mammoth Blue and White Prolific.

BREEDING OBJECTIVES

The order of importance of breeding objectives for peas in New Zealand has been disease resistance first,

quality second, and yield third, although improved disease resistance has a major impact on yield.

Disease resistance

Two diseases which seriously affected pea production in some areas of New Zealand were discovered in the late 1930s and 1940s. In 1937 Chamberlain described bean yellow mosaic virus (BYMV syn. pea mosaic virus) and he published (Chamberlain, 1939) a list of susceptible and resistant garden and field peas. He also stated that a breeding programme had been started at Lincoln to breed mosaic resistance into Greenfeast peas. Pea wilt, caused by *Fusarium oxysporum pisi* Race 1 was common throughout Canterbury and was first studied and described in 1948. It caused serious crop losses in some areas of Canterbury where peas had been frequently grown in the rotation. These diseases affected production more severely in New Zealand than elsewhere and thus became the impetus for a major breeding effort.

Pea top yellow virus, an aphid borne yellows type virus, had been first identified in 1959. It had by then become the most important disease limiting production of peas in Canterbury. There was a wide range of susceptibility among commercial pea varieties, partial resistance was available in some commercial cultivars and in the pea collection.

A serious seed-borne disease, bacterial blight, caused by *Pseudomonas pisi* Sackett spread rapidly throughout pea growing areas in the late 1960s and early 1970s after its accidental introduction from Tasmania. It has considerable significance as a quarantine problem which could restrict exports of pea seed. Two field pea accessions were reported to show resistance (Taylor, 1972) and a breeding programme commenced in 1971 but was discontinued when field screening revealed that the resistance was ineffective.

The arrival of the blue-green lucerne aphid (*Acyrthrosiphon kondoi*) and pea aphid (*A. pisi*) in 1975 and 1978 respectively increased the incidence of Alfalfa Mosaic Virus (AMV) in grain legume crops, especially peas. Field screening in New Zealand confirmed overseas observations that there appears to be no useful resistance to AMV in presently available germplasm. Thus AMV remains a potentially serious problem.

Common root rot of peas caused by *Aphanomyces euteiches* was identified in 1978 (Manning and Menzies, 1980) as the disease causing very serious crop loss in the processing pea area around Motueka and the intensively cropped field pea area of mid-Canterbury where the frequency of pea crops had become as high as one in every two years.

Again, screening of germplasm confirmed experience elsewhere that there is not yet useful resistance and the only means of control to date is avoidance of contaminated fields.

Brien *et al.*, (1955) listed downy mildew (Personospora viciae f. sp. *pisi* and ascochyta blight, caused by a complex of three related fungi, as occasionally important diseases, subject to weather conditions favourable to disease development. They are still occasionally important, and breeding programmes commenced in 1980 to increase the level of tolerance to those diseases in processing and field pea cultivars.

Quality for processing

Throughout the late 1960s and early 1970s there was a rapid expansion in the processing of peas for freezing and dehydration. Processors required cultivars more suited to mobile viner harvest, adapted to production areas and of high quality for processing.

The first cultivar bred specifically for the requirements of the New Zealand processing industry was Poha, from a cross between Greenfeast and Victory Freezer (USA). It was released in 1970 with the advantages over both parents of multiple-disease resistance, green colour, blunt pod for easy vining and a high pea to vine ratio.

Subsequently, four new process pea cultivars were released in 1974, combining resistance to bean yellow mosaic virus, pea top yellows virus and pea wilt with quality requirements for processing. They were Patea, Pania, Piri and Puke. Patea is an early-mid season cultivar and the others are mid-season in maturity. They were selected from crosses among existing foreign-bred processing peas, except Pania which was developed from a cross between Poha and a dark green-seeded introduction.

In the 1980s, new reduced-intake viners have replaced conventional viners, and cultivar development is now directed towards a stronger-stemmed plant with less foliage and a tendency for top-bearing rather than bearing pods over about 6 nodes on a longer stem.

Trends in consumer preference indicate that new cultivars need to be of more even colour and smaller size than present cultivars, but not 'petit-pois'.

Field pea quality

The previously mentioned quality problems for blue peas, i.e. colour retention and evenness, variable hardness, and slow water absorption still remain as important breeding objectives in the blue, marrowfat, and white field peas destined for human consumption.

Yield

Increased yield has been achieved by breeding, especially in processing peas (Casey, 1987). Since there are few management options except irrigation that can positively affect yield potential, breeding higher yielding cultivars remains one of the few methods available to increase yield.

BREEDING METHODS

Disease resistance

Pea wilt and bean yellow mosaic virus resistance.

Because the export market required recognised overseas cultivars, a backcross breeding programme was initiated by D.S.I.R. at Lincoln in 1948 to incorporate disease resistance. However, concurrent field tests in infected soil revealed that a line of Greenfeast supplied by a merchant contained a large number of plants resistant to

pea wilt. These plants were selected and progeny tested for resistance, yield and Greenfeast characteristics in trials over 2 years. One line was dropped while the remaining four were bulked and released as Greenfeast WR through the Department of Agriculture in 1957. Nucleus seed was maintained by Crop Research Division and the original Greenfeast line was completely replaced by Greenfeast WR after that date.

Backcross breeding led to the release of wilt-resistant Onward in 1960 and William Massey in 1964. Resistance was obtained from an American cultivar, Delwiche Commando. In 1967, a multiple-disease-resistant Blue Prussian was released. This was developed from a cross between Blue Prussian and wilt-resistant Onward, which also had resistance to bean yellow mosaic virus. Backcrossing was used to recover Blue Prussian plant characteristics.

Immunity to bean yellow mosaic virus was introduced into Greenfeast from the English cultivar Hursthouse by backcross breeding, and the cultivar Greenfeast 68 was released in 1968. At that time, Greenfeast was still the most popular cultivar grown for processing, seed export and home garden use.

Field pea breeding also continued with the objectives of disease resistance and improved seed quality. A pea wilt-resistant selection of Partridge was released in 1973 as Partridge 73. In the same year, Pamaro, an improved quality white pea resistant to wilt was released. It resulted from a cross between White Prolific and wilt-resistant Victoria.

Bean yellow mosaic virus resistance was incorporated into Partridge 73 from a garden pea, Freezer Elite, by backcrossing. The new mosaic resistant maple pea, Whero, is substantially earlier in maturity than Partridge 73, which allows growers the option of spring or autumn sowing. Whero was released in 1977.

Pea Top Yellows Virus.

Immunity to this virus complex is not known, but a high level of generalised resistance became one of the objectives of subsequent breeding work. This was achieved by successive crosses between moderately resistant cultivars (Crampton & Watts, 1968). A very similar aphid borne disease called top yellows was described in Holland in the 1950s but there were some differences in aphid vectors and varietal reaction, so the lines identified as resistant in Holland were not suitable for use as parents in developing resistant cultivars in New Zealand.

Other diseases

Resistance to the *Ascochyta* complex and downy mildew is being bred by crossing current commercial cultivars of both field and processing peas with germplasm identified as having 'good field tolerance'. Field screening of segregating populations under naturally occurring disease pressure is carried out for both diseases because neither has proved amenable to screening by artificial inoculation.

Quality

Plant type characteristics such as height, nodes to flower, determinacy, pods per node, seed colour, and seed size are simply determined by few major genes, and are therefore easily manipulated in a conventional pedigree breeding system. Evaluation for taste is carried out on advanced breeding lines, by taste panels.

Market acceptability of field peas is evaluated by comparison with standard market grade samples, and while seed size and shape is simply inherited, uniformity of colour and water absorption rate are highly influenced by environment and thus less easily genetically manipulated.

Yield

In both processed and field peas yield is determined by harvesting plots from replicated trials to simulate normal harvest, e.g. process peas are cut and vined through a stationary mini-viner after determination of harvest maturity by tenderometer. Field pea trials are direct headed with a small plot combine. Yield trials commence at F5 and F6 in field peas but because harvest of processing peas is necessarily destructive, it may be delayed until sufficient seed of promising lines is available in F7 or F8.

EVALUATION AND RELEASE

Co-operative, voluntary and free evaluation of potential new processing pea cultivars of either local or foreign origin has been carried out by interested organisations from the early 1970s to the present. The Ministry of Agriculture and Fisheries (MAF) at Hastings, Crop Research Division of D.S.I.R. at Lincoln and Dalgety Agresearch at Timaru (Goulden & Crampton, 1976; Mortlock and Manning, 1976; Wraight, 1976) and more recently MAF staff at Levin (Bussell, 1983) have carried out cultivar evaluation trials. Private seed companies have also carried out extensive imported cultivar evaluation over this period.

Concurrently, or following such trials, processors carried out large scale (0.4 – 1 ha) field trials with promising lines to test their vining characteristics, maturity development and suitability for processing. Following the introduction of the foreign-bred cultivars Puget and C39 in the early 1970s, D.S.I.R. released Pania, Patea, Piri and Puke in 1974, Kuru in 1978, and an early maturing cultivar, Tere in 1980. Further foreign introductions were made during this time; Waverex, a petit-pois cultivar was used for a short time from 1980, Princess since 1981/82, and recently Combi, Novella, and Bolero have been evaluated by processors on a small scale.

Similarly, there is no National or Recommended List Trial procedure for field peas and evaluation is carried out by public and private breeders according to need and resources. However, since 1982, advanced breeding lines and imported cultivars have been exchanged by evaluators and an unofficial , co-operative trialling system is developing. Within Crop Research Division, yield testing of single plant progenies begins with replicated small plot trials in F5 or F6, progressing to on-station full size (6

replicate, 15 m^2 plots) trials for one year, followed by at least two years off-station testing either on farms in representative pea cropping districts or with other breeding organisations. Following satisfactory performance and indications of market acceptability, D.S.I.R. cultivars are submitted for a Plant Varieties Rights grant, and applications for Head Licensee are sought through the New Zealand Plant Breeding and Research Association. Cultivars are released into commerce by the Head Licensee who may issue sub-licenses.

NEW DEVELOPMENTS

Modified foliage pea cultivars (semi-leafless) were first commercially tested in the UK in 1975 and subsequently there has been strong interest in this plant type in the belief it would lead to better foliar disease resistance and standing ability than conventional types. It has now been demonstrated that neither of these traits is necessarily linked with semi-leaflessness, but the type remains popular with breeders and half the entries in the 1985 PGRO preliminary field pea evaluation trials in the UK were semi-leafless. Two such cultivars, Solara and Countess combine high yield with good standing ability.

Novella, a semi-leafless processing pea was introduced in the UK in 1981 and has become established.

In New Zealand, Solara has shown good yield and standing ability, and a semi-leafless white pea, Lovelock, was submitted to NZPBRA by D.S.I.R. in 1985 for licensing.

As previously mentioned, modification to the processing pea plant type will continue as harvesting technology develops further.

The use of peas as a summer forage crop either alone or in mixtures with cereals (Armstrong *et al.*, 1984; Gent, 1985) is common practice in the UK, and in NZ on a very small scale. The practice may expand here with a feed requirement for new or different sheepmeat production.

Traditional breeding objectives of disease resistance, quality, and yield will be as pertinent in the future as the past, with perhaps greatest emphasis likely to be on quality in the future.

SUMMARY

Peas fill an important role in arable cropping rotations, provide an important food resource and earn export income for New Zealand.

Pea breeding and selection in New Zealand began as long ago as the 1920s with the testing of introduced cultivars and selection of pure lines. Since then a wide range of garden and field peas have been released from the D.S.I.R. breeding programme to provide resistance to diseases and improvements in quality. Few introduced pea cultivars are successful in New Zealand as disease problems are more severe in this country than in other pea growing regions. About 60 per cent of the area in peas in New Zealand is planted in DSIR-bred cultivars.

Pea seed and grain exports are an important part of the New Zealand export trade. Pea cultivars bred in New Zealand show excellent performance in overseas countries and it is likely that further developments, particularly in co-operative breeding projects, will lead to a major expansion in our seed trade.

New Zealand has a reputation for very high quality in its garden and process pea seed because of excellent quarantine, a good climate for seed production in Canterbury and good technology.

The future utility of crop legumes is assured by their value as a protein source and the more recent recognition of their value as a source of dietary fibre.

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