

ONION BREEDING IN THE DSIR

D. Grant and B. Carter

Crop Research Division, DSIR, Pukekohe

ABSTRACT

Onion breeding by the Department of Scientific and Industrial Research commenced in 1946, with the establishment of Crop Research Division. Early research was centred around the development of onion hybrids which were 'longkeeping' types. Three hybrids were released but because of problems with seed production and a small export market these were not widely grown.

Present efforts in onion breeding are now concentrated on breeding earlier maturing types, improved longkeeper types with better uniformity, disease resistance and flavour, white types for dehydration and also red storage types for the export trade.

Breeding techniques and schemes used for recurrent selection programmes and the development of hybrid varieties are outlined in this paper.

Additional Key Words: Export markets, hybrids, selection programmes

INTRODUCTION

Before 1970 the onions grown in New Zealand were mainly for local consumption. However, over the past fifteen years considerable expansion has occurred in the industry which has been largely due to the development of markets in the Northern hemisphere, especially in Japan. New Zealand's production in 1985 was 90,000 t from 2700 ha and 80 percent of this was grown in the Pukekohe district (Wood and Wilson, 1986).

The expansion of the industry has been based upon the locally developed cultivar "Pukekohe Longkeeper (PLK)". Other cultivars have not been successful in the district, probably because of the narrow range of environmental conditions (daylength and temperature) required for adaptability.

Expansion has also occurred in the onion research programme run by the DSIR. The aims of the breeding projects are to increase the types of onions available commercially i.e. white types for dehydration, red onions which store well, early maturing globes and long keepers which have better disease resistance, higher yields, milder flavours and which are more uniform in shape and size.

HISTORY OF BREEDING

Before 1930, approximately two-thirds of the onions consumed in New Zealand were from crops which were produced locally. Because of the poor keeping qualities of the cultivars used, the remaining requirements were imported, at high cost, from California and British Columbia. Most of the seed was imported from Europe and the United States (Taylor, 1916). This seed was of uneven quality and poorly adapted to local environmental conditions. The main cultivars then grown were Brown Spanish, Straw Spanish and Australian Brown (Bell, 1938; Allo, 1943). Brown Spanish was a low yielding cultivar, which was susceptible to downy mildew. It had poor skin colour but had good keeping qualities. Straw Spanish was a high yielding, flat topped onion with a thin skin and straw

coloured bulbs. Australian Brown, which was initially favoured for its longkeeping qualities, did not succeed because yields were low.

During the 1920's, local growers began raising their own seed from selected bulbs of introduced cultivars. The best of these early selections was Pukekohe Longkeeper developed by Mr John Turbott at Harrisville, Pukekohe. It was thought to be a selection from Straw Spanish but it also had the desirable keeping qualities of Brown Spanish (Leonard, 1955; Merry, 1967). In later years, an earlier maturing cultivar, 'May and Ryan Early Longkeeper', was selected from PLK by Mr Noel May and Mr Peter Ryan. The only other cultivar to be grown in any quantity during recent times is the early maturing 'Porters Early Globe', selected from PLK in the 1950's by Mr Harry Porter, a Pukekohe grower.

Onion breeding by the DSIR commenced in 1946 with the establishment, at Lincoln, of the Vegetable Section of the Agronomy Division, (now known as Crop Research Division).

Early projects included:

- (i) observation of onion cultivars introduced from North America and Europe and comparison with New Zealand strains (Yen 1959a);
- (ii) reselection of PLK for high yield and better keeping qualities.
- (iii) the introduction of male sterility into PLK lines with the objective of developing hybrid varieties (Yen 1959b).

Sterility is conditioned by the recessive *ms* gene which, when homozygous and associated with cytoplasmic factor, *S*, produces the sterile phenotype. The maintenance of the sterile line is achieved with the fertile, normal cytoplasmic line, *N msm*s (Jones and Clarke, 1943).

The breeding of hybrid varieties by Mr D.E. Yen started in mid-1950's at the Otara Substation of the DSIR. From this programme, three cultivars (New Zealand

Hybrid No. 1, Hybrid 17 and Hybrid 30) were released in the 1960's (Ferral, 1967). These hybrids were developed from crosses between selections of United States male sterile A2267 and DSIR material. They did not gain wide acceptance commercially because of difficulties with seed production and highly priced seed. The flowering periods of the parental lines did not coincide and there was some fertility restoration of the female line (Bussell and Giesen, 1974). Further development of new hybrids encountered the same problems and the hybrid programme was later discontinued.

Onion breeding continued on a small scale at Lincoln from 1967 until 1979. Further evaluation of overseas cultivars did not identify any which were superior to PLK. Selection within PLK resulted in a line which had better keeping qualities but this was not released because yields were low. Testing for resistance to white rot, caused by the fungus *Sclerotium cepivorum*, was also carried out. No useful source of resistance was identified but PLK was found to be less susceptible to infection than most other cultivars.

A breeding programme to develop open pollinated cultivars of white onions suitable for dehydration began at Lincoln in 1967. Cultivars available at that time lacked suitable pungency, percentage dry matter and adaptability (Giesen, 1978). Breeding and evaluation of white onions for dehydration is still continuing, and seed of three lines is presently being multiplied prior to commercial release.

PRESENT BREEDING OBJECTIVES

The Crop Research Division's onion breeding programme was transferred to the Pukekohe substation in 1979 because Pukekohe was the most important onion growing region in the country. In 1981 it was decided to widen the genetic base of the onion cultivars grown locally and to redefine the involvement of the Crop Research Division in onion breeding (Grant, 1983).

The objectives of the onion breeding programme are now:

- (i) to breed an earlier maturing cultivar of onions to supplement the cultivars presently available to export markets. Ideally a desirable cultivar would mature a month earlier than the Early Longkeeper strain but have similar shape, size, colour and storage qualities;
- (ii) to produce lines with the unique characteristics of the PLK type but with better yield, improved flavour, uniformity of shape and size, and resistance to white rot, bacterial soft rot and pink root;
- (iii) to develop a white bulbed onion with a high dry matter percentage suitable for the dehydration industry;
- (iv) to breed a red globe onion which stores well, which would be suitable for exporting;
- (v) to evaluate germplasm from onion breeders and seed producers overseas for possible introduction into New Zealand.

Crop Research Division's onion breeding is supported by research programmes in other divisions of DSIR, for example: evaluation of the firmness of onions and their

quality (Applied Biochemistry Division) resistance to white rot and bacterial soft rot (Plant Diseases Division) physiology of bulbing and flowering (Plant Physiology Division) and modelling of growth (Applied Mathematics Division).

Breeding, selection and evaluation of onion cultivars is also carried out in New Zealand by private seed companies and local onion growers.

BREEDING METHODS

The onion, *Allium cepa*, is a diploid ($2n=16$) and is naturally cross pollinated. It is self compatible but is subject to inbreeding depression. Currah (1981) reports that the onion flower is largely cross pollinated by insects although under field conditions some selfing (8 to 27 percent) does occur naturally.

Because the onion is a biennial crop one breeding cycle occupies two seasons. Emasculation procedures are time consuming if carried out on a large number of plants because the inflorescence, which is an umbel, contains from 50 to 1000 flowers. At Pukekohe controlled pollination is carried out using insect proof cages. Both the housefly, *Musca domestica* and blowfly, *Calliphora vicina* are used for insect pollination.

Breeding methods used in the programme include various recurrent selection plans for both population improvement and development of inbred lines for production of hybrid cultivars. Mass selection has been used in the programme for improvement of bulb dry matter in onions for dehydration, while half-sib and full-sib progeny evaluation is used for improvement of brown globe storage onions. A modified half-sib plan similar to the ear to row method used in maize breeding by Lonnquist (1964) has recently been adopted. This is based on selection among and within half-sib families and is modified to include additional environments. In the Pukekohe programme different sowing dates are used to account for the effects of variation in daylength and temperatures on bulb development.

CONCLUSIONS

Onion breeding should result in a wider range of cultivars becoming available. These will include:

- 1) onions which mature earlier;
- 2) red onions which store well and are suitable for export;
- 3) white onions which are suitable for dehydration;
- 4) longkeeper types which have high yields, better uniformity, milder flavour and resistance to disease.

The present input into research and development of onions in New Zealand by DSIR should thus result in more cultivars becoming available commercially which should give the crop a broader base and allow it to continue to be a significant export crop.

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