



Limpopo cultivar trial under irrigation at Tom Burke in 2017

Jaco Nel (Producer), Albert Boneschans and Chantel du Raan (Potatoes South Africa)

The Limpopo production region produces about 20% of the South African potato crop which is the highest in the country. The region plants potatoes for the table and processing market under irrigation. Its contribution to the latter amounts to nearly 8% (highest of all the regions). The main cultivars earmarked for the table

market include Mondial, Valor and Sifra whereas the popular choices for processing are Hertha, Fianna, Markies and Innovator is. Trials were conducted at Tom Burke which is close to the Botswana border. Tom Burke is situated in a tropical summer rainfall area with an annual average rainfall of 371 mm (Figure 1).

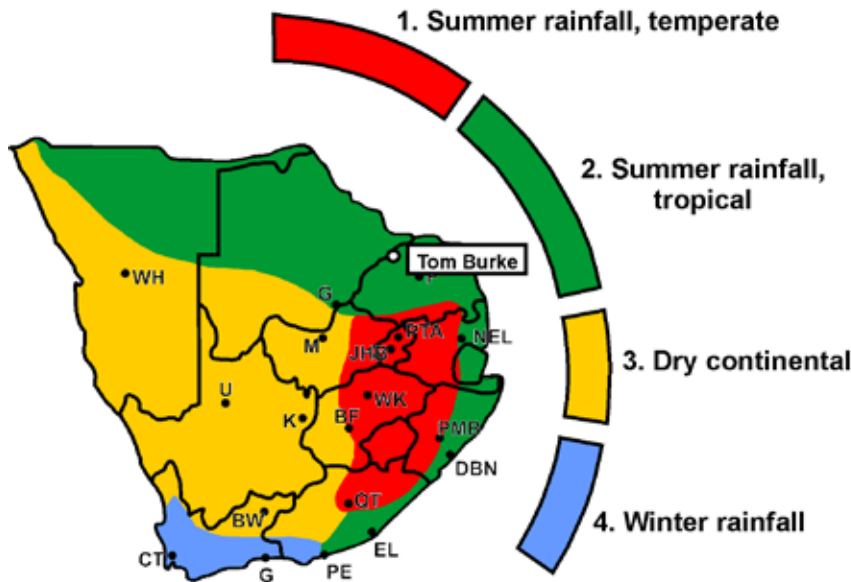


Figure 1: Location of Tom Burke in the Limpopo production region

Very hot summers occur, whereas the winters are cold with black frost regularly being experienced in June and July. One of the reasons why the region is able to make such a huge contribution to the industry is the fact that it has two production seasons, i.e. an early season that is planted from January to March and harvested from May to August as well as the main

season that is planted from April to September and harvested between September and April the following year. The trial site consisted of sandy loam soil and the trial was planted in a randomised block design with three replicates. Additional technical information regarding the trial site and lay-out is summarised in Table 1.

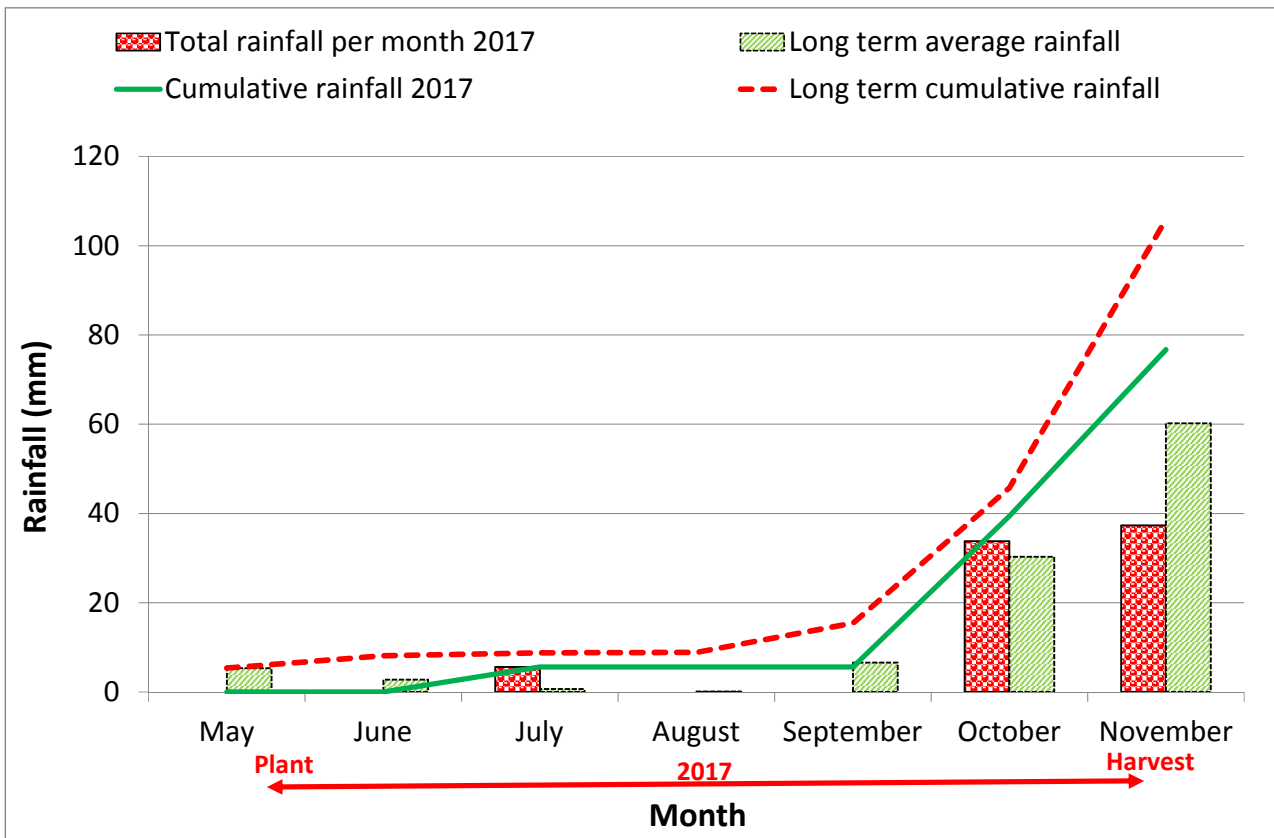


Figure 2: Rainfall during the growing season (2017) as well as the long term average rainfall.

Table 1: Summary of technical information regarding the trial site and lay-out.

| | | | |
|--------------------------------|---------------------------|--------------|--------------|
| Farm: | Ratho Boerdery | | |
| Farmer: | Mr Jaco Nel | | |
| Planting date: | 25 May 2017 | | |
| Harvesting date: | 1 November 2017 | | |
| Irrigation / Dryland: | Irrigation | | |
| Double or single rows: | Double rows | | |
| Foliage die-off: | Natural | | |
| In-between row spacing: | 0.75 m | | |
| In-row spacing: | 0.30 m | | |
| Trial site: | 15 m ² | | |
| Plant population: | 44 444 plants / hectare | | |
| Soil type: | Sandy loam | | |
| Fertiliser program: | | | |
| | Nutritional value: | | |
| | N (kg/ha) | P (kg/ha) | K (kg/ha) |
| Total | 301 | 142 | 106 |

It is important to note that growing periods can influence cultivar yields. Growing periods are defined as the number of days from emergence until natural foliage die-off, depending on the season. The exact timing of the five growth phases (sprouting, vegetative growth, tuber initiation, tuber bulking and maturity) depends on the area and the management practices that differ between localities as well as cultivars, inter alia, as a result of different growing periods (Table 2).

Yield and tuber size are also influenced by the number of haulms per area and thus by the number of seed potatoes planted as well as the number of haulms per seed potato. The number of haulms per seed potato depend on the number of eyes per tuber, the number of sprouts per eye and number of stems per sprout. The number of eyes per tuber are cultivar-dependent, whereas the number of haulms per tuber are influenced by the size and plant readiness of the seed potatoes. It is important to note that the eyes vary between cultivars. The cultivars, plant readiness of seed potatoes, stand (%) and haulm count of this trial are indicated in Table 2.

Temperature, photoperiod (day-length) and water are the most important abiotic factors that influence the growth pattern, yield and quality of potatoes. To determine the adaptability of new cultivars in the Tom Burke area, it is important to take these factors into account when the performance of the different cultivars is evaluated. It is also important that the cultivars are evaluated for a number of seasons as the climatic conditions differs from season to season. The daily weather data were obtained from the Hanover station on the trial site and the long term weather data from the

ARC's Swartwater station (-22.85186, 28.19898). The cumulative rainfall during the 2017 growing season was continuously lower than the long term average rainfall. The most rain was received during October and November (at the end of the bulking stage and skin set) compared to the long term data (Figure 2).

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The minimum and maximum temperatures (Figure 3) for the 2017 growing season followed the same pattern as in previous years with the exception that the maximum temperatures from May to August were lower

Table 2: Characteristics regarding growing period, plant readiness, stand (%) and haulm count for each cultivar in 2017.

| Cultivar | Growing period (Days) ¹ | | Plant readiness ² | Stand (%) | Haulms per plant | Haulms per hectare |
|------------|------------------------------------|-----------|------------------------------|-----------|------------------|--------------------|
| Allison | Medium to long | (120) | 2 | 100 | 4.8 | 213 331 |
| Almera | Short | (85) | 3 | 97 | 3.6 | 159 998 |
| Challenger | Medium | (110) | 3 | 100 | 3.4 | 151 110 |
| Fandango | Medium to long | (120) | 2 | 98 | 2.6 | 115 554 |
| Fianna | Medium to long | (120) | 3 | 100 | 4 | 177 776 |
| Georgina | Medium | (90-110) | 1 | 95 | 1.9 | 84 444 |
| Jelly | Medium to long | (120) | 1 | 79 | 3.7 | 164 443 |
| Joly | Medium | (100-110) | 1 | 100 | 2.9 | 128 888 |
| Labadia | Short to medium | (100) | 2 | 85 | 1.7 | 75 555 |
| Libertie | Medium | (90-110) | 2 | 45 | 2.5 | 111 110 |
| Markies | Medium | (110) | 1 | 97 | 1.5 | 66 666 |
| Mondeo | Medium | (90-110) | 2 | 100 | 5.5 | 244 442 |
| Mondial | Short to medium | (95-100) | 1 | 98 | 3.4 | 151 110 |
| Panamera | Short to medium | (95-100) | 2 | 88 | 2.3 | 102 221 |
| Rumba | Medium | (90-110) | 2 | 94 | 3.8 | 168 887 |
| Sifra | Short to medium | (90-100) | 2 | 91 | 3 | 133 332 |
| Valor | Medium | (100-110) | 3 | 97 | 2.8 | 124 443 |

¹ General guidelines and categories (days from emergence to natural foliage die-back, depending on the season):

Short = 70-90 days; Short to Medium = 80-100 days; Medium = 90-110 days;

Medium to Long = 90-120 days; Long = 90-140 days.

² Plant readiness of seed tubers: 1 – Fresh; 2 – Slightly fresh; 3 – Plant ready; 4 – slightly old; 5 – Old.



whereas the minimum temperatures were slightly higher compared to the long term data. Towards the end of the growing season (last two months) both the minimum and maximum temperatures varied significantly and were between 35-40 °C for a number of days. When the temperature rises above 29 °C, little or even no tuber initiation or tuber growth will occur as the carbohydrates are used for respiration. This year no frost damage was experienced during the growing season.

Heat units is another important factor to take into account because the development of the plant is primarily dependent on the accumulation of heat units. It is, therefore, accepted that the plant must accumulate a certain number of heat units to complete a development phase. The heat units for the 2017 growing season followed about the same pattern as the long term average heat units and are indicated in Figure 4. At the end of the season the long term data's cumulative heat units were 6% higher than the cumulative heat units of the relevant year's growing season.

The yield data was statistically processed using the GenStat® program and the means were separated

by making use of the Tukey LSD test. The cultivar effect in respect of the 2017 trial (Figure 5) was statistically highly significant in respect of yield ($p < 0.01$), whilst the coefficient of variation was very low (8.3%). This indicates that the trial was well executed and that the results are trustworthy. The trial average of all the cultivars is taken as 100%. The yield of the individual cultivars is then divided by the trial average and the yield performance of each cultivar is expressed as a percentage of the trial average (yield index).

The average yield (54.2 t/ha) for the 2017 season was 9.2.t/ha lower compared to the trial averages of the previous two years (59.4 t/ha). In respect of the 2017 trial (Figure 5) the cultivars Valor, Mondeo, Fandango, Panamera, Allison and Mondial attained the highest yields, whereas Sifra and Libertie delivered the poorest yields. Libertie's poor performance can probably be ascribed to a stand of 45%. Higher yields than the trial average (54.2 t/ha) were attained by the cultivars Valor, Mondeo, Fandango, Panamera, Allison, Mondial, Rumba, Joly, Fianna and Georgina.

In order to determine the performance of the cultivars in terms of yield and quality, the yield, size group distribution and class were used to calculate

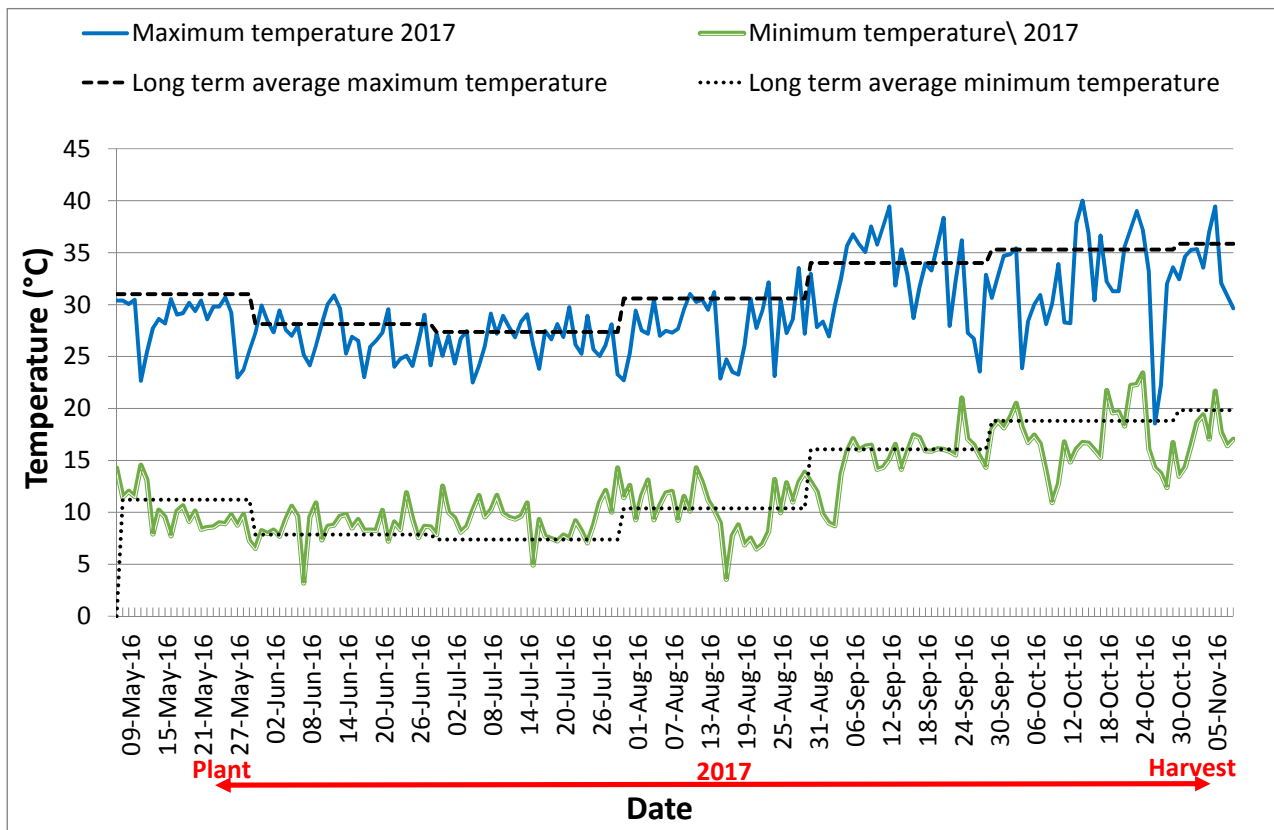
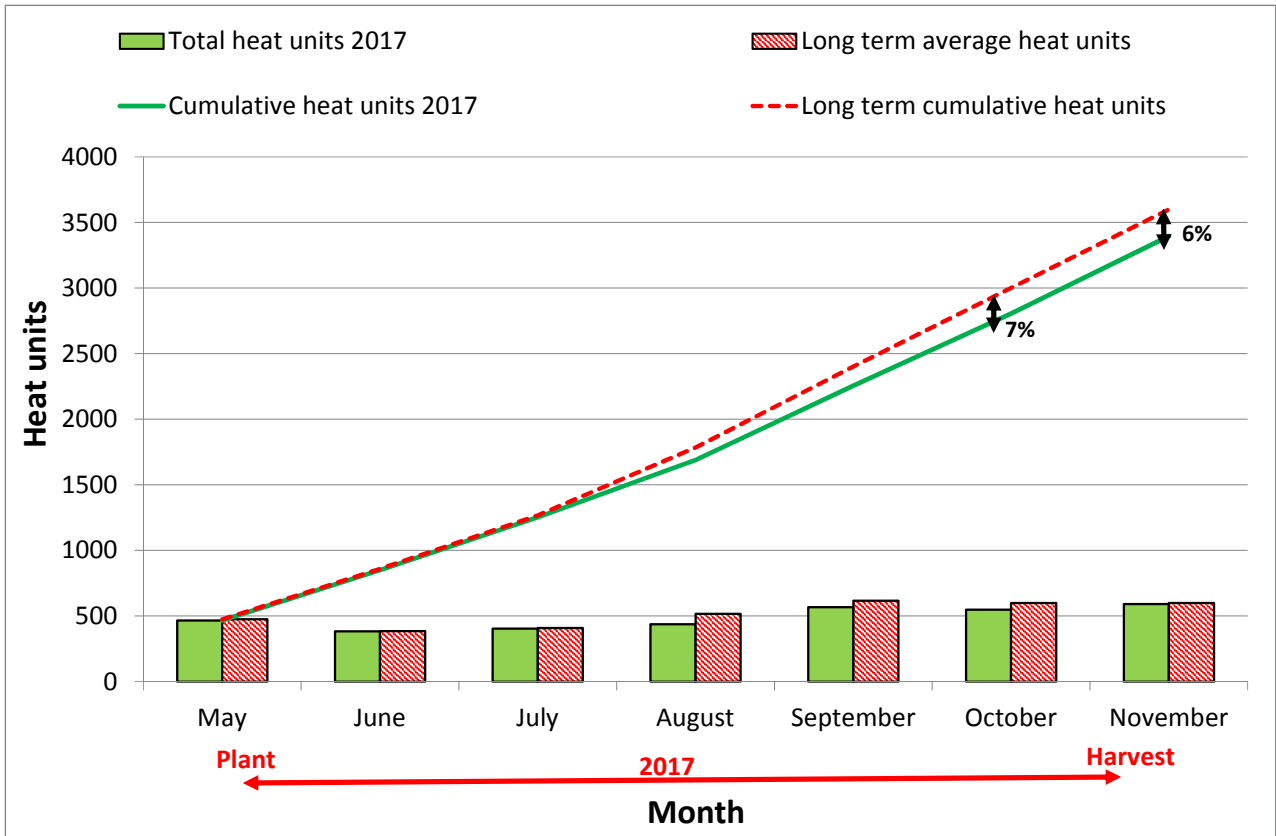
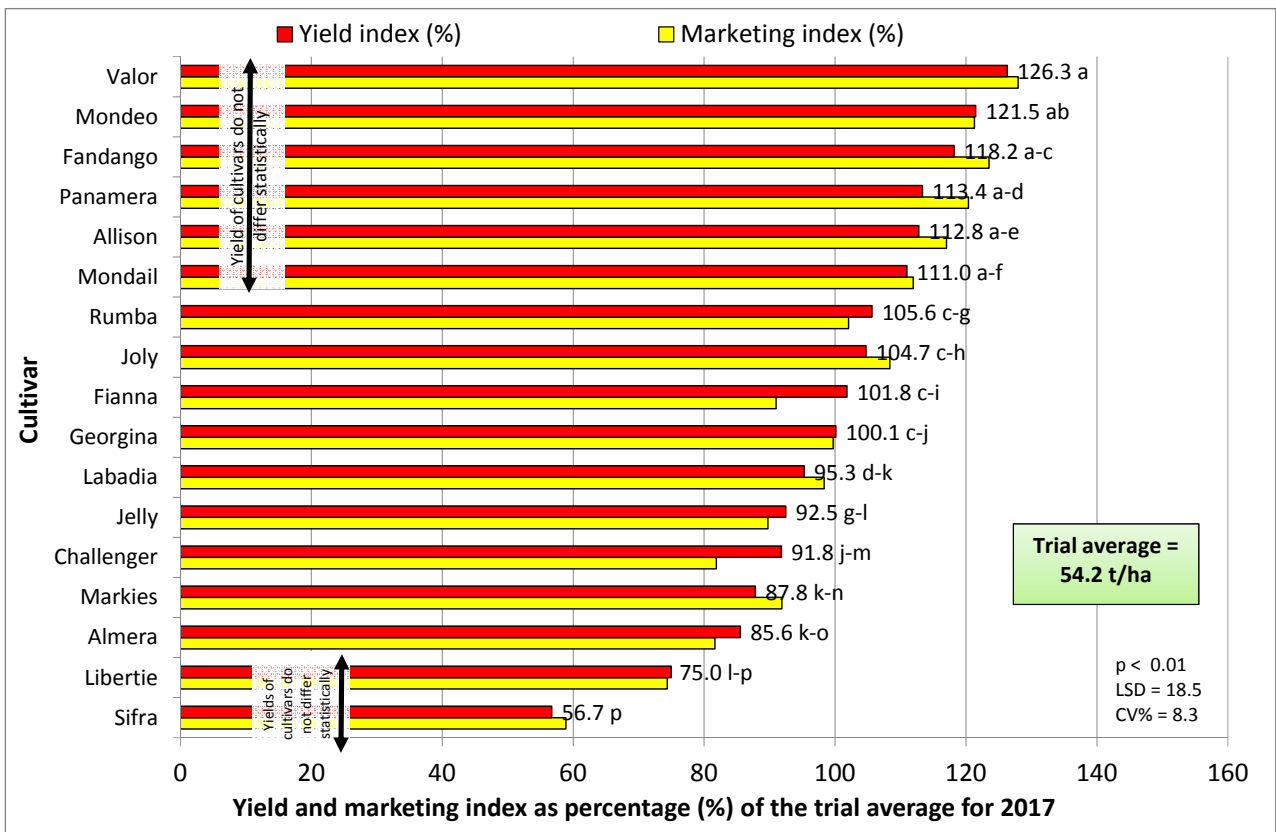


Figure 3: Minimum and maximum temperatures (°C) during the growing season (2017) as well as long term.



*Total heat units specifically determined for potatoes (threshold temperature = 5°C) as a crop [calculated from hourly data].

Figure 4: Heat units during the growing season (2017) as well as long term average.



*Values followed by the same letter do not significantly differ from one another.

Figure 5: Total yield index and marketing index per cultivar as percentage of the trial average.

a marketing index based on the average market prices for the specific day. The yield multiplied by the current price, which is determined by the size group distribution and the grading, gives the marketing index (Figure 5). Valor, followed by Mondeo, attained the highest marketing index, which can be ascribed to high yield and a high percentage large potatoes delivered by the cultivar (Figure 7). It is conspicuous that Fianna has a lower marketing index as a result of the lowest percentage large potatoes (Figure 7). However it was Sifra and Libertie that reflected the lowest marketing index because the cultivars delivered the lowest yields. As the size group distribution and grading are also of the factors used to class potatoes, they are important factors to take into account in order to ensure an optimal economically marketable yield. In Figure 7 the size group distribution is indicated, in Figure 8 the grading of the yields and in Table 3 the main reasons for downgrading the different cultivars.

The LINTUL-POTATO-DSS plant growth model was used to calculate the potential potato yields which is defined as the theoretical top yield limit in a situation where water, nutrients and biological factors are at an optimum for the season during the trial's growing season. This allows us to evaluate how the actual yield attained in the yield compares with simulated potential

yields. The control cultivar, Mondial, was used to determine the potential potato yield of 74.4 t/ha, as influenced by the specific area's environmental factors (soil type, climate, planting and harvesting date, etc.). The difference between the potential and actual trial yield refers to the yield gap. It illustrates to what extent producers optimally utilise their environment and available resources to attain high yields. The ratio between the actual:potential yield rate reached 73% which represents a small yield gap. This indicates that the available environmental factors are being utilised efficiently. There are thus minimal opportunity for further yield increases.

The potential yield of the Tom Burke 2017 trial is significantly lower than for the other production areas. This can to an extent be explained by studying the day-length. The trial (situated on the 20 degree of latitude) was planted and harvested in a period when the day-length varied between 10.8 and 11.7 hours (Figure 6). At the beginning of the season the shorter days stimulated tuber initiation whilst the vegetative stage was influenced negatively. The short photoperiods causes a shorter growing season and therefore less time for vegetative growth, which result in less photosynthesis and lower yields.

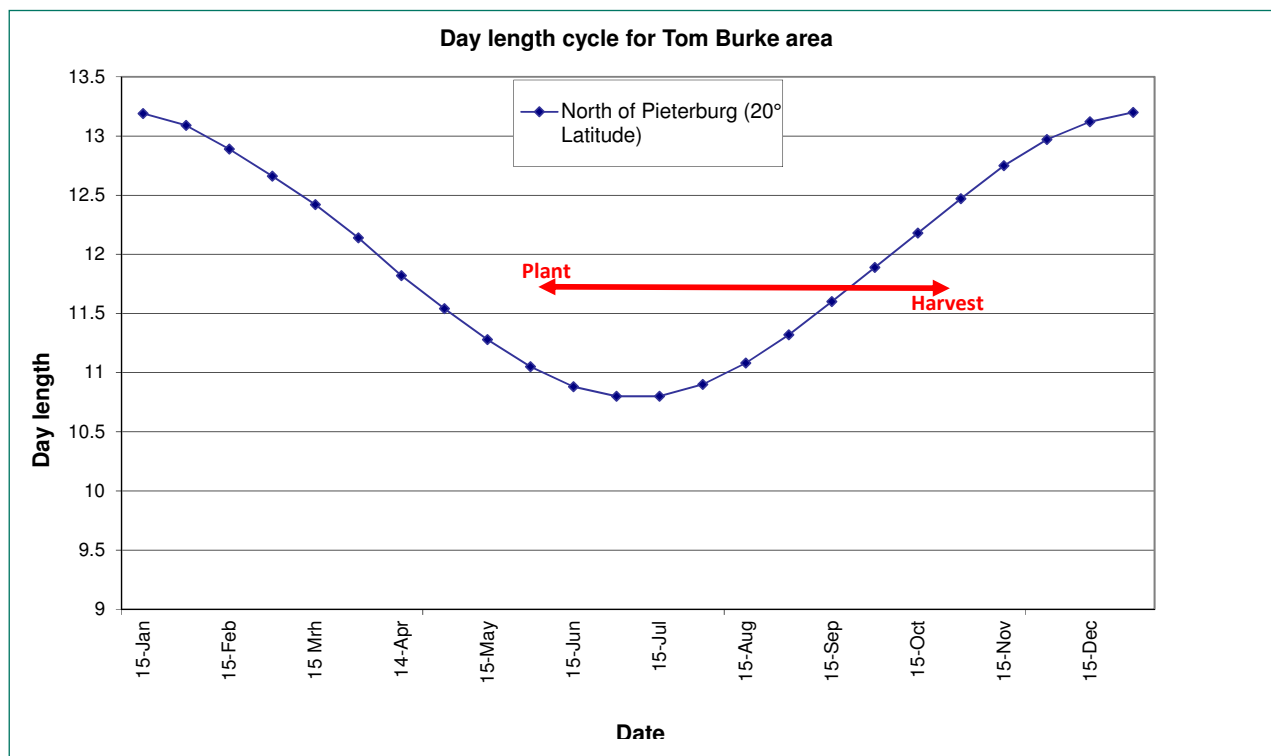


Figure 6. Day length during each month for the Tom Burke area situation on the 20 degree of latitude.

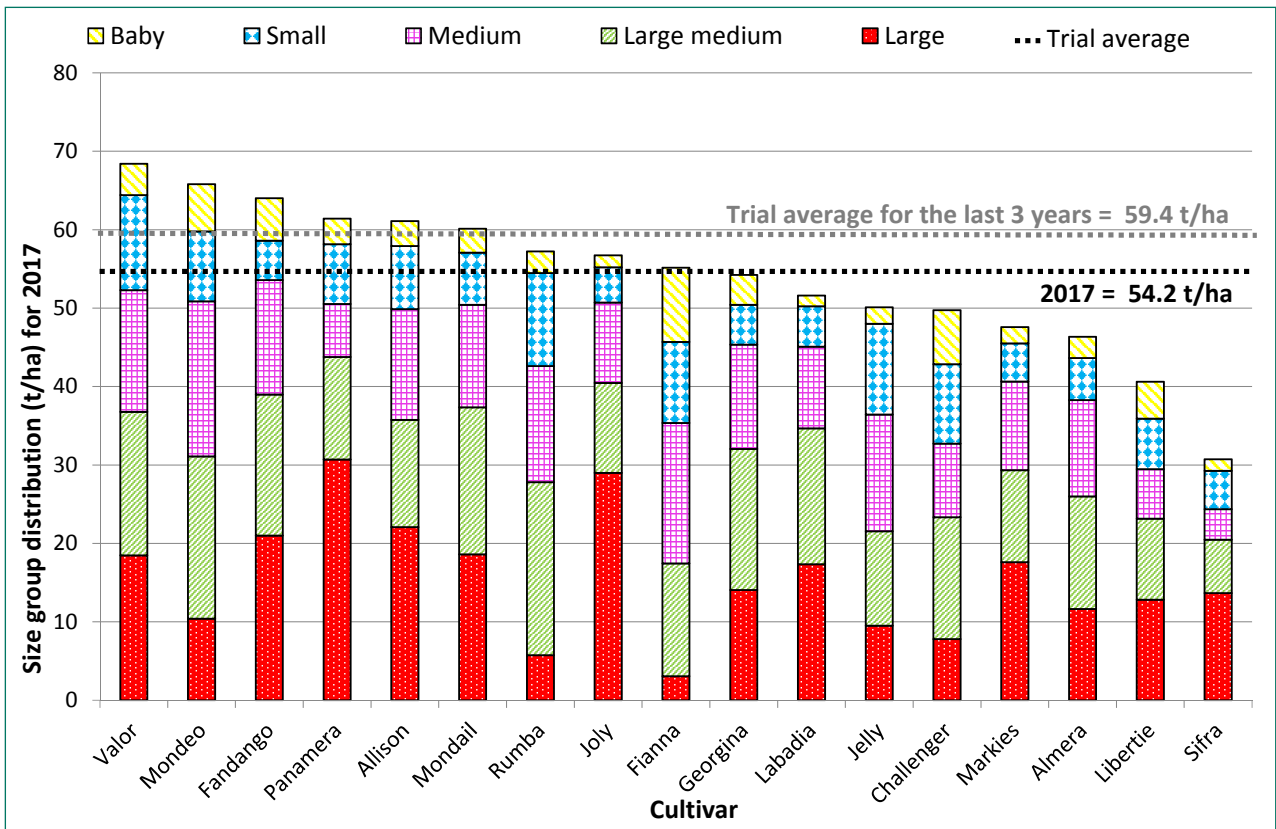


Figure 7. Size group distribution of each cultivar during final harvesting.

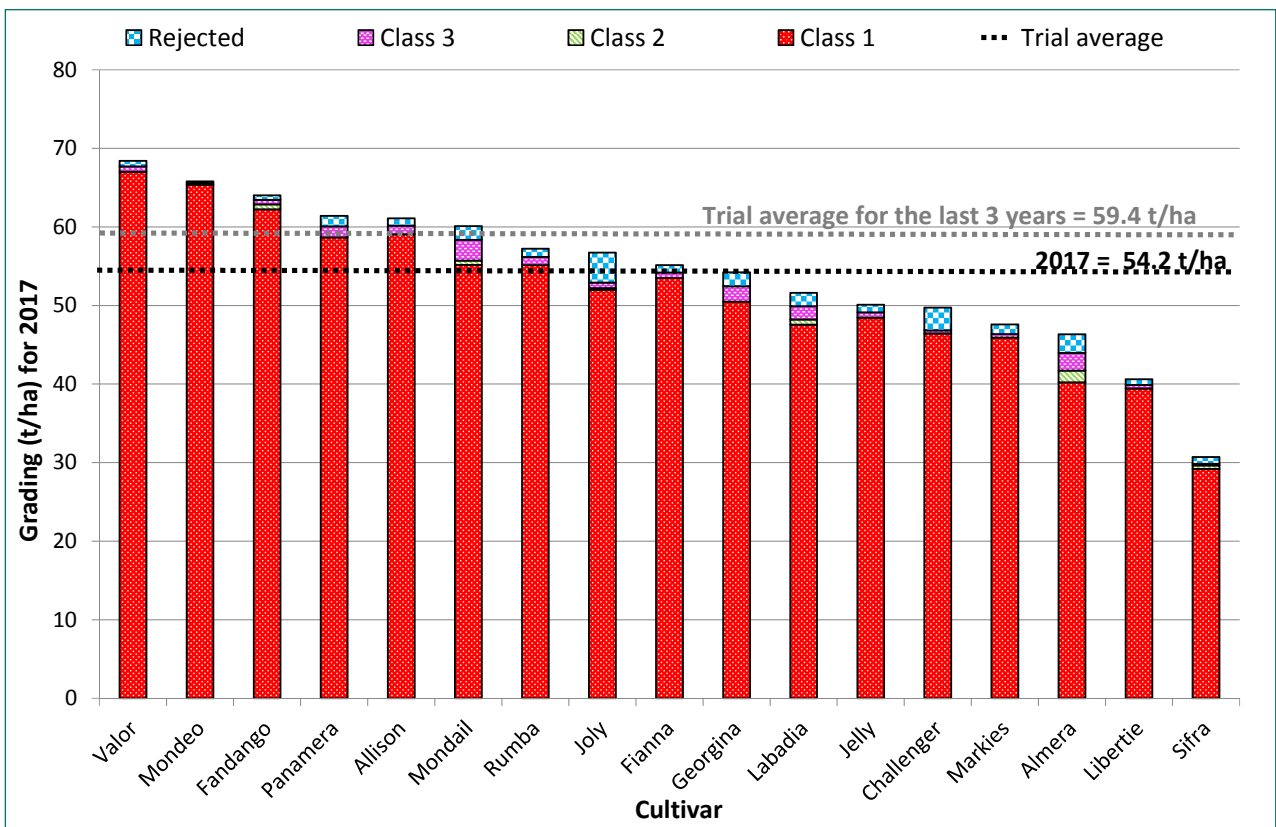


Figure 8. Grading of each cultivar during final harvesting.

Table 3: Main reasons for down-grading during the 2017 Tom Burke harvesting.

| Cultivar | Main reasons for down-grading | | | | | | | | | | |
|------------|-------------------------------|---------------|------------------|------------|-------------------|-------------|--------------|-----------|--------------|----------|----------|
| | Regrowth | Insect damage | Enlarged lentils | Loose skin | Mechanical damage | Moth damage | Malformation | Tip decay | Stem-end rot | Greening | Decay |
| Allison | X | | | | | X | | | | X | X |
| Almera | | X | | | | X | | | | X (High) | X |
| Challenger | X | | | | | X | X | X | | | X |
| Fandango | X | X | | | | X | | | X | | |
| Fianna | | X | | | | X | | | | | X |
| Georgina | X | X | | | X | X | | | | | |
| Jelly | | X | | | | X | X | | | | |
| Joly | | | | X | X | X | | | | | X (High) |
| Labadia | X | | | | X | X | | | | | X |
| Libertie | | | | | | X | X | | | | X |
| Markies | X | X | | | | X | | | | X | |
| Mondeo | | | | | | X | | X | | | |
| Mondial | | | | | | X | | X | X | | X |
| Panamera | | | | | X | X | | | | | X |
| Rumba | | | | | | X (High) | | | | X | X |
| Sifra | X | | | | | X | | | | | X |
| Valor | | X | | | X | X | | | | | X |

The extensive moth damage that occurred on all the cultivars was significant. It can possibly be ascribed by the fact that the trial remained in the soil for a long period after foliage die-off. The longer the potatoes are left in the soil, the higher the risk of infestation. Problems were also experienced with the irrigation during the growing season that could have caused cracks, even microscopically small, that provided access for the larvae.

It is important to take note of the cultivars' ability to perform consistently, notwithstanding climatic fluctuations over time. In Figure 9 the three year data for the cultivar trials in the Tom Burke production area is given. It would seem that the cultivars Labadia,

Panamera and Mondeo showed the least variation for the Tom Burke production area.

It is furthermore important to focus on the internal quality of the product to ensure an optimum economically marketable yield and thus profitability. This includes important factors such as cooking and processing characteristics, specific gravity (SG) and internal defects (hollow heart, brown fleck and vascular bundle discoloration) that are summarized in Table 4. During the 2017 growing season all the cultivars except for Allison, Mondeo and Valor complied with the chip colour norm of >50. As far as specific gravity (SG) is concerned, the cultivars Challenger, Fianna, Labadia, Markies, Mondial,

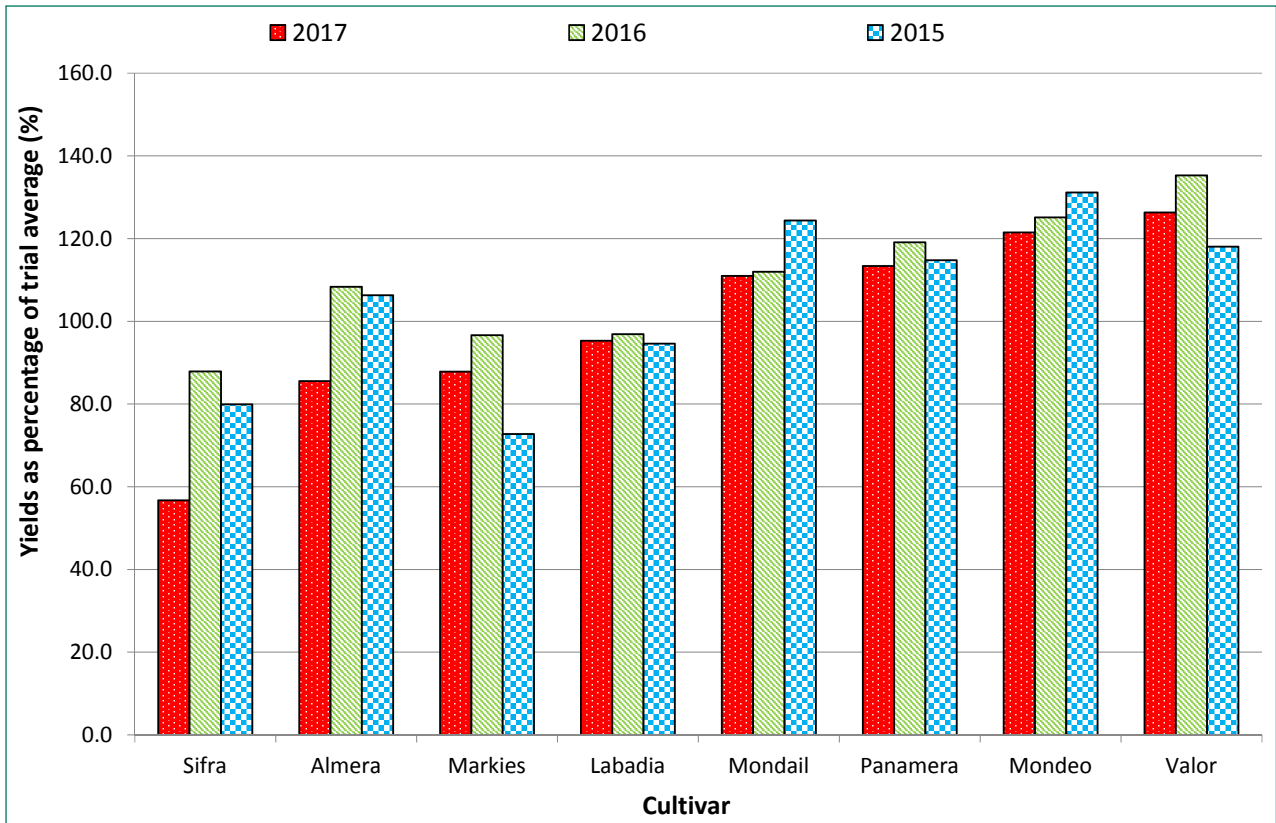


Figure 9. Performance of cultivars over three years as percentage of the trial average.

Panamera, Rumba en Sifra complied with the norm of ≥ 1.075 for processing. In the case of internal defects the cultivars Challenger, Fandango, Labadia and Sifra

showed 20% hollow heart and the cultivars Allison and Libertie had 80% brown fleck (Figure 10). ©



Table 4. Cooking and processing characteristics and internal quality of the yields for 2017 (Conducted by ARC Roodeplaat).

| Cultivar | Flesh colour | Chip colour ¹ | SG ² | Dry matter (%) ³ | Hollow heart (%) | Brown fleck (%) |
|------------|--------------|--------------------------|-----------------|-----------------------------|------------------|-----------------|
| Allison | Cream | 46 | 1.071 | 18.3 | 0 | 80 |
| Almera | Cream | 60 | 1.061 | 16.2 | 0 | 0 |
| Challenger | Light yellow | 52 | 1.079 | 20.0 | 20 | 0 |
| Fandango | Cream | 55 | 1.069 | 17.9 | 20 | 0 |
| Fianna | White | 59 | 1.090 | 22.3 | 0 | 0 |
| Georgina | Dark yellow | 52 | 1.066 | 17.2 | 0 | 0 |
| Jelly | Yellow | 52 | 1.069 | 17.9 | 0 | 0 |
| Joly | White | 53 | 1.068 | 17.6 | 0 | 0 |
| Labadia | Cream | 55 | 1.076 | 19.4 | 20 | 0 |
| Libertie | White | 53 | 1.068 | 17.7 | 0 | 80 |
| Markies | Yellow | 58 | 1.081 | 20.4 | 0 | 0 |
| Mondeo | Cream | 45 | 1.068 | 17.6 | 0 | 0 |
| Mondial | Cream | 55 | 1.076 | 19.3 | 0 | 0 |
| Panamera | Light yellow | 52 | 1.076 | 19.3 | 0 | 0 |
| Rumba | Yellow | 56 | 1.090 | 22.4 | 0 | 0 |
| Sifra | Cream | 56 | 1.078 | 19.7 | 20 | 0 |
| Valor | Cream | 47 | 1.071 | 18.2 | 0 | 0 |


¹Chip colour with a value of >50 and without defects is acceptable for the crisp industry.

²Specific gravity of >1.075 is acceptable for the processing industry.

³The percentage dry matter is a calculated value:

$$DM\% = 24.182 + 211.04 * (SG - 1.0988)$$

The actual percentage value will differ slightly between varieties based on this calculating value.

 ≥ Norm (Acceptable for processing)


 < Norm (Unacceptable for processing)



Figure 10: Flesh colour and internal quality of yields 2017 at Tom Burke

