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Onion Production to Meet Domestic and Export Market Requirements

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Final report for the HAL Project VG98005

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1. Media Summary

Queensland produces an onion under short to intermediate day growing conditions. Consequently, growers are faced with an extensive array of cultivars to choose from. These cultivars are sown from late February through to late June. This results in Queensland onions being available in the market place from early August through to late December. Consequently, Queensland onions face strong competition from southern storage onions (South Australia and Tasmania) early in the season and fresh onions from New South Wales late in the season. Due to the nature of the Queensland style of onion, soft, mild and few skins, there is a negative opinion of these onions when compared to the more pungent and harder storage onion from southern states. The aim of this project was to evaluate current and new varieties and assess environmental and climatic factors affecting the growth of the onion in Queensland.

Variety evaluation trials were conducted in each of the three years of the project. Trials were conducted in March, April, May and June in 1999, May and June in 2000 and April, May and June in 2001. In total, 73 different cultivars were assessed. Seed companies supplied the majority of the cultivars with a small number of cultivars obtained from local seed producers. The seed companies that supplied germplasm included Yates Seeds, South Pacific Seeds, Henderson's Seeds, Jarit Seeds, Lefroy Valley Seeds, May and Ryan Seeds and Magnus Kahl Seeds.

Golden Brown remains the only variety available for an early to mid season sowing. Local seed producers predominantly supply seed of this variety. A number of cultivars performed very well when sown in the mid season trials (March and April). These included: Yates Cavalier, Predator, K5151, K5155 and J5114, South Pacific Seeds Red Rocks and Columbus, Henderson's Sombrero, Lefroy Valley L1003, and Jarit's Gladalan Brown and White. The cultivars that performed well in a June sowing included: Yates' Predator, K5156 and H5097, South Pacific Seeds' Red Rocks and 1347, and Henderson's Sombrero.

During the 2000 season an investigation was undertaken to evaluate cultivars for the jumbo onions market. The cultivars Colossus, K5161 and K5162 produced the highest yield of desirable sized onions (> 100mm diameter). Colossus also produced the most acceptable pungency (pyruvic acid concentration) indicating this onion as being suitable for the jumbo onion market.

Population density investigations were carried out during the 2000 season. Plant spacings varied from 60mm to 160mm. Maximum marketable yield was obtained at the 60mm spacing. Actual spacing selected would depend on market requirements and this varies throughout the season and from year to year.

The production of doubles and seed heads is an issue that results in reduced marketable yield and bulb quality. Investigations have suggested that high daily temperatures play a major roll in the production of doubles in onions. Exact temperature regimes have yet to be determined. Temperature is also a factor in the production of excessive seed heads. In this case, it is minimum temperatures that are considered important.

2. Technical Summary

This project was established to continue and expand on the findings of the projects: VG530 "Evaluation and Development of Onion Varieties for Domestic and Export Markets" and VG95030 "Onion Production and Varietal Improvement Studies to meet domestic and Export Market Requirements". Queensland onions continue to experience poor acceptance in the market place due to strong market requirements for a hard brown onion with several intact skins. Queensland onions are generally soft with only one or two skins. Identification of improved germplasm is essential for the continued viability of the industry in Queensland. Other factors including doubling, bolting and bulb size are also of concern to the industry.

Onion growth is sensitive to variations in climate, namely, temperature and photoperiod. This impacts greatly on the Queensland industry due to the extended growing season. Onions in Queensland are sown from late February (summer) through to late June (winter). Climatic conditions fluctuate greatly during this time period necessitating the requirement for a large cultivar collection. Evaluation of semi-commercial cultivars from seven seed companies (South Pacific Seeds, Yates Seeds, Henderson Seeds, Jarit Seeds, Lefroy Valley Seeds, Magnus Kahl Seeds, May and Ryan Seeds (NZ)) was undertaken from 1999 to 2001. Two additional trials were undertaken during the 2000 season. These trials were a jumbo onion pungency trial and a population density trial. In addition to these trials, a large number of growth development trials were conducted in 1999 and 2000. These growth study trials are the foundations for a Masters Degree to be completed in 2004.

Cultivar evaluation trials consisted of three replicates of the nominated varieties planted in March, April, May or June in each of the years from 1999 to 2001. Trials in 1999 and 2000 were planted using an air-seeder while the trials in 2001 were planted using seed tape. Intra-row plant spacing was set at 75mm. Seed taping ensures a more accurate plant spacing. The jumbo onion pungency trial consisted of three replicates but was planted using a cone planter and then hand thinned to an intra-row plant spacing of 150mm. The population density trial evaluated three cultivars sown at their optimum sowing time at six different intra-row plant spacings. Once again a cone planter was used to sow the trials and the plots were then hand thinned to achieve intra-row plant spacings of 60, 80, 100, 120, 140 and 160mm. Data collected for each of these trials included yield characteristics, production of doubles and bolters, bulb appearance and bulb quality, sugar content and pungency.

The growth development trials consisted of two sets of trials each year. The first suite of trials (growth study trials) consisted of six trials sown one month apart from February to July in each of the two years. Varieties for each of the growth study trials were selected on the basis of their optimum sowing times. Data collection was via destructive sampling. Individual plant parts: leaves, pseudo-stems, bulbs and roots were removed and the fresh and dry weights were recorded. Additional data was also recorded including plant height, bulb and stem diameter and number of leaves.

The second suite of trials consisted of twelve trials sown at fortnightly intervals during each of the two years from late February through to late July. These trials consisted of the same five varieties sown at each of the twelve sowing dates. Data recorded included days to emergence, timeliness of leaf development, number of

leaves produced, number of days to bulbing, incidence of doubles and bolting, and final bulb weight.

As a result of the variety evaluation a number of cultivars have seen commercial release. This has included Mellow Yellow (Lefroy Valley Seeds), HA 890 (Lefroy Valley Seeds), and Yates' hybrids: Sirius, K5161, J5118, J5119 and H5082.

The jumbo onion pungency trial identified the Yates' hybrid Colossus as the mildest jumbo onion currently available. There are other jumbo cultivars available that were not trailed. It is uncertain if these cultivars will match Colossus for mildness. This supports the result of the previous project that indicated the potential for the experimental line Yates E511 (now Colossus) as a jumbo onion.

Interesting results were obtained from the population density trials. For all three cultivars evaluated maximum marketable yield (40-90mm) was obtained at an intra-row spacing of 60mm. The results also indicated that spacing selection would be greatly influenced by market requirements. For example if market requirements were for a mid-session onion with a size requirement of 80-90mm this is best achieved by sowing the cultivar Wallon Brown at an intra-row spacing of 120mm.

Preliminary results from the growth study trials indicate that temperature has a large role to play in the incidence of doubling (high temperatures) and bolting (low temperatures) in onion cultivars currently utilised by the Queensland onion industry. The selection of the correct sowing date is essential for the current suite of varieties available to Queensland growers. Sowing two weeks too early or too late can mean the difference between a very good crop and a crop full of doubles and/or bolters.

3. Introduction

Onion research in Queensland recommenced in 1994 at the request of the Queensland Fruit and Vegetable Growers Heavy Produce Committee. This is the third project since that research began. The project continued the evaluation of potentially new germplasm that may prove to be useful to the Queensland onion industry. The project also included the evaluation of current jumbo onions, the assessment of the effect on marketable yield of different planting densities and the evaluation of onion growth in a short-day tropical environment.

Queensland onion production is centred in the Lockyer Valley and on the Darling Downs. Annual production varies between 20 000 and 25 000 tonnes 80% of which is produced by the aforementioned regions. Producers commence sowing as early as late February, with their own maintained strains, and continue until late June when the germplasm is hybrids supplied by the commercial seed companies. This broad sowing window requires an extensive collection of cultivars to meet the requirements of the changing climatic and environmental conditions including temperature and photoperiod. As a consequence of this a number of variety evaluation trials were conducted during each year of the project. These trials were conducted at monthly intervals during the growing season. Selection of suitable varieties is essential to ensure maximum returns to the producer.

The onion market is constantly changing and resellers change their requirements from season to season. This has resulted in a desire by growers to investigate different markets and constantly update their growing techniques. An example of investigating new markets involved the continued evaluation of jumbo onions. This primarily took the form of onion pungency assessments. Although this market is currently small there is potential for expansion if suitable varieties are available to industry.

Supermarkets are continually revising their requirements for bulb size. Early in the season the requirement may be for 65-75mm diameter bulbs then later in the season the requirements may be for a 75-90mm diameter bulb. Population density was examined as a means to determine optimum plant spacings in order to meet these fluctuating demands from resellers. The selection of optimum plant spacing will allow growers to plan for and meet the fluctuations experienced on the domestic market.

Queensland produces a short-day onion under sub-tropical to tropical conditions. Little research has been undertaken to examine the effects of climate and the environment on the growth of short-day onions in Queensland. This lack of knowledge has led to a somewhat hit and miss scenario as far as varietal selection for Queensland is concerned. The onion growth study will examine the effects of climate and the environment on the current suite of onion cultivars available for the Queensland onion industry. This information will ensure the selection of the most suitable cultivar for each sowing date and prove to be an invaluable tool in the assessment of potentially new cultivars for the Queensland onion industry.

4. Varietal Evaluation

4.1. Introduction

A number of varietal evaluation trials were conducted at Gatton Research Station from 1999 to 2001 (complete data sets – See Appendices 1-4). In 1999 four trials were planted at monthly intervals from March through to June evaluating a total of forty-three cultivars. During the 2000 season, twenty-five varieties were evaluated in May and June only. This was as a result of no cultivars being supplied by seed companies for early sowings. Variety trials and screening trials were carried out in 2001. Twenty-six cultivars were evaluated in variety trials (April to June) and fifteen cultivars were evaluated in screening trials (April and May).

4.2. Materials and Methods

In each planting, 3 replicates or plots of each entry were established. Each plot consisted of four rows of which the two centre rows were designated the datum rows with a single guard row on either side. Plots were established on beds with 1.5m centres. In 1999 and 2000, seed was planted at the rate of 8g per row using an air seeder. Plant stands were hand thinned to an intra row spacing of 75-100mm. In 2001, all trials were planted using the Livyn® taping method (See Plate 4.1) at an intra row spacing of 75mm. The tape was planted using a small self-propelled four-wheel drive planter (See Plate 4.2.). Plots were 10m long and yield was measured from 8m of each of the two centre rows leaving a buffer of 1m at each end of the plot. Varieties were harvested when 80-100% of the tops were down and allowed to dry in trays before mechanical grading.

Plate 4.1. Taped onion seed –75mm spacing.

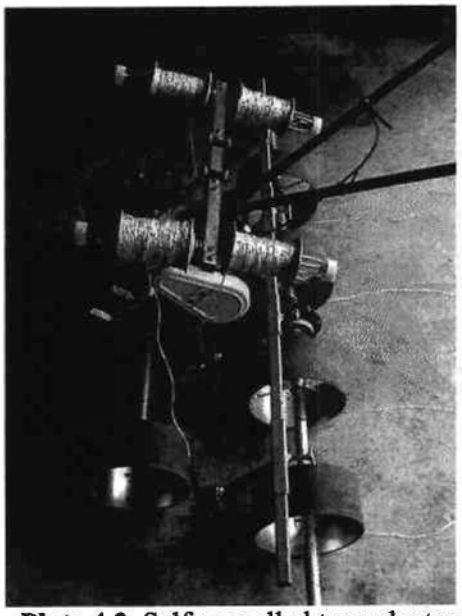

Plate 4.2. Self-propelled tape planter

At harvest, the number of seed stems and bullnecks were counted. When grading, the yield (kg) and number of doubles, purples and off-types (off-colours) were recorded as well as the yield (kg) and numbers within the pickling, No. 1 and No. 1 Large grades. These grades refer to bulb diameters with the pickling grade being 0-40mm, the No.1 grade 40-75mm and No. 1 Large grade being greater than 75mm.

Thirty bulbs were randomly selected from the harvested portion of the datum area during grading. Five of these were used to determine total soluble solids, percentage dry matter and the number of centres per bulb, five were used to determine the pungency (pyruvic acid concentration) of the bulbs and the remaining twenty were stored in racks to determine the effect of storage on bulb quality. Two weeks after harvest the bulbs were assessed for firmness, shape and colour. After a further 8-12 weeks, the bulbs were assessed for skin colour, soundness (incidence of breakdown), firmness, degree of greening (1 nil - 5 intense) and incidence of sooty or black mould (*Aspergillus niger*).

4.3. Results

4.3.1. 1991

Comprehensive results are presented in Appendix 1.

March Sowing

Whites

Only three white cultivars were tested in this trial. Else Early White, a local strain produced the highest marketable yield (48.3 t/ha). Both Neuendorf and Jarit Early Lockyer White produced greater than 30% yield as double bulbs.

Browns

The March planting consisted predominantly of local seed producer cultivars with very few commercial varieties suited to this early planting. The commercial cultivar SPS 7-509 (SPS 509) yielded (60.5 t/ha) well but may struggle to be accepted due to its unfavourable and inconsistent shape. The variety Yates Cavalier (Yat Cav) (67.7 t/ha) was the highest yielding variety in this trial but the seed company does not recommend planting early due to the likelihood of bolting. The mild season this year resulted in a large percentage of doubles and bolters (seedheads). Some varieties produced up to 45% unmarketable bulbs as doubles and seedheads. Even local varieties produced unacceptable numbers of doubles.

Pungency

Brown onions dominate the sweet mild onion market. These onions require a TSS (%brix) greater than 8.0 and a pungency reading of less than 5.92 µmole/g of fresh weight. The only variety that met the TSS requirement was Neuendorf's Early Lockyer Brown but there were no bulbs available for pungency testing. This variety

would expect to have a pungency level similar to the Gatton Research Station Early Lockyer Brown (6.79).

April Sowing

Whites

Only one white cultivar was entered in this trial. This variety produced an average marketable yield but 30% of its total yield was as doubles.

Browns

An increase in the number of commercial varieties is evident in the April planting. The mild season resulted in the production of an unacceptable number of seedheads. In some cases this was as high as 30% including the local variety Wallon Brown (Neu Wab) (31%). Once again the variety Yates Cavalier produced the highest yield (44.6 t/ha). A local strain of Golden Brown (Els Gob) performed well (40.9 t/ha). Golden Brown's acceptance on the domestic market is waning due to its pale colour and tendency for 'baldness'. Although the Jarit variety Lockyer Gold (Jar Gol) produced a marginally acceptable yield (38.8t/ha) the majority of the bulbs produced were quite small thereby hindering its acceptance.

Pungency

Jarit Lockyer Gold (Jar Gol) had the lowest pungency (4.85 μmole/g) with an acceptable sweetness (8.09 % brix). This indicates a variety that would be suitable for the sweet mild onion market. Its small bulb size (< 75mm diameter) would restrict the acceptance of this variety. Magnus Kahl Seeds Sun-K BR (MKS BR) is a very mild onion ideally suited in flavour for the fresh salad market but its unevenness of shape would hinder its acceptance. The Yates variety Cavalier (Yat Cav) had a reasonably high pungency and its high yield results in good variety for the Lockyer Valley.

May Sowing

Whites

The Yates experimental line H5083 produced the highest marketable yield – 42.2 t/ha. The cultivars Yates' Cossack and Henderson's Bolero produced average yields of 29.1 t/ha and 36.5 t/ha respectively.

Browns

Commercial seed company varieties dominate the May planting with only one local variety, Wallon Brown (Neu Wab) which still produced acceptable yields. Downy mildew was a major problem in this trial. Initially the crop was growing vigorously but a severe outbreak of downy mildew mid way through the season halted this growth. Consequently, yields are somewhat less than expected. Yates Predator (Yat Pre) was the outstanding variety with a good yield (58.9 t/ha) and a good measure of partial resistance to downy mildew. Jarit Gladalan Brown (Jar Glb) also yielded well

(54.6 t/ha) but its shape may detract from its marketability. Good yields were also obtained from the South Pacific Seeds variety Columbus (SPS Col) (46.3 t/ha) and Yates Nautilus (Yat Nau) (47.4 t/ha). Most varieties produced very few seedheads or doubles with the exception of Magnus Kahl Seeds Sun-K Br which yielded 21.1% seedheads.

The cultivar Jarit's Gladalan Brown (Jar Glb) showed the best resistance to downy mildew. There was no mildew present on this variety for up to five weeks after the initial outbreak with a final level of infection of about 50-60% compared to 85-100% for the remainder of the varieties. Under a lower disease pressure the majority of varieties would have performed better.

Pungency

None of the varieties tested could be considered as true sweet onion types due to their low TSS (% brix). The varieties South Pacific Seeds Columbus (SPS Col), Magnus Kahl Seeds V50 – 994 (MKS 994) and Henderson's Sombrero (Hen Somb) all had pyruvic acid levels less than 5 µmole/g of fresh weight which classifies them as mild onions. Their brix % is less than 8%, which means that they cannot be classified as sweet onions despite their mildness.

June Sowing

Whites

The Yates cultivar Dove was the only white cultivar entered in this trial. Total marketable yield was very low (11.5 t/ha) due to the high incidence of downy mildew.

Browns

The final trial contained cultivars only available from commercial seed companies. These varieties are predominantly creamgold types. Downy mildew again caused major damage and subsequent yield loss. In the majority of cases the marketable yield consisted of predominantly small bulbs. A number of varieties produced higher yields of picklers (bulb diameter <45mm) than the standard No. 1 Grade (bulb diameter 45-75mm). This included the recognised standard Yates Gladiator (Yat Gla) which produced 65 % of the total number of bulbs as picklers. The Magnus Kahl experimental line Sun-K Br (MKS Br) produced the best marketable yield (27.1 t/ha) but 58.8% of the bulbs were picklers. Due to the high incidence of downy mildew the yields obtained are not a true indication of the yield potential for the varieties tested. This is reflected in the high percentages of picklers produced by all varieties for example Yates 5078 (Yat 5078) produced 98.9% picklers.

Pungency

Varieties planted at this time of the year tend to be pungent types due to their creamgold heritage. The exception to this is the Henderson's variety Sombrero (Hen Somb) (4.50 µmole/g of fresh weight). Varieties such as Magnus Kahl Seeds Sun-K BR and V50-1035 are borderline for mildness with pyruvic acid concentrations of 5.79 and 5.76 µmole/g of fresh weight respectively.

4.3.2. 2000

Comprehensive results are presented in Appendix 2.

May Sowing

All cultivars tested produced marketable yields (bulbs > 40mm diameter) in excess of 55 t/ha (22 t/ac). In all cases this high yield was as a result of high percentage of No 1 Large bulbs (bulb diameter > 75mm) being produced. With the exception of Yates' H5083 (white), the No 1 Large grade accounted for more than fifty percent of this total marketable yield for all cultivars.

Whites

Only two whites, Yates' H5082 and H5083, were tested at this planting time. Both varieties performed well producing good yields. H5083 matured three weeks earlier than H5082. H5082 (79.4 t/ha) produced a significantly higher marketable yield than H5083 (59.5 t/ha).

Browns

A number of excellent brown cultivars were tested. High yields of good quality bulbs were produced. The majority of the cultivars tested produced high numbers of No 1 Large bulbs with the exceptions being Neuendorf's Wallon Brown and May and Ryan's 19042. Both of these varieties produced equivalent numbers of No 1 (40-75mm) and No1 Large (> 75mm) bulbs. This accounts, in part, for their reduced marketable yields. The best yielding varieties were Henderson's Sombrero and Yates' Predator with marketable yields of 90.4 t/ha and 92.2 t/ha respectively. Both cultivars produced a large number of bulbs greater than 90mm in diameter. Low percentages of unmarketable bulbs (doubles, off-types etc) were evident and this combined with the low numbers of picklers resulted in a better than average pack out of marketable bulbs for all cultivars. The Yates' cultivar J5119 produced a high marketable yield of excellent quality uniformly shaped bulbs.

Reds

Four commercial reds were tested in this planting. Excellent yields were produced by all cultivars. The Yates' experimental lines H5078 and H5094 performed well with marketable yields of 82.4 t/ha and 83.7 t/ha respectively. The shape of H5078 is a little variable. The South Pacific Seeds variety Red Rocks (83.2 t/ha) out performed its stable mate Rio Demon (67.9 t/ha).

Pungency

Pungency levels were determined for all cultivars. The levels in all cases were higher than expected. This is primarily due to the dry season resulting in higher than usual levels of pyruvic acid concentration in the bulbs. This can be attributed to a higher bulb dry matter percentage than usual. All varieties exceeded the maximum pyruvic

acid level of 5 µmol/gm of fresh weight that is used to classify an onion as a sweet mild type.

June Sowing

Marketable yields of varieties tested at this planting time varied from 16 t/ha (Jarit Sunshine) up to 72 t/ha (South Pacific Seeds 1347). The majority of the cultivars tested at this sowing date recorded higher percentages of No 1 grade bulbs than No 1 Large bulbs the reverse of the May planting. Doubling was also more evident at this planting time.

Whites

Henderson's Bolero was the only white variety tested at this planting time. It performed quite well producing a uniform bulb shape with a good marketable yield.

Browns

A number of browns were compared in the June trial. SPS 1347 significantly out yielded all varieties and shows promise with a good consistent uniform shape and appearance. Henderson's Sombrero, South Pacific Seeds experimental line 1347 and Yates' experimental line H5097 each produced a significantly higher marketable yield than all other cultivars. The Jarit Seeds' cultivars Sunshine, JT091 and JT520 produced significantly high percentages of doubles. The May and Ryan experimental line 19042 is a very hard onion with excellent storage capabilities. It has a similar colour to the local Golden Brown strains. Subsequently, this characteristic may result in the expansion of the market for this type of onion. This cultivar may struggle to find acceptance in the local growing area due to its low marketable yield.

Reds

Two commercial red varieties were tested in the June trial. Both of these cultivars are available commercially. South Pacific Seeds' Red Rocks out yielded Henderson's Red Rojo and also has a more readily acceptable bulb shape.

Pungency

Pungency levels remained high for this planting time. Henderson's Sombrero was the only cultivar that recorded a pyruvic acid concentration below the level for acceptance as a sweet mild onion. Onion cultivars planted late tend to have a higher pungency than early onions. This is due to their Creamgold parentage, which results in an onion that can be stored.

4.3.3. 2001

Comprehensive results are presented in Appendix 3.

April Sowing

The cultivars tested in the April sowing were all brown types. These included the local varieties Golden Brown and Wallon Brown of which Wallon Brown produced the highest yield (67.7 t/ha). The highest yielding cultivar was the Yates experimental line K5151 with a marketable yield (> 40mm bulb diameter) of 79.3 t/ha. The commercial variety Cavalier and the experimental line K5155 also yielded well with marketable yields of 73.9 t/ha and 71.2 t/ha respectively.

Very few unmarketable bulbs were produced. The only exception to this was the Lefroy Valley experimental cultivar LV35 that yielded 44.2 t/ha in doubles. This accounted for 55.9% of the total plot yield. Seedhead production was very low. The experimental lines L1003 (Lefroy Valley) and K5155 (Yates) yielding only 3.9% and 3.4% respectively of total bulbs produced.

Pungency

Pungency of all cultivars was assessed and the Lefroy Valley experimental varieties L1003 and L1005 produced the lowest pyruvic acid concentrations of 5.8 and 4.5 μmol/gm of fresh weight respectively. These cultivars would be classified as mild onions. L1003 has a light brown skin that ensures its acceptance in the fresh mild onion market. Although L1005 has the lowest pungency its flat shape will make it difficult to be accepted under current domestic market requirements for a globe shape onion. The variety J5128 produced the highest concentration of pyruvic acid (pungency), 10.8 μmol/gm, but this is still not quite as high as the majority Creamgold types grown in southern Australia.

May Sowing

Whites

Only two varieties were tested at this time of sowing. Both cultivars presented well at harvest time. The South Pacific Seeds experimental line 153/9 produced a significantly higher marketable yield than the Yates' Seeds experimental line H5082 with yields of 75.4 t/ha and 53.8 t/ha respectively. The SPS cultivar stored better than H5082 but was slightly more prone to greening. Both cultivars showed little (H5082) or no (153/9) evidence of sooty mould.

Reds

Only one red cultivar, South Pacific Seeds' Red Rocks, was entered in this sowing. This variety has a good even shape and an even red colouration throughout the entire bulb. Total marketable yield was 51.0 t/ha. Its keeping quality is quite good with only 25% of the bulbs showing signs of sooty mould.

Browns

Thirteen brown cultivars were trailed alongside two standard varieties. The highest yielding variety, J5114 (Yates), produced a significantly higher marketable yield (94.9 t/ha) than all other varieties. The Yates experimental cultivars J5158 and K5161 produced very good marketable yields of 78.5 t/ha and 70.8 t/ha respectively. The marketable yield of all cultivars consisted mainly of bulbs greater than 75mm in diameter. In some cases this grade size accounted for up to 85% (J5114 and K5159) of all bulbs produced.

The Lefroy Valley experimental cultivar LV35 produced a large percentage (37.2%) of double bulbs. This accounted for almost 50% (34.2t/ha out of total yield of 82.9t/ha) of the total yield. All other cultivars produced negligible quantities of unmarketable bulbs.

Pungency

The Henderson's variety Sombrero was the mildest cultivar with a pyruvic acid concentration of only 5.48 µmol/gm of fresh weight. This ensures that this variety would be acceptable on the fresh mild onion market. The cultivars K5159 (Yates) and L1005 (Lefroy Valley) also produced quite low pyruvic acid levels of 6.57 and 6.13 µmol/gm of fresh weight respectively. The cultivar L1005 is unlikely to accepted on the Australian domestic market due to its very flat shape. The onion industry, at a national level, is yet to set the upper limit for pyruvic acid concentration that would determine whether an onion cultivar is mild or not. Until this happens, it is likely that cultivars J5114 (7.73), J5118 (7.85), and K5158 (7.95) would be considered acceptable as a mild onion.

June Sowing

Whites

The only white cultivar tested was South Pacific Seeds experimental line 153/9. This cultivar produced a good marketable yield of 73.5 t/ha. No unmarketable bulbs were produced but it did not store well with only 20% of the bulbs remaining after ten weeks in storage. The bulb produced was somewhat flat.

Reds

The only red variety tested was SPS Red Rocks. This variety produced bulbs with quite a high pyruvic acid concentration – 11.75 µmol/gm of fresh weight. The yield of 65.0 t/ha was quite good. This line stored well with 90% of bulbs remaining after ten weeks storage.

Browns

Seven brown cultivars were trailed in the June sowing. Three of the lines tested are commercially available and four cultivars are still in the experimental phase. The highest yielding cultivar was K5156 (Yates). The marketable yield of this variety was 110.1 t/ha, significantly higher than all other varieties. Bulbs greater than 75mm in

diameter contributed to 80% of its marketable yield. The cultivars Predator (Yates), Sombrero (Henderson Seeds) and Samba (Henderson Seeds) also produced good yields of 86.1, 78.3 and 76.5 t/ha respectively.

Pungency

The variety Sombrero maintained the low pungency level that it achieved in the May sowing. The level in this sowing, 5.42 µmol/gm of fresh weight was only marginally lower than for the May sowing. The cultivars Predator (Yates), J5121 (Yates) and Samba (Henderson Seeds) produced pungency levels (7.17, 7.75 and 7.69 respectively) that could see them accepted as mild onions.

A number of varieties (K5150, K5156 E507, J5121 and Sombrero) stored well but the incidence of sooty mould was quite high (55-65%).

4.3.4. North Queensland

Comprehensive results are presented in Appendix 4.

The South Pacific Seeds variety Rio Pancho produced a high No. 1 grade yields (51.4 t/ha) but the bulbs tended to be too flat on top. The varieties Sombrero (15.67 t/ha), Lockyer Gold (14.00 t/ha) and Golden Brown (10.48 t/ha) produced substantial yields of undersized bulbs (< 55mm diameter). The production of doubles was not a major problem in this trial. The variety Tropic produced bulbs that were torpedo shaped.

Brown onions for the sweet onion export market are required to meet the following criteria (i) a bulb diameter between 70 and 90 mm, (ii) a TSS (% brix) level greater than 8.00and (iii) a pyruvic acid concentration less than 5.00 µmole/g of fresh weight. All varieties tested had good sweetness levels but their pyruvic acid concentrations were too high.

The majority of varieties did not produce sufficient numbers of bulbs in the desired size range (70-90mm). South Pacific Seeds Rio Xena (16.94 t/ha) and Henderson's Bronco (14.4 t/ha) were the only varieties that produced acceptable yields in this size. The white onion Henderson's Bolero produced an acceptable yield in the required size range but white onions are not accepted on the sweet export market.

4.4. Discussion

Early Season Sowings – March and April

Locally developed strains of white and brown onions still dominate the early sowing season. Over the years the number of local seed producers has diminished due to the lack of demand for seed for this early season production window. Currently there are perhaps only two or three local seed producers left. A number of growers have developed their own seed. This seed has been selected over a number of years and is well adapted to the individual grower's micro-climate.

The early local strains include Golden Brown, Early Lockyer Brown and Early Lockyer White. The local selection Golden Brown continues to produce good marketable yields when sown in both March (1999 only) and April (1999 and 2001). Yields range from 32.8 t/ha (Gatton Research Station 1999) to 42.7 t/ha (Tom Else 1999). Only two commercial strains were evaluated in a March (1999) season sowing, namely, Yates' Cavalier and South Pacific Seeds' 509. Both varieties performed very well with very high yields of large onions. They produced somewhat reduced yields in the corresponding April sowing. A number of new cultivars were evaluated in April 2001. The Yates experimental lines K5151 and K5151 performed very well with very high marketable yields. The Lefroy Valley experimental lines LV81 and LV90 performed well and have since been released on a commercial basis by the seed company.

The market for white onions is diminishing. Consequently, fewer strains of early cultivars are now available. Unless the demand for early white onions increases, it is likely that within a few years there will be no early white onions available. Despite this Early Lockyer White is still the premium early white onion cultivar.

Mid-Season Sowings – Late April to Late May

Mid season (late April to Late May) evaluations were the most extensive with a large number of cultivars evaluated. Brown onions dominate this sowing window but there has been an increase in the number of red onions being grown due to the increased availability of improved germplasm. A large number of cultivars performed well including the local open-pollinated strain Wallon Brown. Outstanding commercial varieties included: Yates' Cavalier, Predator, J5114, J5119, K5161; South Pacific Seeds' Colombus and Henderson's Sombrero.

Five white onion cultivars were evaluated. All cultivars were hybrids with the highest yielding cultivar being the Yates experimental line H5082. This cultivar is due to be released for the 2003 growing season.

The consumption of red onions has increased over the years at the expense of white onions. Consequently a number of red cultivars have been evaluated. The currently available commercial red cultivars, South Pacific Seeds' Rio Demon and Red Rocks performed well with consistently good yields. Yates Seeds has developed two red cultivars that are showing promise, namely 5078 and 5094. The marketable yield of these varieties has been quite high with good bulb shape.

Late Season Sowings – June.

Late season sowings consist predominantly of brown cultivars. Henderson's Sombrero, Yates' Predator, 5097 and K5156 produced the highest marketable yield. Henderson's' Sombrero consistently produced the lowest pyruvic acid concentration. Subsequently, this cultivar is deemed to be suitable for the mild onion market. The limiting factor to the acceptance of this variety as a mild onion is its slightly inconsistent shape and top shaped bulbs.

The drop in popularity of white onions on the domestic market for a late sowing resulted in only four cultivars being evaluated. South Pacific Seeds' experimental line 153/9 was the highest yielding late sown white variety.

Only three red onion cultivars were evaluated. The commercially available cultivar South Pacific Seeds' Red Rocks significantly out-yielded the other two cultivars.

5. Population Density

5.1. Introduction

Correct plant density is essential to ensure that growers can meet the market requirements for onion bulb size. In general, market requirements for bulb size vary between 55mm and 90mm. Growers must ensure correct plant densities to achieve this size range to produce maximum yields thereby maximising profits. Plant densities in onions are critical to achieving this as low densities result in onion bulbs that are too large and high densities result in bulbs that are either too small or misshapen and hence unmarketable.

5.2. Materials and Methods

Three trials were planted in 2000 investigating the effects of the various plant spacings (60, 80, 100, 120, 140 and 160mm) on the composition of marketable yields for the onion varieties Golden Brown, Wallon Brown and Brownsville. Each variety was sown at their optimal sowing time, namely, Golden Brown in March, Wallon Brown in May and Brownsville in June.

In each planting, three replicates or plots of each entry were established. Each plot consisted of four rows of which the two centre rows were designated the datum rows with a single guard row on either side. Plots were established on beds with 1.5m centres. Seed was planted at the rate of 30g per row using a cone planter. This was necessary to ensure sufficient plants were available to achieve the desired plant spacings. The plots were hand thinned to the desired intra-row plant spacings. Plots were 10m long and yield was measured from 8m of each of the two centre rows leaving a buffer of 1m at each end of the plot. Varieties were harvested when 80-100% of the tops were down and allowed to dry in trays before hand grading.

At harvest, the number of seed stems and bullnecks were counted. When grading, the yield (kg) and number of doubles, purples and off-types (off-colours) was recorded. Marketable yield and the number of bulbs of the various grade sizes was recorded. These grade sizes were based on the following bulb diameters: 0-40mm, 40-70mm, 70-80mm, 80-90mm, 90-100mm and > 100mm.

5.3. Results

Comprehensive results are presented in Appendix 6.

All three cultivars produced their maximum marketable yield at a spacing of 60mm. The yields were Brownsville - 71.26 t/ha followed by Wallon Brown – 58.07 t/ha and finally Golden Brown – 56.88 t/ha. For all varieties these yields were composed predominantly of bulbs in the 40-70mm and 70-80mm size ranges (See Figures 5.1

to 5.3). In general, total yield decreased as the spacing increased varying from 71.26 t/ha (60mm) down to 53.85 t/ha (160mm) for Brownsville; 58.07 t/ha (60mm) down to 38.39 t/ha (160mm) for Wallon Brown and from 56.88 t/ha (60mm) down to 37.07 t/ha (160mm) for Golden Brown.

In general terms, as the spacings increased and the bulb grading sizes increased there was a corresponding increase in yield. For example, for Golden Brown (See Figure 5.1) the yield of bulbs in the size range 90-100mm increased from 1.97 t/ha to 11.65 t/ha for the spacings of 60mm and 140mm respectively. This trend was evident for all varieties. The opposite also occurred in the smaller grade sizes eg for Wallon Brown (See Figure 5.2) the yield of bulbs in the size range 40-70mm decreased from 22.80 t/ha to 4.37 t/ha for 60mm to 160mm spacings respectively

Golden Brown produced the greatest number of doubles and bolters. The number of doubles produced averaged 20% of the total plant number. The yield of doubles increased as plant spacings increased from 21.5 t/ha to 14.92 t/ha for plant spacings of 60mm and 140mm respectively. The cultivars Wallon Brown and Brownsville produced no or very few doubles and bolters.

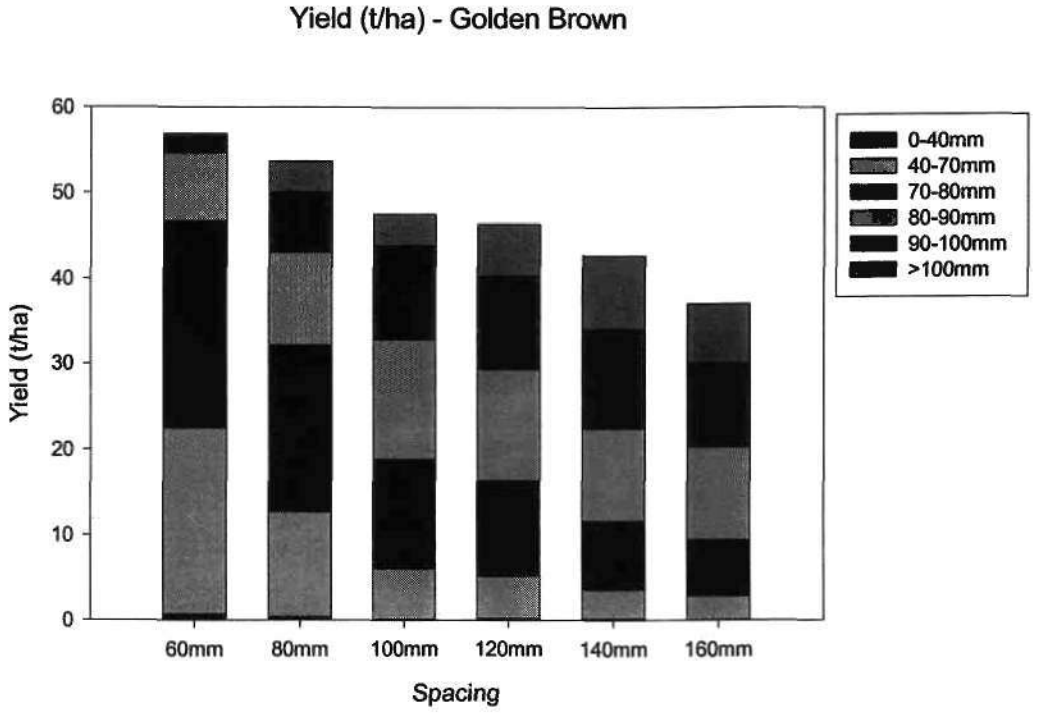

Figure 5.1. Yield (t/ha) distribution of various bulb sizes for the onion variety Golden Brown planted at a number of different intra-row plant spacings.

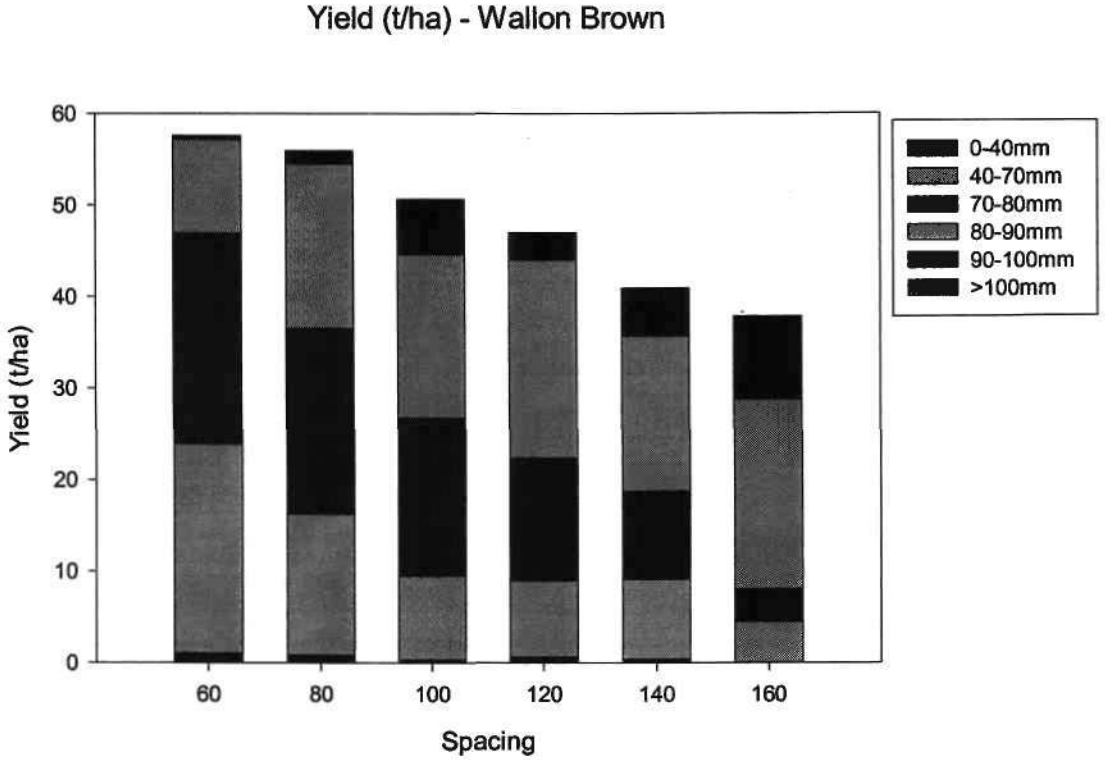

Figure 5.2. Yield (t/ha) distribution of various bulb sizes for the onion variety Wallon Brown planted at a number of different intra-row plant spacings.

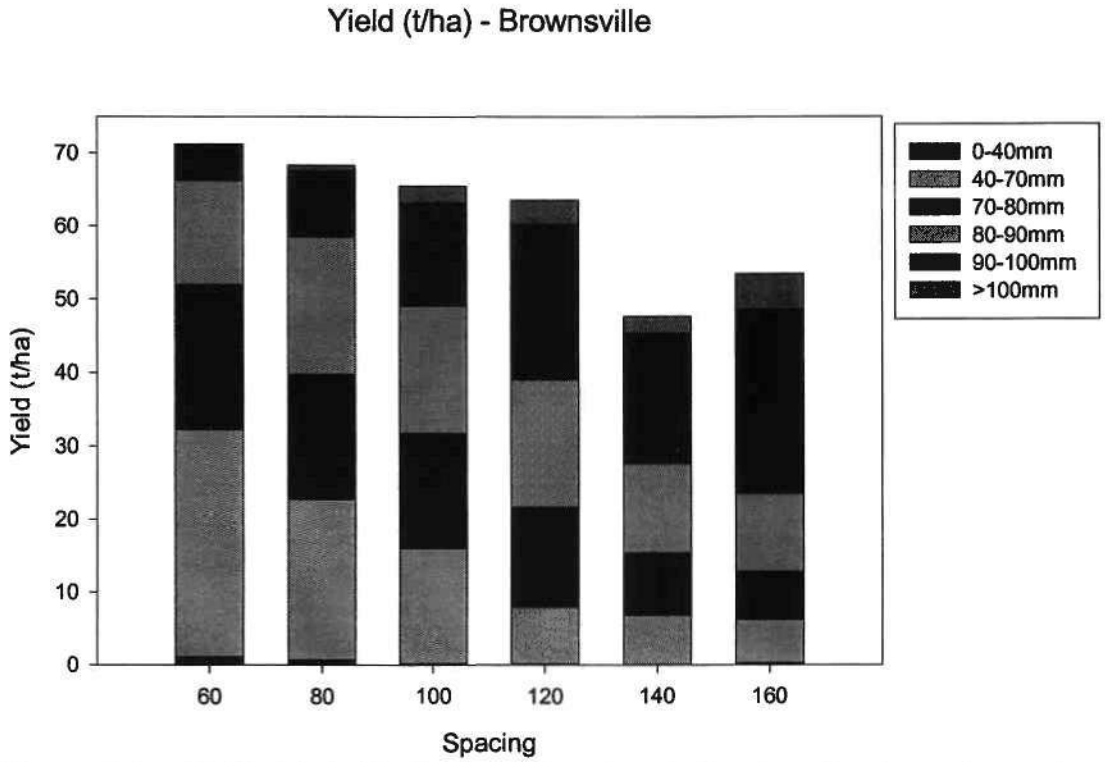

Figure 5.3. Yield (t/ha) distribution of various bulb sizes for the onion variety Brownsville planted at a number of different intra-row plant spacings.

5.4. Discussion

Plant spacing is an important issue when considering the market requirements. Growers need to ensure selection of the correct plant spacing to be confident that the majority of bulbs produced meet the market's size specification.

All cultivars performed as expected in regard to the increase in bulb size as the spacings increased. An increase in plant spacings resulted in an increase in the percentages of bulbs produced in the large size grades. The most notable differences in the bulb size distribution occurred in the cultivar Brownsville. For this cultivar, there was a tenfold increase in bulb numbers in the 90-100mm bulb size as the plant spacings increased from 60mm to 160mm. This occurred in all cultivars where the bulb size was greater than 80mm. For bulb sizes less than 80mm the inverse was true; the number of bulbs in the individual grade sizes decreased as the plant spacings increased. These results were to be expected as increased plant spacing allows the individual bulbs to grow to their potential without competition from neighbouring plants.

Maximum yield (marketable) was obtained at the smallest plant spacing (60mm). This is due in part to the increased number of plants at this spacing. Twice the number of plants was produced at the 60mm spacing as compared to the 160mm spacing. Consequently, there was a greater yield potential at this narrow spacing. The major differences in yield occurred as a result of the combination of the plant spacings and the grading of the plot yield into the various sizes. All three cultivars experienced decreases in yield of bulb sizes up to 80mm as the plant spacings increased. For bulb sizes greater than 90mm this trend was reversed with increases in yield occurring. The greatest variability between cultivars occurred in the 80-90mm bulb size. The cultivar Wallon Brown had an increase in yield at this bulb size as the plant spacings increased. In the 80-90mm bulb size, yield increased in the cultivar Brownsville from a plant spacing of 60mm to 80mm but then decreased as the plant spacings increased. The trend was similar for the cultivar Golden Brown but the yield increased up to a plant spacing of 100mm and then decreased.

As there is strong market influence on acceptable bulb size there is a need for growers to ensure accurate sowing densities to meet this requirement. Results have indicated that plant density and cultivar selection greatly influences the end product, in particular, bulb size. Growers can meet market demands by ensuring correct cultivar selection for the chosen sowing window and then selecting the optimum planting density to maximise returns.

6. Jumbo Onion Pungency

6.1. Introduction

The jumbo onion market in Queensland is small but at times quite lucrative. There is potential for expansion of this market in line with the development of a sweet mild onion industry in Queensland. In the USA, sweet onions range in size from 100mm to 150mm in diameter. In Queensland, this size onion is classified as a jumbo. If a sweet mild onion industry is to be developed in Queensland it will be necessary to identify cultivars that will satisfy this requirement for size. These onions will also have to have a pyruvic acid level of less than 5.0 µmol/gm bulb fresh weight. This experiment was conducted to assess potential new jumbo cultivars alongside current jumbo cultivars.

6.2. Materials and Methods

The trial design was a completely randomised blocks with 3 replicates or plots for each entry. Each plot consisted of a pair of single rows (used to determine yield) and a single guard row on each side. Ten metre long plots were established on beds with 1.5m centres. Inter-row spacing was set at 380mm. The trial was planted using a cone planter and thinned to the required inter-plant spacing of 150mm. This spacing based on the results of jumbo onion trials carried out in 1996 and 1997 was chosen to ensure that the maximum number of bulbs in excess of 100mm in diameter would be produced. Yield measurements were taken from 8m of each of the single rows leaving a buffer of 1m at each end of the plot. The trial was planted on the 17th May 2000. The early maturing varieties were harvested on the 18th October 2000 and the late maturing varieties on the 16th November 2000.

At harvest, the number of seed stems and bullnecks were counted. When grading, the number of doubles and off-types (off-colours) were recorded as well as the numbers within the following grade sizes 0-75mm, 75-100mm and > 100mm.

Thirty bulbs were retained at harvested. Six of these bulbs were used to determine pyruvic acid levels. Katherine Raymont from the School of Agriculture and Horticulture at the University of Queensland Gatton College carried out this testing. A further five bulbs were used to determine percentage dry matter, soluble solids (% brix) and the number of centres per bulb. The remaining nineteen bulbs were assessed for shape, colour and firmness.

6.3. Results

The results are presented in Table 6.1: yield (t/ha) for individual bulb grades (0-75mm, 75-100mm, > 100mm and doubles), Table 6.2: days to maturity and percentage of bulbs produced for each category and Table 6.3: bulb quality and

characteristics (pungency, percentage dry matter, soluble solids - %brix, centres, shape, colour and firmness).

Table 6.1. Yield (t/ha) for individual bulb grades for the jumbo onion pungency trial planted 17th May 2000.

Varieties	Yield – t/ha (Bulb size in mm)				
	0-75	75-100	> 100	Total	Doubles
Yates Colossus	2.5	33.4	51.2	87.1	0.0
Yates K5159	2.9	44.1	5.7	52.8	0.2
Yates K5160	3.6	48.5	0.4	52.6	0.0
Yates K5161	2.0	34.5	45.1	81.6	0.0
Yates K5152	1.7	43.4	41.3	86.3	0.0
Cavalier	2.5	47.7	1.1	51.3	0.5
Wallon Brown	7.4	38.2	0.2	45.8	0.4
LSD 5%	**1.5**	**12.9**	**18.1**	**10.0**	**0.4**

Table 6.2. Days to maturity and percentage of bulbs produced in each category for the jumbo onion pungency trial planted 17th May 2000.

Varieties	Days to Maturity	Percentage of Bulbs (Bulb size in mm)				
		0-75	75-100	> 100	Doubles	Seedheads
Yates Colossus	183	10.3	42.2	46.2	0.0	1.3
Yates K5159	154	14.7	73.4	7.0	0.3	4.6
Yates K5160	154	16.6	81.6	0.5	0.0	1.3
Yates K5161	175	10.4	47.1	41.7	0.0	0.8
Yates K5152	175	7.9	53.3	35.5	0.0	3.3
Cavalier	154	11.8	85.4	1.4	0.8	0.6
Wallon Brown	154	26.6	72.1	0.3	1.1	0.0
LSD 5%		**7.1**	**15.2**	**12.6**	**0.6**	**4.3**

Table 6.3. Bulb quality and characteristics for all cultivars assessed for the jumbo onion pungency trial planted 17th May 2000.

Varieties	Pungency	TSS (% brix)	% Dry Matter	Number of Centres	Shape	Colour	Firmness
Yates Colossus	6.8	6.64	9.53	1.8	3	Brown	Firm
Yates K5159	8.9	8.87	8.88	1.5	2,3	Brown	Soft-Firm
Yates K5160	10.0	8.31	9.16	1.5	2,3,8	LtBr-Brown	Firm
Yates K5161	8.9	6.82	7.87	2.0	2	Brown	Soft-Firm
Yates K5152	8.0	5.86	8.95	1.4	2,3	LtBr-Brown	Soft-Firm
Cavalier	8.7	8.11	9.04	1.6	2,3,4	Brown	Soft-Firm
Wallon Brown	9.7	7.62	8.42	1.3	2,3	Brown	Soft-Firm

6.4. Discussion

The cultivars Colossus, K5161 and K5162 produced the highest yield of bulbs greater than 100 mm in diameter (Table 6.1). These cultivars also produced good yields in the 75-100 mm diameter category although Colossus and K5161 produced significantly lower yields than all other cultivars in this size category. The remaining cultivars produced negligible yields of bulbs with a diameter greater than 100 mm. These cultivars produced 72% (Wallon Brown) to 85 % (Cavalier) of their total yield in the 75-100mm size category (Table 6.2).

The three high yielding cultivars matured three to four weeks later than the other cultivars. This additional growing time ensured the bulbs reached their maximum size. This increase in size and therefore yield is achieved by the plant converting more carbohydrates from the leaves into the growth and development of the bulb. It is therefore possible to manipulate the size of these cultivars to suit the required market. This can be achieved by stopping irrigation early or mechanically inducing top down and hence maturity (rolling the crop). These late maturing cultivars also have a lower soluble solids concentration (Table 6.3) than the early maturing cultivars.

All cultivars are similar in shape i.e. flat to flat-globe. The bulbs produced tended to be soft-firm and as a consequence did not store well.

The recognised jumbo cultivar Colossus performed substantially better than all other cultivars. Colossus produced the lowest concentration of pyruvic acid. This is desirable to ensure acceptance as a sweet mild onion. The pungency level of all other cultivars was quite high. The dry growing season is a likely contributor to the higher than normal pungency levels experienced in this trial.

6.5. Conclusions

The experimental lines K5161 and K5162 produced good yield of bulbs greater than 100mm diameter. Their yields were equivalent to the recognised jumbo cultivar Colossus but their pyruvic acid concentration (pungency) was much higher than Colossus. Colossus produced a marginally more acceptable bulb shape than K5161 and K5162.

In conclusion, none of the cultivars trialed performed better than the commercially acceptable jumbo cultivar Colossus.

7. Alliums 2000

7.1. Itinerary

Saturday, 28th October2000
Flight: Brisbane-Sydney-Los Angeles-Atlanta-Athens

Sunday, 29th October 2000
Tour University Georgia Campus
Symposium Registration and Welcome Reception

Monday, 30th October 2000
Day 1: Alliums 2000

Tuesday, 31st October 2000
Day 2: Alliums 2000

Wednesday, 1st November 2000
Day 3: Alliums 2000
Poster Presentation
Symposium Dinner

Thursday, 2nd November 2000
Day 4: Alliums 2000

Friday, 3rd November 2000
Field Tour to Vidalia Onion district

Saturday, 4th November 2000
Flight: Athens-Atlanta-Dallas-College Station (Texas A&M)

Sunday, 5th November 2000
Tour Texas A&M University campus and Field Research facilities

Monday, 6th November 2000
Tour Vegetable and Fruit Improvement Centre (VFIC) included demonstration of VFIC Kids Program; pyruvic acid analysis demonstration; inspection of biotech lab and other facilities.

Tuesday, 7th November 2000
Flight: College Station-Dallas-Los Angeles-Sydney-Brisbane

7.2. Alliums 2000 – The 3rd International Symposium on Edible Alliaceae

The symposium was held at the Georgia Centre for Continuing Education (Plate 1) at the University of Georgia, Athens, Georgia, USA. It was held from 29th October to the 3rd November 2000. The International Symposium on Edible Alliaceae occurs every three years. This third symposium followed on the success of the first symposium in Mendoza, Argentina and the highly successful second event in Adelaide, Australia in 1997.

Plate 7.1. Georgia Centre for Continuing Education, University of Georgia, Athens, Georgia, USA.

Attendance was disappointing with approximately 150 participants. It had been anticipated that 300 researchers would attend. It seems that cost of travel was a mitigating factor as there were no attendees from the African continent and only one or two from India and China. The majority of participants were from the USA and Europe. There were two other Australian participants.

Presentations were both oral and via posters. There were 64 scheduled oral presentations but sixteen were cancelled. Communication problems between the organisers and presenters resulted in a number of oral sessions being cancelled or mistakenly presented as posters. This was disappointing in that a number of the oral sessions that were cancelled were of particular interest to me. A total of 69 posters were displayed.

The symposium consisted of a number of sessions concentrating on different aspects of Edible Alliums. A keynote speaker who gave a brief overview of current international research in the discipline introduced each session. The symposium consisted of the following sessions: Genetics and Breeding, Garlic, Allium Flavours, Alliums and Health, Plant Pathology, Physiology/Post-Harvest and Production. The symposium was dominated by genetics and breeding (25% of the total number of presentations, both oral and posters).

There were several issues that dominated the symposium. Health benefits of all alliums proved to be the number one issue. All Allium species contain chemicals that

have proven health benefits. These benefits include prevention of colon cancer, inhibition of platelet aggregation that leads to heart attack and stroke, blood thinning, antibiotic traits, anti-cholesterol and anti-oxidants. The majority of the research into theses health benefits is being carried out in the USA.

Biotechnology, in its various guises, is also an important area for international research. There are a number of areas where excellent outcomes are being achieved. Gene mapping is proving to be a useful tool for plant breeders. It will allow breeders to patent their material as the gene maps of their cultivars can be used as a genetic fingerprint. Current genetic research is also looking at ways to turn genes off. This will prove to be invaluable in the area of disease and insect resistance. An example of this would be for the control of white root rot where the plant can be manipulated in such a way as to turn off the gene that produces the attractant for white rot infection.

The cost of biotechnology restricts research in this filed to the multi-national companies and universities with access to large funding reservoirs.. Currently it costs US$50 million to transfer a gene into a single vegetable species. Consequently the economic returns for doing so must be high. Monsanto can now transfer the Roundup gene into onions but at an extremely high cost the question must be asked – Is it economically viable? There is still a long way to go before the fruits of this type of research will be seen at the grass roots level.

A number of pesticides are in the pipeline and due for release in the near future. These include the insecticide Swift and the fungicides Tilt and L500. L500 is a new generation chemical developed by BASF for the control of leaf diseases. The major disease worldwide is white root rot and there is work being carried out in Canada looking at the control of this disease using vesicular arbuscular mycorrhizae (VAM). This work looks promising but is still in the early stages.

The symposium was concluded by a field trip to the Vidalia onion growing district. The Vidalia onion district is situated in southeast Georgia where the growing of Vidalia onions is restricted to a small area. Georgia's state legislature limited the growing area of the onions to 20 southeast Georgia counties. Approximately 12 000 acres of Sweet Vidalia Onions are produced annually. In 1989, the Vidalia onion gained federal recognition and protection through a federal Marketing Order. This order makes the selling of non-Vidalia Sweet Onions as Vidalia's illegal.

The trip was a visit to Bland Farms. Bland farms grow approximately 2 000 acres of sweet Vidalia onions per year. Consequently they are the largest producer in the Vidalia growing district. The tour included an inspection of the Bland Farms large packing shed. It was disappointing in that the only onions available for inspection were poor quality sweet onions imported from Peru (Plate 7.2). Early November is not the ideal time of the year to visit the onion growing districts in the USA as planting has just commenced.

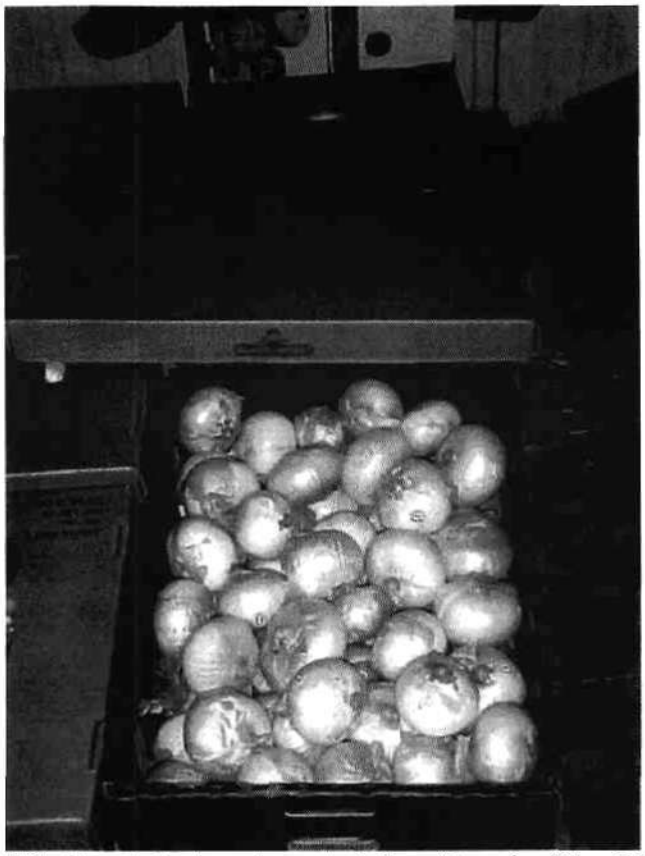

Plate 7.2. Sweet Onions imported from Peru by Bland Farms

The venue and timing for the next symposium is always decided at the close of the current symposium. Nominations to host the fourth symposium were received from Holland (two) and China. After serious discussion and a pledge of sponsorship from the Chinese delegate it was decided in an extremely close vote that China will host the next symposium in 2003.

7.3. Vegetable and Fruit Improvement Centre (VFIC)

The Vegetable and Fruit improvement Centre is based at Texas A&M University, College Station. This Centre was established to support and strengthen the Texas vegetable industry through research. The Centre concept is based on "scientists and industry working together to develop quality vegetable and fruit products with enhanced health and nutritional benefits". The Centre consists of scientists based at Texas A&M University and a number of companies working in partnership to develop and carry out research for industry.

The onion breeding program at Texas A&M is an important part of this centre. Currently, the primary focus of this breeding program is in the area of improving the health benefits derived from eating onions (Plate 7.3). This is being achieved by the development of low pungency (sweet) onions. The Texas sweet onion industry originated as a direct result of cultivars released from this breeding program, in particular, Texas 1015 (Plate 7.4).

Plate 7.3. VFIC Onion Variety Nursery

Plate 7.4. Texas 1015 (right) and new early maturing Texas 1015 – Texas Legend (left).

A tour of the Centre included demonstration of pyruvic acid testing facilities (Plate 7.5), discussions with scientists involved in the onion breeding program and an inspection of the excellent lab facilities. A general tour of Texas A&M University was also conducted with a tour of the field research facilities utilised by the Centre's scientists.

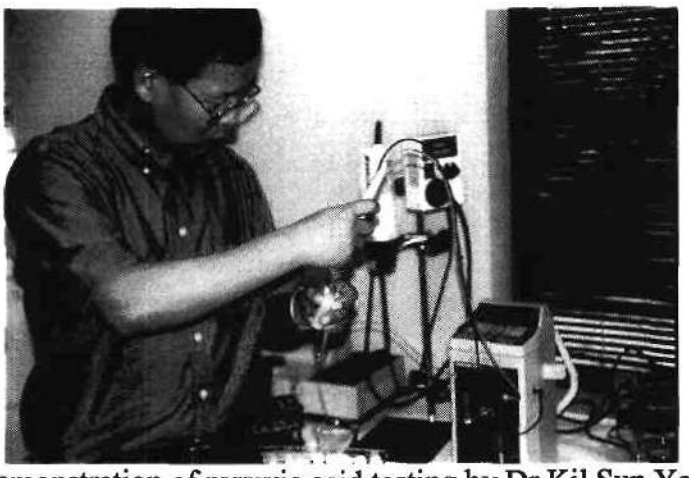

Plate 7.5 Demonstration of pyruvic acid testing by Dr Kil Sun Yoo at VFIC

7.4. Outcomes

- Secured access to short day onion germplasm that is essential for the development of a sweet onion industry in Queensland. Germplasm is available from seed companies i.e. Seminis (USA), Sunseeds (USA), Hazera (Israel), Bejo (Holland), May and Ryan (New Zealand) and Rio Colorado and the onion breeding programs based at the universities i.e. Texas A & M, University of Wisconsin etc.
- Established link with Vegetable and Fruit Improvement Centre at Texas A & M for development of a partnership in research and development with the Queensland Horticulture Institute.

- Assessed sweet onion industries in Georgia and Texas. Information gained and contacts established will ensure the development of a successful sweet onion industry for Queensland

Follow-ups required:

- Importation of short day germplasm for assessment under Queensland growing conditions.
- Development of a industry development project in consultation with QFVG for the establishment of a sweet onion industry for Queensland growers.
- Investigate the possibilities of the development of a pungency testing service within QDPI to service the fledgling sweet onion industry.
- Development of national sweet onion standards in collaboration with the Australian Onion Industry Association

8. Onion Growth Study

8.1. Introduction

Queensland onions are produced over an extensive growing season. Onions can be sown as early as late February through to late June. Consequently, Queensland onions are subjected to an extensive range of climatic and environmental conditions. Problems encountered by growers as a result of this include excessive production of doubles and bolters. Limited understanding of the growth of the onion plant under Queensland growing conditions is a major contributor to the occurrence of these problems. As part of this project a phenology study was undertaken to gather information that would contribute to the understanding of onion production in Queensland.

This study forms the basis of a Masters Degree to be submitted by July 2004. Due to the extensive nature of the data collected for this study the complete data set will not be presented in this report. It has also been proposed that it may be possible to upgrade the Masters Degree to a PhD. This is still being considered.

8.2. Materials and Methods

Field trials were conducted during 1999 and 2000. These field trials consisted of two different suites of trials in each of the years. The trials were designed to investigate the dry matter accumulation of the onion plant (Growth Study Trials) and the development of the onion plant (Growth Development Trials).

Growth Study Trials

The first suite of trials was designed to investigate dry matter accumulation in the onion plant. Trials (six in each year) were planted at monthly intervals from late February through to late July. At each sowing date varieties were chosen on the basis that the sowing date is within the ideal sowing window for that variety. The cultivar Golden Brown was sown at each of the six sowing dates as a control cultivar throughout the trial series. The number of cultivars at each sowing date varied from three to six and included brown, white and red types. A complete list of cultivars and there sowing dates is outline in Table 8.1.

Each trial was a completely randomised design consisting of two replicates. Individual plots were made up of three ten-metre beds each bed consisting of four rows. Two beds were used to supply the samples for the assessment of dry matter accumulation. The beds were divided into ten sub-plots per bed. Each of these sub-plots was a sampling site and were randomly numbered to ensure complete randomisation at sampling time. Destructive sampling occurred every fortnight approximately from the two-leaf stage of the plant until full maturity of the plant. At sampling time, five plants were removed from each predesignated subplot within each replicate. Individual plants were then dissected (See Plate 8.1) into their major plant

components, namely, roots, bulb, pseudo-stem, leaves (green and dead) and flower. Data collected from the individual plants included leaf number, plant height, bulb diameter, pseudo-stem diameter, fresh and dry weights of the individual plant parts, and total plant leaf area. When bulbs reached a diameter of 35mm they were assess for soluble solids (% brix) by the use of an electronic refractometer. The third bed was used to record percentage light interception by the plants. Percentage light interception was recorded at fortnightly intervals between the hours of 10:00am and 1:00pm. Light interception was performed using a Monitor Sensors constructed light wand for inside the crop and a point sensor for the external above crop reading. Three readings were taken along the length of the plot at an angle of 45 degrees to the rows.

1999	**22 Feb**	**26 Mar**	**22Apr**	**20 May**	**17 Jun**	**15 Jul**
Golden Brown	[	[	[	[	[	[
Early Lockyer White	[	[				
Early Lockyer Brown	[					
Cavalier		[	[			
Wallon Brown			[	[		
Wallon White			[			
Gladalan White				[		
Diamond White				[	[	
SPS 1367				[	[	
Gladiator					[	[
Red Vein					[	
Rio Xena					[	[
2000	**23 Feb**	**22 Mar**	**19 Apr**	**17 May**	**20 Jun**	**17 Jul**
Golden Brown	[	[	[	[	[	[
Early Lockyer White	[	[				
Early Lockyer Brown	[	[				
Cavalier		[	[	[		
Wallon Brown			[	[		
Bolero				[	[	
Sombrero				[	[	[
Rio Demon				[		
Red Rojo					[	
Gladiator					[	[
Red Vein						

Table 8.1. Cultivars sown at different sowing dates during 1999 and 2000 onion growth study trials

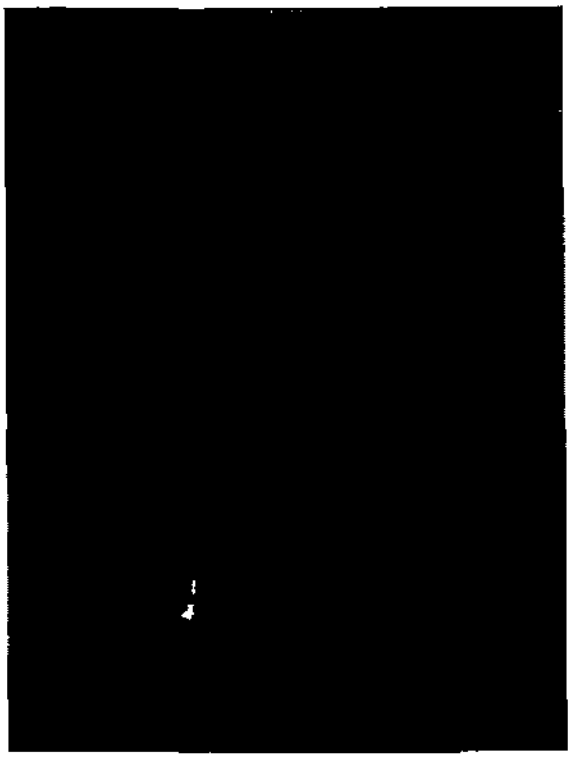

Plate 8.1. Dissection of the onion plant into its various component parts for analysis.

Growth Development Trials

These trials were designed to record the timeliness of the various growth stages of the onion plant. Data collected includes number and timing of leaf formation, time to bulbing, incidence of doubling and bolting, time to maturity and final yield.

In each of the two years, trials were sown at fortnightly intervals commencing late February with the final sowing being late July. In total, twelve trials were plant each year. Trial design was a completely randomised block consisting of five cultivars (Golden Brown, Wallon Brown, Contessa, Gladiator, and Cavalier) and four replicates. The cultivars were selected based on their perceived daylength requirement for bulb initiation. The suite of varieties included short day to intermediate daylength types. All varieties are currently grown in Queensland. Data was recorded from six individual plants in each of the plots. This resulted in a total of 24 observations per cultivar. Plots were four-rows and five meters in length. All trials were planted using a small air seeder.

8.3. Results

Due to the nature of the trials and extremely large amount of data collected it is not possible to report on all information collected to date. Data presented will concentrate on that collected from the 2000 trials and for the variety Golden Brown. This cultivar is extremely bolt tolerant and was entered in all trials in both years of testing. It is a local selection that was originally selected from the Japanese cultivar Senshu Yellow. It is also a parent used to develop the Yate's hybrid Cavalier.

Growth Study Trials

The cultivar Golden Brown reaches maximum total dry matter accumulation of 47.8 gm from a March sowing (See Table 8.2.). This dry matter accumulation is significantly greater than for any other sowing. Total dry matter accumulation then declines to a minimum of 6.3 gm in July. For Golden Brown, maximum dry matter accumulation occurs approximately three quarters of the way during the life of the crop. It includes total active leaf and bulb dry matter.

	February	March	April	May	June	July	LSD 5%
Weight (gm)	31.5	47.8	30.4	20.1	11.2	6.3	9.42

Table 8.2. Total dry matter (gm) accumulation for the cultivar Golden Brown during the 2000 growing season.

Time of planting has a strong influence on the final yield of the cultivar Golden Brown. Maximum marketable yield (See Table 8.3) was achieved from an April sowing. This yield of 81.8 t/ha consisted predominantly of large onions (> 75mm diameter) i.e. 92%. As the sowing date moves into the winter months the composition of the various grade sizes contributing to total marketable yield changes dramatically. The production of picklers increases until it reaches its maximum (14.9 t/ha) in the July sowing. There is a corresponding decrease in the production of No. 1 Large bulbs. The yield of No. 1 grade bulbs also varies somewhat as the sowing date progresses. Initially, it is quite low, 2.5 t/ha, then steadily increase to a maximum of 26.7 t/ha in June but then decreases again in July.

The cultivar Golden Brown is susceptible to the production of excessive doubles when sown in either February or March. Doubles account for more than 65% (50.6 t/ha) of the total yield (74 t/ha) from a March sowing. This is somewhat reduced for the February sowing (23%) but it is still significant (13 t/ha).

	Pickler	No 1	No 1 Large	Doubles	Marketable	Total
February	0.3	2.5	38.8	13.0	41.4	54.7
March	0.6	2.0	20.7	50.6	22.7	74.0
April	0.5	6.1	75.7	3.2	81.8	85.5
May	1.6	18.6	30.6	0.3	49.2	51.1
June	1.8	26.7	14.2	0.4	40.9	43.1
July	14.9	17.8	0.9	0.2	18.8	33.9
LSD 5%	**4.3**	**9.9**	**10.4**	**18.5**	**14.1**	**28.4**

Table 8.3. Final yield (t/ha) for the cultivar Golden Brown during the 2000 growing season.

Growth Development Trials

Growth of the cultivar Golden Brown was studied in this series of trials. Growth stages studied included: days to bulbing, development of doubles and the incidence of bolting.

The level of doubling was greatest from early sowings (See Table 8.4) and reached 58% of plants when sown on 22nd March 2000.

	Sowing Date											
	23-Feb	8-Mar	22-Mar	4-Apr	19-Apr	4-May	17-May	31-May	14-Jun	29-Jun	13-Jul	26-Jul
Doubles	17.4	41.7	58.3	16.7	4.2	0	4.2	0	4.2	0	0	0
Bolters	0	4.2	0	16.7	0	0	0	0	0	0	0	0

Table 8.4. Percentage of doubles and bolters produced by the onion cultivar Golden Brown sown at fortnightly intervals from 23rd February 2000 until 26th July 2000.

The cultivar Golden Brown is bolt–tolerant. Bolters were only produced from the early March (4.2%) and early April (16.7%) sowings. The incidence of bolting is minor for this cultivar.

	Sowing Date											
	23-Feb	8-Mar	22-Mar	4-Apr	19-Apr	4-May	17-May	31-May	14-Jun	29-Jun	13-Jul	26-Jul
50%	65	110	99	113	115	110	106	107	100	85	82	73
100%	135	148	144	128	129	130	120	114	110	95	86	73
Maturity	163	183	165	156	161	148	148	144	135	140	114	115

Table 8.5. Number of days to 50% bulbing, 100% bulbing and maturity (80% tops down) of the onion cultivar Golden Brown sown at fortnightly intervals from 23rd February 2000 until 26th July 2000.

Bulbing for the individual plants was deemed to have occurred when the diameter of the bulb was twice the diameter of the pseudo-stem. In general terms, the number of days to both 50% and 100% bulbing decreases as the sowing date progresses. The maximum number of days to 50% bulbing occurred from the 19th April sowing (See Table 8.5) decreasing to 73 days for the 26th July sowing. Adverse weather conditions and poor emergence resulted in the plants from the 23rd February sowing requiring only 65 days to reach 50% bulbing. This would not generally be the case for this sowing as previous trials have indicated 50% bulbing to occur at approximately 110-120 days. The number of days to 100% bulbing decreases from 135 for the February sowing to 73 for the final sowing. As the sowing date moves into winter the number of days between 50% bulbing and 100% bulbing decreases i.e. the number of days between each event decreases. For the early March sowing the difference is 38 days (110 to 148 days) whilst the difference for the mid July sowing is only 4 days. This corresponds with the reduction in the number of days to maturity.

8.4. Discussion

Results analysed to date support the anecdotal evidence that time of sowing for onions is critical under Queensland growing conditions. An early sowing (late February to early April) increases the risk of production of large numbers of unmarketable bulbs (doubles). This reinforces the need for correct varietal selection to achieve maximum yield. Indications are that temperature has the greatest effect on the incidence of doubling in the onion cultivar Golden Brown. Sowing early in the season pre-disposes the onion plant to higher temperatures than would normally be expected. It is hypothesised that these unexpectedly high temperatures cause the initiation of more than one growing point in the base plate of the onion. This results in the

production of a double onion. Additional trial work is therefore required to support this hypothesis.

Late sowings of the cultivar Golden Brown result in a reduced marketable yield due to the increase in the number of small sized bulbs. The plants are not capable of producing a large bulb due to the reduced growing season. The reduced growing season results in fewer leaves being produced by the onion plant. This results in a smaller plant to draw the resources from for the production of the bulb. Consequently, a smaller bulb and thereby a smaller marketable yield results.

9. Technology Transfer

A number of technology transfer activities were undertaken during the life of this project including: field days where results were presented to local industry including growers and agri-business representatives; publications and media reports. A local Mild Onion Committee was formed following a grower meeting in March 2001. This committee consists of three growers, one seed company representative, one grower/packer and two QDPI representatives (project leader and marketing officer). This committee is still active and meets approximately twice a year.

Field Days

30 September 1999
24 November 1999
21 September 2000
24 November 2000
8 March 2001
20 September 2001
15 November 2001

Publications

Duff, A.A. and O'Donnell, W.E. (1999). Queensland – Investigating Varieties, Growth and Development. *Onions Australia* 16 : 7-8.

Duff, A.A. (2000). Extending the Onion Market in Queensland. *Onions Australia* 17: 7-8.

Duff, A.A., Jackson, K.J. and O'Donnell, W.E. (2001). Onion Production and Varietal Improvement. *Onions Australia* 18: 16-17.

Duff, A.A. (2002). How Sweet I Is – Queensland Sweet Mild Onion Varietal Assessment. *Onions Australia* 19: 37-19.

Duff, A.A. (2002). Onions – Queensland Style, Are Mild Onions the Future. Proceedings "Onions 2002 Conference", Yanco, Australia, 3-5 June 2002. pp 24-30.

Onions Australia Regional Roundups – 1999 to 2002.

Posters

"Growth and Development of the Onion Variety Golden Brown in the Lockyer Valley" presented at Alliums 2000, Third International Symposium on Edible Alliaceae, Georgia, USA. October 2000.

Reports

Annual Reports: 1999, 2000, 2001. Presented to participating seed companies, QFVG and local seed producers.
Travel Report – Alliums 2000, Third international Symposium on Edible Alliaceae, Georgia, USA October-November 2000.

10. Appendices

11. Appendix 1 – 1999 Trial Results: Actual Data

LEGEND

GRS ELB	Gatton Res Station	Early Lockyer Brown
GRS GOB	Gatton Res Station	Golden Brown
ELS GOB	Else	Else Golden Brown
ELS EW	Else	Else Early White
NEU ELW	Neuendorf -	Early Lockyer White
NEU ELB	Neuendorf -	Early Lockyer Brown
NEU GOB	Neuendorf -	Golden Brown
NEU WAB	Neuendorf -	Wallon Brown
CAV	Yates Seeds-	Cavalier
COS	Yates Seeds	Cossack
DOV	Yates Seeds	Dove
NAU	Yates Seeds	Nautilus
RED	Yates Seeds	Red Vein
GLA	Yates Seeds -	Gladiator
PRE	Yates Seeds -	Predator
5078	Yates Seeds -	Experimental Line H5078
5079	Yates Seeds -	Experimental Line H5079
5080	Yates Seeds -	Experimental Line H5080
5082	Yates Seeds -	Experimental Line H5082
5083	Yates Seeds -	Experimental Line H5083
5094	Yates Seeds -	Experimental Line H5094
5097	Yates Seeds -	Experimental Line H5097
5114	Yates Seeds -	Experimental Line J5114
5119	Yates Seeds -	Experimental Line J5119
5120	Yates Seeds -	Experimental Line J5120
DEM	South Pacific Seeds -	Rio Demon
ROC	South Pacific Seeds -	Red Rocks
1347	South Pacific Seeds -	Experimental Line 1347
Hen Bol	Henderson Seeds -	Bolero
Hen Brn	Henderson Seeds -	Bronco
Hen Rojo	Henderson Seeds -	Red Rojo
Hen Som	Henderson Seeds -	Sombrero
M&R	May and Ryan Seeds	Experimental Line – 19042
Jar 520	Jarit Seeds -	Experimental Line – JT520
Jar 91	Jarit Seeds -	Experimental Line – JT091
Jar Sun	Jarit Seeds -	Sunshine

Table 2a. Number of days to harvest and yield (t/ha) (marketable and non-marketable) of onion varieties tested at Gatton Research Station from a mid-March planting (planted: 18.3.99)

Variety	Days to Harvest	Pickler	No1 Grade	No1 Large	Total	Purples	Off-Types	Doubles	Total
Grs Elb	168	0.2	6.5	31.6	38.4	0.0	1.3	6.5	9.1
Grs Gob	168	0.7	11.9	20.3	32.8	1.3	0.2	21.4	21.6
Els Gob	168	0.4	11.7	30.6	42.7	0.0	0.6	21.6	22.2
Els Ew	168	0.1	10.4	37.8	48.3	0.8	1.3	10.1	12.2
Neu Elb	168	0.4	2.9	24.4	27.7	1.5	1.0	6.5	9.0
Neu Elw	175	0.5	6.1	29.8	36.4	0.0	0.0	19.3	19.3
Neu Gob	168	0.7	18.0	21.9	40.5	0.0	0.0	18.0	18.0
Yat Cav	175	0.1	8.9	58.7	67.7	0.0	0.0	6.4	6.5
SPS 509	175	0.1	7.5	52.8	60.5	0.0	0.0	6.5	6.4
Jar Elw	175	0.5	9.3	30.0	39.8	0.0	0.0	11.7	11.7
Jar Elb	175	0.7	7.8	15.2	39.7	0.0	0.0	29.7	29.7
MKS 991	168	0.3	8.4	23.8	32.4	0.2	0.3	29.3	29.8
MKS 992	175	0.4	8.0	19.7	28.2	0.0	0.0	21.0	21.0

Table 2b. Percentage of bulbs occurring in saleable and unsaleable categories for onion varieties planted at Gatton Research Station in mid March 1999 (18.3.99).

Variety	Pickler	No1 Grade	No1 Large	Total	Purples	Off-Types	Doubles	Bullnecks	Seedheads	Total
Grs Elb	2.5	24.0	56.4	82.9	2.4	2.5	12.2	0.0	0.0	17.1
Grs Gob	3.0	32.1	29.7	64.9	0.0	0.3	34.6	0.3	0.0	35.1
Els Gob	2.9	26.4	39.5	68.8	0.0	0.6	30.6	0.0	0.0	31.2
Els Ew	1.8	31.1	51.4	84.3	1.2	1.4	12.8	0.2	0.2	15.7
Neu Elb	1.6	14.7	61.2	77.6	2.8	2.8	16.0	0.5	0.5	22.4
Neu Elw	1.3	20.3	44.9	66.5	0.0	0.0	32.9	0.0	0.6	33.5
Neu Gob	4.3	37.6	26.1	68.0	0.0	0.0	31.2	0.2	0.6	32.0
Yat Cav	0.9	20.2	64.8	85.9	0.0	0.0	8.1	1.6	4.3	14.1
SPS 509	0.8	17.8	64.2	82.8	0.0	0.0	8.8	0.9	7.5	17.2
Jar Elw	0.9	21.9	37.6	60.4	0.0	0.0	16.4	1.2	22.0	39.6
Jar Elb	3.7	21.3	24.5	49.5	0.0	0.0	46.5	1.1	2.9	50.5
MKS 991	2.2	20.2	30.5	52.8	0.4	0.4	46.0	0.2	0.3	47.2
MKS 992	2.3	17.9	25.3	45.5	0.0	0.0	33.5	0.3	20.7	54.5

Table 2c. Bulb characteristics and quality of onion varieties tested at Gatton Research Station in mid March 1999 (18.3.99).

Variety	Bulb Characteristics			Bulb Quality			
	Shape	Colour	Firmness	TSS (%brix)	% Dry Matter	Centres	Pungency (µmole/g)
Grs Elb	4,12	Lt Brown	Hard	9.09	8.43	2.1	6.79
Grs Gob	4	Golden Br	Hard	9.18	9.47	2.1	
Els Gob	4	Golden Br	Hard	8.59	9.28	2.1	
Els Ew	4	White	Hard	9.60	8.88	2.8	
Neu Elb	4	White	Firm	7.54	7.81	1.7	
Neu Elw	4,12	White	Hard	7.78	8.37	1.8	
Neu Gob	4	Golden Br	Hard	8.47	9.41	2.3	
Yat Cav	4,12	Lt Brown	Hard	8.91	9.21	1.7	10.65
SPS 509	3,4,11	Dk Brown	Hard	8.37	8.99	1.9	8.12
Jar Elw	4,11,12	White	Hard	9.63	9.50	3.1	
Jar Elb	4,12	Mid Brown	Hard	8.71	9.31	2.5	7.66
MKS 991	11	Lt Brown	Hard	9.37	9.30	2.3	9.31
MKS 992	12	Lt Brown	Hard	8.84	8.91	2.2	10.55

NB Any varieties not included in these tables of results were not harvested due to either too many seedheads or the plants did not produce any bulbs.

Table 3a. Number of days to harvest and yield (t/ha) (marketable and non-marketable) of onion varieties tested at Gatton Research Station from a mid-April planting (planted: 14.4.99)

Variety	Days to Harvest	Pickler	No1 Grade	No1 Large	Total	Purples	Off-Types	Doubles	Total
Els Gob	182	1.5	14.9	24.6	40.9	0.0	0.0	4.2	4.2
Neu Gob	182	2.1	16.0	16.2	34.3	0.0	0.0	2.8	2.8
Neu Wab	182	1.3	8.1	18.6	28.1	0.0	0.0	3.1	3.1
Yat Cav	182	1.3	12.2	31.1	44.6	0.0	0.0	1.2	0.2
SPS 509	182	1.1	20.8	10.8	32.7	0.0	0.0	0.2	1.2
MKS 993	182	2.0	17.1	6.8	25.9	0.0	0.0	3.4	3.4
MKS BR	182	1.9	9.9	10.6	22.4	0.0	0.0	13.4	13.4
MKS SR	182	0.3	4.3	2.0	6.6	0.0	0.0	3.7	3.7
MKS St	182	1.7	10.8	8.4	20.9	0.0	0.0	0.8	0.8
JAR ELB	182	2.0	13.3	19.0	34.3	0.0	0.0	6.2	6.2
JAR ELW	182	1.1	9.5	14.2	24.8	0.0	0.0	1.2	1.2
JAR GOL	182	1.2	16.9	20.8	38.8	0.0	0.0	3.6	3.6

Table 3b. Percentage of bulbs occurring in saleable and unsaleable categories for onion varieties planted at Gatton Research Station in mid April 1999 (14.4.99).

Variety	Pickler	No1 Grade	No1 Large	Total	Purples	Off-Types	Doubles	Bullnecks	Seedheads	Total
Els Gob	13.7	42.5	25.8	92.0	0.0	0.0	7.3	0.0	0.8	8.0
Neu Gob	17.9	46.2	25.7	89.8	0.0	0.0	5.0	0.0	5.2	10.2
Neu Wab	11.0	25.2	27.2	63.4	0.0	0.0	5.4	0.0	31.2	36.6
Yat Cav	10.8	34.4	43.0	88.2	0.0	0.0	1.8	0.0	10.1	11.8
SPS 509	11.0	63.9	20.2	95.0	0.0	0.0	0.6	0.0	4.3	5.0
MKS 993	18.4	55.7	11.7	85.8	0.0	0.0	8.5	0.0	5.6	14.2
MKS BR	16.8	37.6	19.5	73.8	0.0	0.0	25.7	0.0	0.5	26.2
MKS SR	7.6	52.9	13.2	73.7	0.0	0.0	26.3	0.0	0.0	26.3
MKS St	16.7	41.3	17.7	75.6	0.0	0.0	2.4	0.0	22.0	24.4
JAR ELB	15.0	38.9	29.9	83.8	0.0	0.0	10.0	0.0	6.2	16.2
JAR ELW	11.0	30.1	25.6	66.8	0.0	0.0	3.3	0.0	30.1	33.3
JAR GOL	11.4	48.6	30.6	90.6	0.0	0.0	6.7	0.0	2.7	9.4

Table 3c. Bulb characteristics and quality of onion varieties tested at Gatton Research Station in mid April 1999 (14.4.99).

Variety	Bulb Characteristics			Bulb Quality			
	Shape	Colour	Firmness	TSS (%brix)	% Dry Matter	Centres	Pungency
Els Gob	4,5	Golden Br	Firm	7.06	7.32	1.9	6.52
Neu Gob	3,4,5	Brown	Firm	7.41	7.87	2.2	5.36
Neu Wab	4,5	Br-Dark Br	Firm-hard	6.69	7.10	1.9	7.00
Yat Cav	4,5	Golden Br	Firm	7.21	7.39	1.6	8.98
SPS 509	3,5	Lt Brown	Soft-firm	6.89	7.72	1.1	5.53
MKS 993	2,3	Br-Dark Br	Firm	7.36	7.99	1.5	7.89
MKS BR	6,8,10	Br-Dark Br	Firm	5.26	5.85	2.0	5.51
MKS SR	3,4,5	Dark Br	Firm	6.08	6.33	1.6	5.46
MKS St	5,6	Lt Br-Brown	Soft-firm	6.05	6.53	1.9	8.83
JAR ELB	5,6	Br-Dark Br	Firm	8.41	7.85	1.7	6.22
JAR ELW	5	White	Soft-firm	8.01	7.31	1.6	7.03
JAR GOL	3,5	Lt Br- G Br	Firm-hard	8.83	8.09	1.9	4.85

NB Any varieties not included in these tables of results were not harvested due to either too many seedheads or the plants did not produce any bulbs.

Table 4a. Number of days to harvest and yield (t/ha) (marketable and non-marketable) of onion varieties tested at Gatton Research Station from a mid-May planting (planted: 12.5.99)

Variety	Days to Harvest	Pickler	No1 Grade	No1 Large	Total	Purples	Off-Types	Doubles	Total
Neu Wab	154	0.9	25.1	16.1	42.1	0.0	0.4	1.2	1.6
Yat Cav	154	1.0	30.0	13.4	44.5	0.0	0.2	0.0	0.2
Yat Cos	154	1.3	24.8	3.0	29.1	0.0	5.5	0.6	6.1
Yat Nau	154	3.0	32.9	11.5	47.4	0.0	0.0	0.4	0.4
Yat Pre	154	0.7	21.2	37.0	58.9	0.0	0.1	0.0	0.1
Yat 538	154	1.9	29.8	12.0	43.7	0.0	0.7	0.2	0.9
Yat 5082	154	2.2	30.6	3.3	36.1	0.0	0.4	1.2	1.6
Yat 5083	154	1.0	32.2	9.0	42.2	0.0	0.1	0.1	0.1
SPS Col	154	0.5	13.7	32.1	46.3	0.0	0.0	0.3	0.3
Sps Dem	154	5.0	11.5	1.5	18.0	0.0	0.5	0.4	0.9
MKS 994	154	0.2	16.8	16.0	32.9	0.0	0.1	0.4	0.5
MKS 995	154	2.6	25.1	3.6	31.3	0.0	0.0	3.8	3.8
MKS BR	154	2.2	17.9	2.2	22.4	0.0	0.0	6.0	6.0
MKS St	154	5.7	17.5	0.7	23.9	0.0	0.3	0.1	0.4
JAR Glb	154	1.1	19.0	34.4	54.6	0.0	0.0	1.3	1.3
JAR Gol	154	2.4	36.3	3.8	42.6	0.0	0.2	0.3	0.6
Hen Bol	154	0.2	32.0	2.2	36.5	0.0	1.4	0.1	1.5
Hen Rojo	154	5.6	11.8	0.2	17.6	0.0	1.3	0.4	1.7
Hen Somb	154	2.8	26.7	2.9	32.3	0.0	0.0	0.0	0.0

Table 4b. Percentage of bulbs occurring in saleable and unsaleable categories for onion varieties planted at Gatton Research Station in mid May 1999 (12.5.99).

Variety	Pickler	No1 Grade	No1 Large	Total	Purples	Off-Types	Doubles	Bullnecks	Seedheads	Total
Neu Wab	6.4	62.1	26.6	95.1	0.0	1.1	2.7	0.0	1.1	4.9
Yat Cav	8.5	70.7	20.5	99.7	0.0	0.2	0.0	0.0	0.2	0.3
Yat Cos	7.9	69.4	5.5	82.7	0.0	13.3	1.3	0.0	2.7	17.3
Yat Nau	16.4	67.7	14.2	98.3	0.0	0.0	0.8	0.0	0.9	1.7
Yat Pre	4.9	46.2	48.7	99.7	0.0	0.2	0.0	0.0	0.2	0.3
Yat 538	10.5	69.6	18.1	98.2	0.0	0.3	0.3	0.0	1.3	1.8
Yat 5082	12.0	78.5	5.0	95.5	0.0	0.9	2.2	0.0	1.4	4.5
Yat 5083	6.1	73.1	14.4	93.6	0.0	0.1	0.2	0.0	6.1	6.4
SPS Col	4.6	39.8	55.1	99.4	0.0	0.0	0.6	0.0	0.0	0.6
Sps Dem	36.1	53.3	5.6	95.0	0.0	2.5	2.0	0.0	0.5	5.0
MKS 994	2.2	56.9	39.1	98.2	0.0	0.5	1.3	0.0	0.0	1.8
MKS 995	15.1	68.7	5.7	89.5	0.0	0.2	10.0	0.0	0.3	10.5
MKS BR	16.8	57.4	4.7	78.9	0.0	0.0	21.1	0.0	0.0	21.1
MKS St	38.6	58.3	1.1	98.1	0.0	1.0	0.6	0.0	0.3	1.9
JAR Glb	7.6	44.0	45.6	97.1	0.0	0.0	2.2	0.0	0.7	2.9
JAR Gol	12.3	80.9	5.5	98.7	0.0	0.7	0.6	0.0	0.0	1.3
Hen Bol	11.4	80.0	3.3	94.6	0.0	3.7	1.3	0.0	1.4	5.4
Hen Rojo	46.8	47.3	0.3	94.5	0.5	3.6	1.4	0.0	0.0	5.5
Hen Somb	16.9	77.6	5.1	99.6	0.0	0.0	0.0	0.0	1.0	0.5

Table 4c. Bulb characteristics and quality of onion varieties tested at Gatton Research Station in mid May 1999 (12.5.99).

Variety	Bulb Characteristics			Bulb Quality			
	Shape	Colour	Firmness	TSS (%brix)	% Dry Matter	Centres	Pungency
Neu Wab	3,4,5	Br-Dark Br	Firm	7.02	7.35	2.1	
Yat Cav	3,5	G Br-Brown	Soft-firm	6.86	7.55	1.1	7.69
Yat Cos	4,5,6	White	Firm	7.77	8.39	2.0	9.56
Yat Nau	4,5	Lt Br-Brown	Firm-hard	6.99	7.71	1.1	5.41
Yat Pre	4	Brown	Firm	7.35	7.49	1.1	7.33
Yat 538	4,12	Lt Br-Brown	Firm	7.31	7.94	1.5	8.34
Yat 5082	3,4	White	Soft-firm	7.97	8.67	1.7	
Yat 5083	3,4,16	White	Soft-firm	6.79	7.30	2.7	
SPS Col	4,6,12	Br-Dk Brown	Soft-firm	6.33	6.84	1.1	4.47
Sps Dem	5,12	Red	Firm	7.35	8.29	1.6	
MKS 994	12	Lt Br-Brown	Soft-firm	6.23	7.21	1.4	4.78
MKS 995	3,5,6	Brown	Soft-firm	6.53	7.53	1.9	7.53
MKS BR	2,4,12	Br-Dk Brown	Soft-firm	5.79	6.48	2.2	7.03
MKS St	3,6,12	Lt Br-brown	Firm	6.49	7.04	1.5	8.29
JAR Glb	12	Brown	Firm	7.63	8.08	1.4	5.97
JAR Gol	12,16	G Br-Brown	Firm	6.99	8.04	1.7	5.66
Hen Bol	3,4,12	White	Soft-firm	7.12	7.51	1.8	5.03
Hen Rojo	3	Red	Firm	6.84	7.80	1.5	9.23
Hen Somb	5,6,12	Lt Br-Brown	Firm	5.27	6.66	1.5	3.08

NB Any varieties not included in these tables of results were not harvested due to either too many seedheads or the plants did not produce any bulbs.

Table 5a. Number of days to harvest and yield (t/ha) (marketable and non-marketable) of onion varieties tested at Gatton Research Station from a early June planting (planted: 9.6.99)

Variety	Days to Harvest	Pickler	No1 Grade	No1 Large	Total	Purples	Off-Types	Doubles	Total
Yat Cen	161	6.8	10.2	0.0	17.0	0.0	0.0	0.1	0.1
Yat Dov	161	8.2	3.3	0.0	11.5	0.0	0.6	0.0	0.6
Yat Gla	161	7.7	6.1	0.0	13.8	0.0	0.0	1.1	1.1
Yat Red	161	8.2	5.5	0.0	13.7	0.0	0.0	0.2	0.2
Yat 537	161	9.0	3.4	0.0	12.4	0.0	0.0	0.3	0.3
Yat 541	161	7.4	7.4	0.0	14.8	0.0	0.0	0.8	0.9
Yat 5078	161	9.6	1.0	0.0	10.6	0.0	0.0	0.0	0.0
Yat 509	161	7.7	7.6	0.1	15.4	0.0	0.0	0.5	0.5
Sps 1348	161	4.0	17.7	0.2	21.9	0.0	0.0	0.2	0.2
MKS 1035	126	8.0	9.7	0.0	17.7	0.0	0.0	0.2	0.2
MKS 1092	161	6.8	10.7	0.2	17.8	0.0	0.0	0.5	0.5
MKS BR	161	6.1	20.9	0.0	27.1	0.0	0.0	2.7	2.7
MKS St	126	7.1	7.3	0.0	14.4	0.0	0.0	0.0	0.0
Hen Bol	126	6.3	14.1	0.0	20.5	0.0	0.4	0.0	0.4
Hen Rojo	161	8.2	2.5	0.0	10.7	0.0	0.0	0.1	0.1
Hen Somb	126	7.6	10.2	0.0	17.8	0.0	0.0	0.1	0.1

Table 5b. Percentage of bulbs occurring in saleable and unsaleable categories for onion varieties planted at Gatton Research Station in early June 1999 (9.6.99).

Variety	Pickler	No1 Grade	No1 Large	Total	Purples	Off-Types	Doubles	Bullnecks	Seedheads	Total
Yat Cen	54.0	46.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0
Yat Dov	78.7	16.4	0.0	95.1	0.0	4.9	0.0	0.0	0.0	4.9
Yat Gla	65.0	28.4	0.0	93.3	0.0	0.5	6.1	0.0	0.0	6.7
Yat Red	75.1	23.5	0.0	98.6	0.0	0.0	1.4	0.0	0.0	1.4
Yat 537	80.7	16.9	0.0	97.6	0.0	0.0	2.4	0.0	0.0	2.4
Yat 541	61.0	34.5	0.0	95.6	0.0	0.2	4.2	0.0	0.0	4.4
Yat 5078	93.9	6.1	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0
Yat 509	62.8	34.7	0.2	97.7	0.0	0.0	2.3	0.0	0.0	2.3
Sps 1348	30.2	68.8	0.5	99.4	0.0	0.0	0.6	0.0	0.0	0.6
MKS 1035	58.7	40.1	0.0	98.8	0.0	0.0	1.2	0.0	0.0	1.2
MKS 1092	53.1	43.8	0.5	97.4	0.0	0.0	2.6	0.0	0.0	2.6
MKS BR	58.8	26.3	0.0	85.1	0.2	0.0	14.7	0.0	0.0	14.9
MKS St	62.6	37.4	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0
Hen Bol	39.9	58.9	0.0	98.8	0.0	1.2	0.0	0.0	0.0	1.2
Hen Rojo	87.2	12.6	0.0	99.8	0.0	0.0	0.2	0.0	0.0	0.2
Hen Somb	57.2	42.4	0.0	99.6	0.0	0.0	0.4	0.0	0.0	0.4

Table 5c. Bulb characteristics and quality of onion varieties tested at Gatton Research Station in early June (9.6.99).

Variety	Bulb Characteristics			Bulb Quality			
	Shape	Colour	Firmness	TSS (%brix)	% Dry Matter	Centres	Pungency
Yat Cent	4	Br-Dk Brown	Very hard	7.52	9.07	1.6	9.00
Yat Dov	4,5	White	Firmness	8.2	8.41	1.4	8.57
Yat Gla	4	Br-Dk Brown	Very hard	6.94	8.13	2	7.36
Yat Red	3,4,6	Red	Soft-firm	5.68	6.13	2	6.62
Yat 537	5,12	Brown	Hard	8.08	8.81	2	6.62
Yat 541	6,16	Brown	Hard	8.16	9.35	2	7.48
Yat 5078	5,6	Red	Firm	7.54	8.51	1	
Yat 509	4,5	Brown	Firm-hard	8.08	9.14	1.4	5.97
Sps 1348	3,4,5	Brown	Soft-firm	7.06	8.00	2.4	7.00
MKS 1035	3,5,12	Br-Dk Brown	Soft-firm	6.28	6.92	1.2	5.76
MKS 1092	2,5,16	Straw	Soft-firm	6.34	7.57	2.6	6.50
MKS Br	3,4,12	Brown	Soft-firm	5.22	6.00	1.6	5.79
MKS St	12	Lt Brown	Soft-firm	6.64	7.23	2.2	6.65
Hen Boi	3,4,5,6	White	Firm-hard	7.02	7.31	3.4	
Hen Rojo	3,4,5,6	Red	Soft-firm	6.36	7.24	1.4	
Hen Som	4,5,12	Lt Brown	Soft-firm	4.98	6.04	1.2	4.50

NB Any varieties not included in these tables of results were not harvested due to either too many seedheads or the plants did not produce any bulbs.

12. Appendix 2 – 2000 Trial Results: Actual Data

LEGEND

WAB	Neuendorf -	Wallon Brown
CAV	Yates Seeds-	Cavalier
GLA	Yates Seeds -	Gladiator
PRE	Yates Seeds -	Predator
5078	Yates Seeds -	Experimental Line H5078
5079	Yates Seeds -	Experimental Line H5079
5080	Yates Seeds -	Experimental Line H5080
5082	Yates Seeds -	Experimental Line H5082
5083	Yates Seeds -	Experimental Line H5083
5094	Yates Seeds -	Experimental Line H5094
5097	Yates Seeds -	Experimental Line H5097
5114	Yates Seeds -	Experimental Line J5114
5119	Yates Seeds -	Experimental Line J5119
5120	Yates Seeds -	Experimental Line J5120
DEM	South Pacific Seeds -	Rio Demon
ROC	South Pacific Seeds -	Red Rocks
1347	South Pacific Seeds -	Experimental Line 1347
Hen Bol	Henderson Seeds -	Bolero
Hen Brn	Henderson Seeds -	Bronco
Hen Rojo	Henderson Seeds -	Red Rojo
Hen Som	Henderson Seeds -	Sombrero
M&R	May and Ryan Seeds	Experimental Line – 19042
Jar 520	Jarit Seeds -	Experimental Line – JT520
Jar 91	Jarit Seeds -	Experimental Line – JT091
Jar Sun	Jarit Seeds -	Sunshine

Table 1(a) Number of days to harvest and yield (t/ha) data for the May planting .

Variety	Harvest	Picklers 0-40mm	No 1 40-75mm	Large > 75mm	Market > 40mm	Doubles	Off Types	Purple
Hen Som	176	0.5	5.0	85.4	90.4	2.5	0.1	
M&R 19042	177	0.6	21.5	39.6	61.1	0.5	0.0	
WAB	154	1.2	21.7	33.7	55.4	3.2	0.1	
DEM	178	1.0	14.6	53.3	67.9	1.3	0.2	
ROC	177	0.8	12.5	70.7	83.2	1.2	0.0	
CAV	154	0.6	16.4	49.9	66.3	2.1	0.0	
PRE	176	1.1	5.2	87.0	92.2	1.8	0.5	
5078	187	1.0	9.0	73.4	82.4	2.0	0.0	
5079	176	1.0	15.8	47.9	63.7	4.4	0.2	
5080	187	0.3	5.6	63.8	69.4	2.0	0.0	
5082	176	1.0	11.9	67.5	79.4	0.6	0.0	
5083	154	0.3	24.9	34.6	59.5	2.6	0.1	
5094	197	0.7	25.0	58.7	83.7	0.0	0.0	
5114	176	0.7	9.7	71.5	81.2	2.0	0.2	
5119	178	0.7	5.0	70.5	75.5	0.1	1.5	
5120	176	0.7	9.2	58.8	68.0	0.0	0.2	
LSD 5%		**ns**	**7.7**	**13.3**	**7.5**	**ns**	**0.5**	

Table 2(a) Number of centres per bulb and percentage bulbs occurring in saleable and unsaleable categories for the May planting.

Variety	Number of Centres	SALEABLE				REJECTS	
		Picklers < 40mm	No. 1 40-75mm	Large > 75mm	Market > 40mm	Doubles	OffTypes
Hen Som	1.1	3.3	10.8	79.4	90.3	2.6	0.2
M&R 19042	1.3	4.9	43.2	51.2	94.5	0.7	0.0
WAB	1.2	8.8	43.1	43.2	86.2	4.5	0.2
DEM	1.0	8.2	28.2	60.7	88.9	1.5	0.3
ROC	1.3	5.2	22.3	71.3	93.6	1.1	0.0
CAV	1.5	5.0	31.5	60.9	92.4	2.4	0.0
PRE	1.1	8.2	11.5	78.3	89.8	1.6	0.3
5078	1.0	6.4	16.4	74.4	90.8	2.2	0.0
5079	1.5	5.6	35.1	53.7	88.8	5.0	0.2
5080	1.5	2.6	16.8	78.6	95.5	2.0	0.0
5082	1.4	7.4	25.5	63.6	89.1	1.3	0.0
5083	1.7	1.9	48.1	45.6	93.7	3.5	0.2
5094	1.1	4.2	37.1	58.7	95.8	0.0	0.0
5114	1.1	5.9	17.0	74.0	91.0	2.1	0.2
5119	1.3	4.1	13.4	80.3	93.8	0.2	1.3
5120	1.0	5.0	22.0	71.2	93.2	0.0	0.2
LSD 5%	**0.4**	**ns**	**14.5**	**15.2**	**ns**	**ns**	**0.4**

Table 3(a) Bulb description, soluble solids (TSS), pungency and dry matter (%) data for the May planting.

Variety	TSS (brix %)	Dry Matter %	Pungency	Shape	Skin Colour	Firmness
Hen Som	6.7	7.0	7.3	3,11	LtBr-Straw	Soft
M&R	10.8	11.1	9.0	3	GBr-Brown	Hard-V Hard
WAB	8.3	9.0	10.7	3,4	Brown	Firm
DEM	9.6	11.3	8.7	3,8	Red	Firm
ROC	8.7	9.4	10.2	11	Red	Firm
CAV	8.7	8.7	9.3	3,4	LtBr-Brown	Firm
PRE	7.2	8.2	9.4	3,4	LtBr-Brown	Firm
5078	11.2	12.9	9.4	3,4,5	Pink-Red	Firm
5079	10.2	11.6	11.3	3,4,5	Brown	Hard
5080	10.5	10.8	12.6	3,4	Brown	Firm-Hard
5082	8.7	10.4	11.4	3	White	Firm
5083	8.9	9.1	7.3	3	White	Firm
5094	10.6	11.1	10.0	3	Red	Firm
5114	7.3	8.6	7.7	3	Brown	Firm-Hard
5119	10.2	10.1	13.0	4	Brown	Hard
5120	9.2	10.6	9.5	3,4	Br-Dbrown	Hard
LSD 5%	**1.3**	**1.2**				

Table 4(a) Bulb description and quality after 20 weeks for the May planting.

Variety	Soundness %	Black Mould %	Greening Rating**	Firmness
Hen Som	55	56	1	Soft-Firm
M&R	71	70	1	Firm-Hard
WAB	100	44	1	Firm
DEM	47	12	1	Soft
ROC	86	13	1	Soft-Firm
CAV	90	52	1	Firm
PRE	76	65	1	Firm
5078	94	19	1	Firm
5079	81	90	1	Firm-Hard
5080	45	88	1	Firm
5082	50	14	2	Soft-Firm
5083	72	24	1	Firm
5094	64	40	1	Soft
5114	84	54	2	Hard
5119	78	62	1	Firm-Hard
5120	100	56	1	Firm-Hard

** Greening scale: 1 - nil; 2 - very slight; 3 - slight; 4 - marked; 5 - pronounced.

Table 1(b) Number of days to harvest and yield (t/ha) data for the June planting.

Variety	Days to Harvest	SALEABLE				REJECTS		
		Picklers < 40mm	No .1 40-75mm	Large > 75mm	Market > 40mm	Doubles	Off Types	Purple
Hen Bol	147	1.1	29.5	12.7	42.2	1.9		
Hen Brn	149	1.0	28.1	22.5	50.6	1.4		
Hen Rojo	160	0.7	29.5	13.6	43.1	1.6		
Hen Som	147	0.5	19.3	44.2	63.5	2.1		
Jar 520	175	0.1	17.8	11.3	29.1	32.4		
Jar 91	175	0.1	28.1	19.9	48.0	11.5		
Jar Sun	175	0.3	11.6	4.4	16.0	38.9		
M&R	151	2.3	32.9	6.5	39.4	0.4		
1347	154	0.5	9.5	62.5	72.0	0.5		
ROC	147	0.2	26.4	37.2	63.6	0.5		
5097	175	0.2	40.2	21.3	61.5	2.8		
GLA	175	0.5	33.9	19.5	53.4	4.4		
LSD - 5%		**0.5**	**7.0**	**8.3**	**6.8**	**2.8**		

Table 2(b) Number of centres per bulb and percentage bulbs occurring in saleable and unsaleable categories for the June planting.

Variety	Number of Centres	SALEABLE				REJECTS	
		Picklers < 40mm	No. 1 40-75mm	Large > 75mm	Market > 40mm	Doubles	Off Types
Hen Bol	1.8	6.8	70.5	18.5	89.0	4.2	
Hen Brn	1.9	7.1	59.6	30.9	90.5	2.4	
Hen Rojo	1.7	4.0	74.7	19.0	93.7	2.4	
Hen Som	1.2	3.5	38.4	54.9	93.3	3.3	
Jar 520	2.7	0.6	34.1	15.1	49.2	50.2	
Jar 91	2.0	1.2	50.5	28.0	78.5	20.3	
Jar Sun	2.5	3.2	24.6	7.4	32.0	64.8	
M&R	1.3	11.7	77.5	10.1	87.6	0.7	
1347	1.3	3.5	20.8	75.2	96.0	0.4	
ROC	1.6	2.0	46.6	50.6	97.2	0.8	
5097	1.8	0.7	68.4	27.3	95.7	3.7	
GLA	1.4	3.8	63.6	25.8	89.4	6.8	
LSD - 5%	**0.5**	**2.6**	**10.4**	**9.9**	**5**	**4.4**	

Table 3(b) Bulb description, soluble solids (TSS), dry matter (%) and storage data for the June planting.

Variety	TSS (brix %)	Dry Matter %	Pungency	Shape	Skin Colour	Firmness
Hen Bol	7.2	8.1	5.1	8	White	Firm
Hen Brn	7.2	8.0	8.8	2,3,8	LBr-straw	Soft-Firm
Hen Rojo	7.3	8.1	8.8	2	Red	Soft-Firm
Hen Som	5.7	6.4	4.5	2,3,4	LBr-Straw	Soft
Jar 520	7.1	7.5	8.3	2,3,4	Brown	Firm
Jar 91	8.3	9.3	8.1	2,3,8	GBr-Brown	Firm
Jar Sun	8.5	9.5	10.3	2,3,11	Brown	Firm
M&R	9.9	10.9	8.2	2,3	GBr-Brown	Very Hard
1347	7.9	8.9	9.9	11	Lbr-Brown	Soft-Firm
ROC	7.5	8.5	9.4	8	Red	Firm
5097	9.7	10.6	9.7	2,3,4	Br-Dbrown	Firm-Hard
GLA	9.7	10.6	8.1	3,4	Br-Dbrown	Hard
LSD - 5%	**0.7**	**0.6**				

Table 4(b) Bulb description and quality after 15 weeks for the June planting.

Variety	Soundness %	Black Mould %	Greening Rating**	Firmness
Hen Bol	55	0	1	Soft
Hen Brn	67	13	1	Soft-Firm
Hen Rojo	59	0	1	Soft
Hen Som	73	33	1	Soft
Jar 520	50	38	2	Firm
Jar 91	88	20	1	Firm
Jar Sun	66	33	1	Soft-Firm
M&R	94	59	2	Hard
1347	74	32	2	Firm
ROC	92	9	1	Firm
5097	89	29	1	Hard
GLA	74	42	1	Hard

** Greening scale: 1 - nil; 2 - very slight; 3 - slight; 4 - marked; 5 - pronounced.

13. Appendix 3 – 2001 Trial Results: Actual Data

LEGEND

GOB	Neuendorf -	Golden Brown
WAB	Neuendorf -	Wallon Brown
CAV	Yates Seeds-	Cavalier
PRE	Yates Seeds -	Predator
E507	Yates Seeds -	Experimental Line E507
H5082	Yates Seeds -	Experimental Line H5082
J5114	Yates Seeds -	Experimental Line J5114
J5118	Yates Seeds -	Experimental Line J5118
J5119	Yates Seeds -	Experimental Line J5119
J5121	Yates Seeds -	Experimental Line J5121
J5128	Yates Seeds -	Experimental Line J5128
K5150	Yates Seeds -	Experimental Line K5150
K5151	Yates Seeds -	Experimental Line K5151
K5155	Yates Seeds -	Experimental Line K5155
K5156	Yates Seeds -	Experimental Line K5156
K5158	Yates Seeds -	Experimental Line K5158
K5159	Yates Seeds -	Experimental Line K5159
K5161	Yates Seeds -	Experimental Line K5161
ROC	South Pacific Seeds -	Red Rocks
153/9	South Pacific Seeds -	Experimental Line 153/9
Hen Sam	Henderson Seeds -	Samba
Hen Som	Henderson Seeds -	Sombrero
L1001	Lefroy Valley Seeds	Experimental Line L1001
L1003	Lefroy Valley Seeds	Experimental Line L1003
L1005	Lefroy Valley Seeds	Experimental Line L1005
LV35	Lefroy Valley Seeds	Experimental Line LV35
LV81	Lefroy Valley Seeds	Experimental Line LV81
LV90	Lefroy Valley Seeds	Experimental Line LV90

Table 2(a) Number of days to harvest and yield (t/ha) data for the April planting.

Variety	Days to Maturity	SALEABLE				REJECTS		
		Picklers 0-40mm	No .1 40-75mm	Large > 75mm	Market > 40mm	Doubles	Off Types	Purple
GOB	166	0.8	23.3	18.1	41.3	2.0	0.1	0
WAB	171	1.2	9.2	58.6	67.7	2.4	0	0.7
CAV	171	0.5	9.2	64.7	73.9	0.1	0.1	0
J5128	166	0.8	15.0	38.6	53.5	1.2	0	0
K5151	173	0.1	5.2	74.1	79.3	0.6	0	0
K5155	173	0.5	15.0	56.3	71.2	0.3	0	0
L1001	167	1.5	17.7	22.8	40.4	3.8	0	0.3
L1003	178	1.5	20.4	21.3	41.7	0.9	0	0.2
L1005	178	0.4	16.8	13.7	30.5	0.9	0	0.3
LV35	187	2.0	10.1	17.1	27.2	44.2	0	0
LV81	166	0.5	23.7	18.3	42.0	3.8	0	1.0
LV90	167	0.8	10.1	24.1	34.3	4.4	0	3.0
LSD 5%		**ns**	**4.7**	**14.0**	**10.8**	**4.3**	**ns**	**0.6**

Table 3(a) Number of centres per bulb and percentage bulbs occurring in saleable and unsaleable categories for the April planting.

Variety	Number of Centres	SALEABLE				REJECTS				
		Picklers < 40mm	No. 1 40-75mm	Large > 75mm	Total Market	Doubles	Off Types	Seedheads	Bullneck	Purple
GOB	1.7	5.7	61.0	28.0	94.8	4.2	0.2	0.8		0.0
WAB	1.7	3.4	24.0	66.8	94.2	3.6	0.0	1.3		0.8
CAV	1.9	2.1	21.7	74.8	98.7	0.2	0.2	0.9		0.0
J5128	2.3	2.9	36.4	56.1	95.4	2.0	0.0	2.6		0.0
K5151	1.5	1.1	13.6	82.2	93.9	0.7	0.0	2.4		0.0
K5155	1.2	3.7	31.2	61.1	96.0	0.6	0.0	3.4		0.0
L1001	2.5	9.7	46.5	33.6	89.7	8.8	0.0	0.7		0.9
L1003	1.5	10.6	53.1	29.6	93.3	2.2	0.0	3.9		0.6
L1005	1.9	6.0	62.9	25.8	94.7	3.2	0.0	1.1		1.1
LV35	2.1	9.3	19.9	14.9	44.1	55.9	0.0	0.0		0.0
LV81	1.9	4.4	60.3	26.0	90.7	6.0	0.0	1.4		1.9
LV90	2.1	3.8	34.2	45.8	83.7	8.2	0.0	0.6		7.5
LSD 5%	**ns**	**4.8**	**14.5**	**18.1**	**6.6**	**6.3**	**ns**	**2.3**		**0.8**

Table 4(a) Bulb description, soluble solids (TSS), pungency and dry matter (%) data for the April planting.

Variety	TSS (brix %)	Dry Matter %	Pungency	Shape	Skin Colour	Firmness
GOB	7.8	7.9	8.1	3,4	Golden Brown	Firm
WAB	7.7	7.5	8.0	3,4	Brown	Firm
CAV	8.5	7.8	8.2	4	Lt Br-Gld. Br	Firm
J5128	7.7	8.7	10.3	3,4	Brown	Firm
K5151	8.7	8.4	8.5	3	Brown	Firm
K5155	8.7	8.0	7.1	3,4	Brown	Firm
L1001	8.8	7.9	8.7	10,12	Lt brown	Firm
L1003	7.5	8.0	5.8	10	Lt Brown	Firm
L1005	6.8	7.1	4.5	2,8	Lt Brown	Soft-Firm
LV35	6.9	6.9	7.8	12	Brown	Soft-Firm
LV81	8.6	8.8	9.1	3,8,12	Lt Brown	Firm
LV90	8.9	8.2	7.2	3,12	Lt Brown	Firm
LSD 5%	**1.3**	**0.8**				

Table 5(a) Bulb description and quality after 12 weeks for the April planting.

Variety	Soundness %	Black Mould %	Greening Rating**	Firmness
GOB	100	30	2	Soft-Firm
WAB	90	45	1	Firm
CAV	100	25	2	Soft-Firm
J5128	95	50	1	Soft-Firm
K5151	100	45	1	Firm
K5155	95	25	2	Firm
L1001	90	25	2	Soft
L1003	95	30	1	Soft-Firm
L1005	95	35	1	Firm
LV35	80	55	1	Soft-Firm
LV81	100	45	1	Firm
LV90	100	20	1	Soft-Firm

** Greening scale: 1 - nil; 2 - very slight; 3 - slight; 4 - marked; 5 - pronounced.

Table 2(b) Number of days to harvest and yield (t/ha) data for the May planting.

Variety	Days to Harvest	SALEABLE				REJECTS		
		Picklers < 40mm	No .1 40-75mm	Large > 75mm	Market > 40mm	Doubles	Off Types	Purple
WAB	161	0.4	12.5	51.3	63.8	1.1	0.0	0.2
PRE	169	0.3	5.9	61.7	67.6	0.2	0.9	0.0
H5082	167	0.6	14.5	39.3	53.8	0.6	0.1	0.0
J5114	167	0.2	6.2	88.7	94.9	0.0	0.1	0.0
J5118	167	0.9	15.8	38.3	54.1	0.5	0.0	0.0
J5119	170	0.5	12.1	47.0	59.1	0.0	0.0	0.0
K5158	158	0.5	10.6	67.8	78.5	0.2	0.0	0.0
K5159	158	0.3	4.2	54.9	59.1	0.0	0.1	0.0
K5161	165	0.3	6.8	64.0	70.8	0.2	0.0	0.0
L1001	158	0.9	18.1	46.0	64.1	4.8	0.0	0.9
L1003	167	1.5	13.2	48.8	62.0	1.8	0.2	0.3
L1005	174	0.2	20.6	33.6	54.2	6.3	0.0	0.5
LV35	169	0.4	6.7	42.0	48.7	34.2	0.0	0.0
LV81	158	0.4	17.0	43.6	60.6	2.5	0.0	1.5
LV90	167	0.6	8.7	41.5	50.2	1.6	0.0	2.2
SOM	167	0.1	6.3	51.6	57.9	0.6	0.3	0.0
153/9	165	0.7	15.6	59.9	75.4	0.0	0.5	0.0
ROC	168	0.5	10.9	40.1	51.0	0.2	0.2	0.0
LSD - 5%		**ns**	**5.7**	**11.7**	**11.4**	**1.8**	**ns**	**0.6**

Table 3(b) Number of centres per bulb and percentage bulbs occurring in saleable and unsaleable categories for the May planting.

Variety	Number of Centres	SALEABLE				REJECTS				
		Picklers < 40mm	No. 1 40-75mm	Large > 75mm	Total Market	Doubles	Off Types	Purple	Bullneck	Seed Heads
WAB	2.1	2.9	30.7	64.4	98.0	1.8	0.0	0.3		0.0
PRE	1.9	3.0	16.6	77.7	97.2	0.3	1.5	0.0		0.9
H5082	2.3	2.2	37.4	59.0	98.6	1.1	0.3	0.0		0.0
J5114	1.7	1.1	13.5	85.0	99.6	0.0	0.2	0.0		0.2
J5118	2.2	6.0	40.7	52.3	99.1	0.9	0.0	0.0		0.0
J5119	1.0	3.7	32.4	63.6	99.8	0.0	0.0	0.0		0.2
K5158	1.3	2.7	22.4	74.4	99.6	0.2	0.0	0.0		0.2
K5159	1.6	1.8	13.4	84.5	99.6	0.0	0.4	0.0		0.0
K5161	1.3	1.9	19.0	78.9	99.8	0.2	0.0	0.0		0.0
L1001	2.2	4.4	38.2	49.9	92.6	5.7	0.0	1.6		0.2
L1003	2.2	3.8	31.0	61.9	96.7	2.4	0.2	0.7		0.0
L1005	1.5	2.7	48.9	39.3	90.9	8.2	0.0	1.0		0.0
LV35	2.4	1.8	15.1	45.9	62.8	37.2	0.0	0.0		0.0
LV81	1.8	2.6	36.5	54.8	93.8	4.0	0.0	2.2		0.0
LV90	2.2	4.3	25.7	62.5	92.5	3.6	0.0	3.9		0.0
SOM	1.8	1.8	20.7	76.0	98.4	0.6	0.5	0.0		0.5
153/9	1.1	4.2	29.8	65.6	99.6	0.0	0.4	0.0		0.0
ROC	1.8	4.6	32.4	62.4	99.4	0.3	0.4	0.0		0.9
LSD - 5%	**0.6**	**ns**	**12.1**	**13.0**	**3.8**	**3.3**	**0.8**	**1.2**		**ns**

Table 4(b) Bulb description, soluble solids (TSS), pungency and dry matter (%) data for the May planting.

Variety	TSS (brix %)	Dry Matter %	Pungency	Shape	Skin Colour	Firmness
WAB	8.1	8.1	10.3	4,5	Brown-Dk Br	Firm
PRE	7.8	8.0	7.63	3,4	Lt Brown-Br	Firm
H5082	10.3	8.7	7.49	3	White	Soft-Firm
J5114	7.7	7.9	7.73	3,4	Lt Brown-Br	Firm-Hard
J5118	11.6	11.1	7.85	3,4	Gld Br-Brown	Hard
J5119	10.6	10.7	9.12	4	Brown	Hard
K5158	8.5	7.8	7.95	3,4	Brown	Hard
K5159	7.4	7.4	6.57	4,5	Lt Brown	Firm-Hard
K5161	7.6	7.8	8.50	3,4,5	Lt Brown-Br	Firm
L1001	9.1	8.2	8.92	4,5	Lt Brown	Firm
L1003	8.5	7.8	9.04	4	Lt Brown	Firm
L1005	7.2	7.6	6.13	1,2	Brown	Firm
LV35	7.6	7.4	8.86	12,6	Lt Brown-Br	Soft-Firm
LV81	9.0	8.6	9.86	11,4,3	Brown	Firm-Hard
LV90	8.4	8.3	9.30	4,5	Brown	Firm-Hard
SOM	6.6	7.1	5.48	5,10,12	Lt Brown	Soft-Firm
153/9	8.9	8.3	7.47	2,3,8	White	Soft-Firm
ROC	9.6	9.8	9.58	8	Red	Firm
LSD - 5%	**1.3**	**0.9**				

Table 5(b) Bulb description and quality after 10 weeks for the May planting.

Variety	Soundness %	Black Mould %	Greening Rating**	Firmness
WAB	95	60	1	Firm
PRE	65	35	1	Firm
H5082	65	10	1	Firm
J5114	100	55	2	Firm-Hard
J5118	100	70	1	Firm-Hard
J5119	100	45	1	Firm
K5158	95	45	2	Firm
K5159	100	30	2	Firm
K5161	75	45	1	Firm
L1001	85	40	1	Firm
L1003	95	55	1	Firm
L1005	75	55	1	Soft-Firm
LV35	90	45	1	Firm
LV81	95	40	1	Firm
LV90	95	45	1	Firm
SOM	85	45	1	Soft
153/9	85	0	2	Soft-Firm
ROC	85	25	1	Firm

** Greening scale: 1 - nil; 2 - very slight; 3 - slight; 4 - marked; 5 - pronounced.

Table 2(c) Number of days to harvest and yield (t/ha) data for the June planting.

Variety	Days to Harvest	SALEABLE				REJECTS		
		Picklers < 40mm	No .1 40-75mm	Large > 75mm	Market > 40mm	Doubles	Off Types	Purple
PRE	149	0.5	13.4	72.8	86.1	0.0	1.0	0.0
E507	161	.04	24.1	32.6	56.7	6.8	0.1	0.1
J5121	161	0.4	21.9	40.0	61.8	0.0	0.0	0.0
K5150	161	0.2	24.0	52.0	76.0	0.6	0.1	0.0
K5156	161	0.3	10.4	99.7	110.1	0.5	0.2	0.0
SAM	168	0.3	11.4	65.1	76.5	0.2	0.2	0.1
SOM	147	0.4	5.3	73.0	78.3	1.7	0.0	0.3
153/9	147	0.7	28.8	44.8	73.5	0.0	0.0	0.0
ROC	147	0.6	19.9	45.1	65.0	0.1	0.1	0.0
LSD - 5%		**ns**	**5.4**	**14.6**	**11.6**	**0.9**	**0.5**	**ns**

Table 3(c) Number of centres per bulb and percentage bulbs occurring in saleable and unsaleable categories for the June planting.

Variety	Number of Centres	SALEABLE				REJECTS				
		Picklers < 40mm	No. 1 40-75mm	Large > 75mm	Total Market	Doubles	Off Types	Seedheads	Bullneck	Purple
PRE	1.3	2.6	25.1	71.4	99.1	0.0	0.9	0.0		0.0
E507	1.2	1.8	43.1	45.7	90.5	9.2	0.1	0.2		0.1
J5121	1.0	2.1	43.0	54.8	99.8	0.0	0.0	0.2		0.0
K5150	1.0	0.9	43.5	54.8	99.2	0.6	0.2	0.0		0.0
K5156	1.0	1.2	17.8	79.9	98.9	0.6	0.5	0.0		0.0
SAM	1.1	2.2	24.5	70.8	97.6	0.2	0.3	2.3		0.1
SOM	1.4	2.6	12.9	81.7	97.3	2.1	0.0	0.2		0.4
153/9	1.2	3.0	46.7	50.2	100	0.0	0.0	0.0		0.0
ROC	1.7	2.8	38.2	58.6	99.6	0.2	0.2	0.0		0.0
LSD 5%	**0.2**	**ns**	**9.5**	**10.2**	**1.4**	**1.2**	**0.5**	**0.8**		**ns**

Table 4(c) Bulb description, soluble solids (TSS), pungency and dry matter (%) data for the June planting.

Variety	TSS (brix %)	Dry Matter %	Pungency	Shape	Skin Colour	Firmness
PRE	8.42	7.92	7.17	4	Lt Brown-Br	Firm-Hard
E507	9.44	9.94	9.66	3	Brown	Hard
J5121	11.49	11.17	7.75	4	Brown	Hard
K5150	10.74	10.24	10.02	4	Brown	Hard
K5156	7.75	7.54	8.32	3,4	Lt Brown-Br	Firm
SAM	7.04	7.16	7.69	5,9	Brown	Firm
SOM	7.81	7.75	5.42	5,9	Lt Brown	Soft-Firm
153/9	7.89	8.28	9.10	2,3	White	Soft-Firm
ROC	8.22	9.35	11.75	8,11	Red	Firm-Hard
LSD 5%	**1.03**	**0.98**				

Table 5(c) Bulb description and quality after 10 weeks for the June planting.

Variety	Soundness %	Black Mould %	Greening Rating**	Firmness
PRE	20	30	1	Firm-Hard
E507	80	65	1	Hard
J5121	80	55	1	Hard
K5150	95	65	1	Firm-Hard
K5156	90	65	1	Firm
SAM	65	65	1	Soft-Firm
SOM	95	55	1	Soft-Firm
153/9	20	0	1	Soft
ROC	90	25	1	Firm

** Greening scale: 1 - nil; 2 - very slight; 3 - slight; 4 - marked; 5 - pronounced.

14. Appendix 4 – N. Qld Trial Results – Actual Data

Table 1. Yield (t/ha) and bulb quality of sweet onion varieties tested at Walkamin on the Atherton Tableland in North Queensland in 1999 (Planted: 12.04.99; Harvested: 13.09.99).

Variety	Yield (t/ha)					Bulb Quality		
	Picklers 0-40mm	Jarrahs 40-55mm	No. 1 55-70mm	No 1 Large >70mm	Doubles	TSS % Brix	% Dry Matter	Pyruvic Acid (µmole/g)
SPS Rio Xena	0.94	3.28	21.90	16.94	0.50	8.96	9.39	7.7
SPS Rio Pancho	1.83	8.30	51.39	1.85	0.00	9.40	9.83	6.6
Henderson's Bolero	1.00	4.65	40.20	10.9	2.60	8.92	8.83	5.0
Henderson's Bronco	1.41	5.00	38.38	14.4	1.23	9.84	9.66	7.2
Henderson's Sombrero	3.97	15.67	31.00	1.73	0.30	8.68	8.55	7.2
Jarit Lockyer Gold	3.83	14.00	21.50	0.00	0.00	9.72	8.67	7.5
Jarit Tropic	2.39	9.13	16.39	0.00	1.73	11.28	10.90	11.2
Jarit Sunshine	NH*							
Jarit JT091	NH							
Golden Brown	2.75	10.48	31.08	2.34	0.31	8.92	9.02	6.1

*NH – Not Harvested.

15. Appendix 5 – Bulb Shape

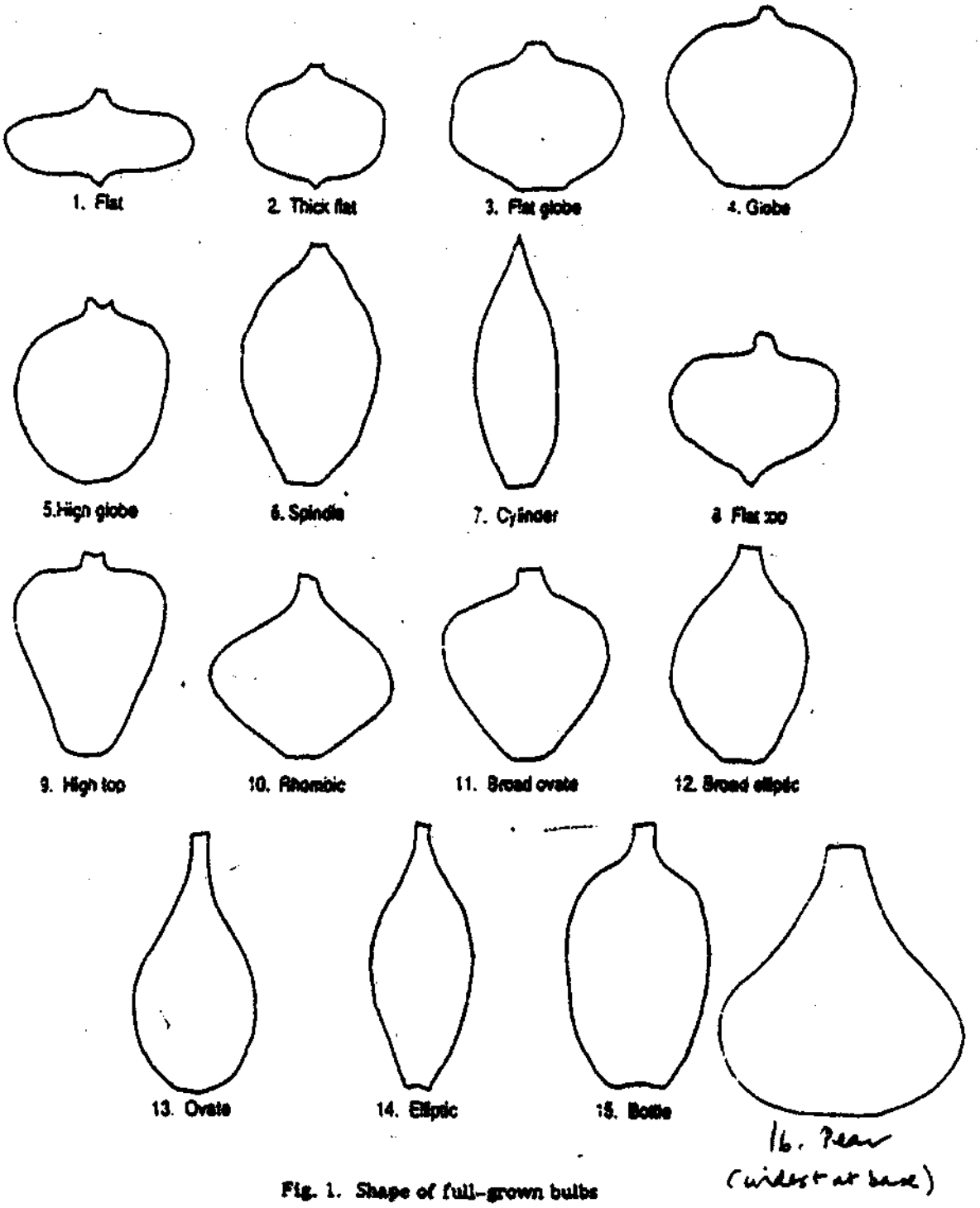

Fig. 1. Shape of full-grown bulbs

16. Appendix 6 – Population Density Results

Table 1. Yield (t/ha) and number of bulbs (%) for the variety Golden Brown at various plant densities during the 2000 growing season.

GOLDEN BROWN											
	Yield (t/ha)										
	0-40mm	40-70mm	70-80mm	80-90mm	90-100mm	>100mm	40-90mm	>40mm	Market	Total	Doubles
Spacing											
60	0.77	21.7	24.25	7.9	1.97	0.3	53.84	56.11	56.88	78.38	21.5
80	0.45	12.22	19.56	10.84	7.02	3.56	42.63	53.2	53.65	71.76	18.11
100	0.18	5.88	12.87	13.91	11.05	3.61	32.66	47.32	47.5	67.04	19.53
120	0.29	4.91	11.29	12.87	10.96	6.05	29.07	46.08	46.38	61.93	15.55
140	0.26	3.32	8.14	10.73	11.65	8.58	22.19	42.42	42.67	58.41	15.74
160	0.16	2.7	6.65	10.79	9.89	6.87	20.15	36.91	37.07	51.99	14.92
LSD 5%	0.35	3.96	5.51	NS	3.58	3.15	5.41	6.22	6.25	4.8	NS
	Percentage Bulbs										
	0-40mm	40-70mm	70-80mm	80-90mm	90-100mm	>100mm	40-90mm	>40mm	Doubles	Seed heads	Total Plant
Spacing											
60	4.51	36.9	23.9	5.7	1.1	0.2	66.5	67.8	19.7	8.1	281
80	2.41	26.9	25.6	10.4	5.8	2.3	62.8	70.9	20.1	6.6	208
100	2.01	17.9	20.5	16.1	10.8	2.8	54.5	68.1	24.3	5.6	175
120	2.72	13.9	20	17.8	12.9	5.4	51.6	69.9	21.8	5.5	148
140	2.97	11.8	17	16.1	14.2	8.6	44.9	67.7	22.1	7.2	128
160	2.14	12.6	15.3	18.1	14.2	8	46	68.2	23.2	6.5	116
LSD 5%	NS	6.4	6.8	5.6	4.5	2.7	7.6	7.3	NS	NS	NS

Table 2. Yield (t/ha) and number of bulbs (%) for the variety Wallon Brown at various plant densities during the 2000 growing season.

WALLON BROWN											
	Yield (t/ha)										
	0-40mm	40-70mm	70-80mm	80-90mm	90-100mm	>100mm	40-90mm	>40mm	Market	Total	Doubles
Spacing											
60	1.12	22.8	23.09	10.13	0.43	0	56.03	56.46	57.58	58.07	0.49
80	0.92	15.32	20.38	17.94	1.39	0	53.64	55.03	55.95	56.17	0.22
100	0.39	9.12	17.34	17.85	5.97	0	44.31	50.28	50.67	50.88	0.22
120	0.72	8.31	13.43	21.57	2.95	0	43.31	46.26	46.98	47.26	0.28
140	0.45	8.75	9.66	16.86	5.23	0	32.27	37.5	37.95	38.67	0.72
160	0.13	4.37	3.67	20.6	9.07	0	28.65	37.72	37.84	38.39	0.56
LSD 5%	NS	3.3	4.22	3.75	4.41	NS	4.15	4.15	4.91	5.32	NS
	Percentage Bulbs										
	0-40mm	40-70mm	70-80mm	80-90mm	90-100mm	>100mm	40-90mm	>40mm	Doubles	Seed heads	Total Plant
Spacing											
60	9.4	46.9	31.3	10.7	0.4	0	88.8	89.2	0.6	0.8	248
80	8.3	37	31.8	20.9	1.4	0	89.8	91.2	0.5	0	211
100	4.9	27.2	34.3	25.8	6.9	0	87.3	94.2	0.3	0.6	161
120	8	24.9	27.3	34.2	4.1	0	86.3	90.4	0.6	1	152
140	7.2	21.1	27.4	34.2	8.3	0	82.7	91.0	1.7	0	112
160	1.5	19.8	11.1	48.8	16.7	0	79.6	96.3	1.4	0.5	103
LSD 5%	NS	10.1	9.6	6.1	7.2	NS	NS	NS	NS	NS	

Table 3. Yield (t/ha) and number of bulbs (%) for the variety Brownsville at various plant densities during the 2000 growing season.

BROWNSVILLE											
	Yield (t/ha)										
	0-40mm	40-70mm	70-80mm	80-90mm	90-100mm	>100mm	40-90mm	>40mm	Market	Total	Doubles
Spacing											
60	1.19	31.08	19.76	14.22	5	0	65.05	70.07	71.26	71.26	0.00
80	0.78	21.96	17.17	18.71	9.1	0.65	57.84	67.64	68.42	68.42	0.00
100	0.32	15.77	15.76	17.27	14.1	2.34	48.79	65.18	65.5	65.92	0.42
120	0.25	7.68	13.81	17.34	21.3	3.24	38.84	63.41	63.66	63.66	0.00
140	0.18	6.65	8.66	12.12	17.8	2.28	27.43	47.49	47.66	49.74	2.08
160	0.38	5.86	6.64	10.63	25.2	4.8	23.13	53.16	53.54	53.85	0.32
LSD 5%	0.56	4.17	4.45	4.73	8.18	NS	7.31	7.2	7.06	6.96	1.19
	Percentage Bulbs										
	0-40mm	40-70mm	70-80mm	80-90mm	90-100mm	>100mm	40-90mm	>40mm	Doubles	Seed heads	Total Plant
Spacing											
60	7.1	53.2	22.4	13.4	3.9	0	89	92.9	0		246
80	4.9	43.4	22	21.1	8.2	0.5	86.4	95.1	0		213
100	3	32.5	23.1	23.9	15.1	2.2	79.5	96.8	0.3		171
120	1.7	17.6	22.4	28.4	26.9	3.1	68.4	98.4	0		147
140	1.7	20.4	19.7	24.6	27.9	2.6	64.7	97.8	3.1		112
160	4.9	18.6	12.7	20.4	37.5	5.5	51.7	94.7	0.4		120
LSD 5%	NS	8.5	NS	6.4	10	NS	11.8	9.9	1.7		

17. Recommendations

This project has highlighted the importance of cultivars developed for the Queensland growing environment in the development of a possible national mild onion industry. The majority of cultivars grown in Queensland are suitable for marketing as a mild onion. This will form the basis for the development of a mild onion industry, initially in Queensland, but with potential to be expanded nationally. It is recommended that this possibility be investigated as an alternative market for Queensland onions. This mild onion industry will also ensure the survival of the onion industry in Queensland.

The establishment of a national mild onion industry will be pursued in future projects both at a state and national level. In the light of this, and the already successful sweet onion industry established in the USA, it is recommended that strong links be established with the Vidalia Sweet Onion Committee, Georgia; the University of Georgia (Dr Bill Randle) and the Vegetable and Fruit Improvement Centre, Texas A&M University (Dr Leonard Pike).

Professor David Midmore (Masters Degree supervisor) has suggested that due to the extensive nature of the data collected in the growth study/development trials that consideration be given to upgrading the Masters Degree to a PhD. Initial thoughts to date have suggested that time and funding constraints will not make this possible as additional trial work may need to be undertaken. It is recommended that consideration be given to this suggestion and the possibilities of future project work be considered to achieve an upgrade.

Additional recommendations of this project include:

- Publication of population density results in Onions Australia or other refereed journal.
- Continued evaluation of mild onion germplasm for Queensland.
- Collection of market data to determine the size and potential of the mild onion industry at a state and national level.
- Thorough investigation into the sweet onion industry in the USA and other overseas countries with a view to determining the strategies needed to ensure the success of a mild onion industry in Australia.

18. Acknowledgements

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