North Eastern Cape cultivar trial under irrigation at Ugie in 2018/2019

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The North Eastern Cape production region produces about 3% (based on the 2016 crop year) of the total potato production in South Africa. The region primarily supplies potatoes to the table market. However, a small quantity of seed potatoes are also produced in the region. The main cultivars for seed potatoes production as well as for the table and processing markets are Mondial, Sifra and Fabula. The trial was conducted in the Ugie area. Ugie receives a lot of rain, even in the driest month. It is a summer rainfall area (Figure 1) with an annual average rainfall of between 693 and 751 mm. Warm moderate summers occur whereas the winters are quite cold. The planting time for the production area is from August to January. The yield for that time of the year is not very high, but marketing opportunities are normally better towards the end of the year because of less competition from the Free State regions. The trial site consisted of a loamy soil and was planted in a randomised block design with three replicates. Additional technical information regarding the trial site and lay-out.

Representative soil samples were taken and analysed prior to planting to determine the soil nutritional status

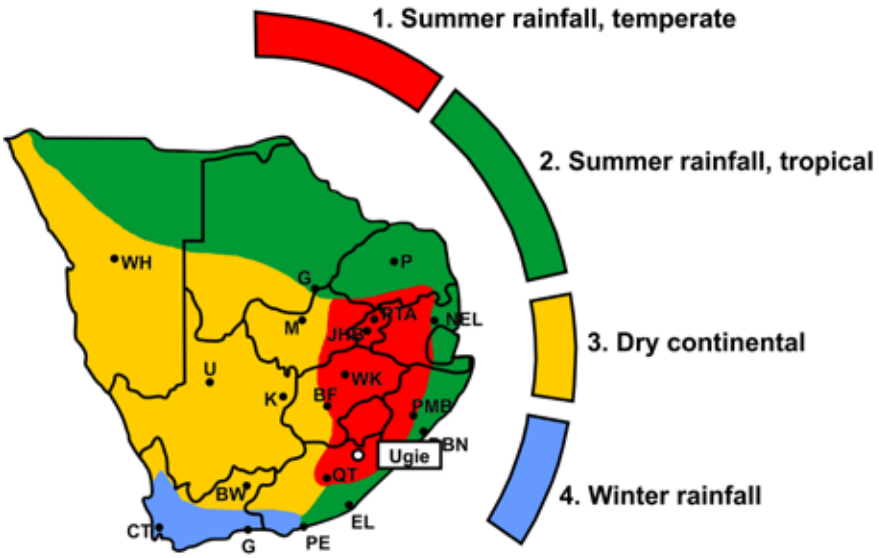


Figure 1: Location of Ugie in the North Eastern Cape production region

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

Farm:	Montgomary
Farmer:	Mr Fanie Vorster
Planting date:	13 September 2018
Harvesting date:	27 February 2019
Irrigation / Dryland:	Irrigation
Double or single rows:	Double rows
Foliage die-off:	Natural
In-between row spacing:	0.9 m
Trial site per unit:	18 m^2
Plant population:	44 444 plants/ha

of the trial site. The results of the soil analysis as well as the fertiliser program are indicated in Table 2. The trial was planted in relatively acidic soil with a pH (KCl) of 4.2. Fertiliser was applied in the form of 800 kg 4:3:5 (34) per hectare at the beginning of the season. It is conspicuous that the nitrogen applied in the fertiliser program was significantly less than was it normally recommended. The reason for this is that during the growth season, early in December (7 December: during the tuber bulking stage), the water source dried-up which meant that no irrigation, and therefore no top fertiliser, could be applied.

It is important to note that growth periods can influence cultivar yields. Growth 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 environment and the management practices that differ between localities as well as cultivars, inter alia, as a result of different growing periods. The cultivars, plant readiness of seed potatoes, stand (%) and haulm count of the trial are indicated in Table 3.

Temperature, photoperiod (day-length) and water are the most important abiotic factors that influence the growth pattern, yield and quality of potatoes. To

Table 2: Soil analysis results and fertiliser program for the Ugie cultivar trial (2018/2019) prior to planting.

pH (KCl)	P-Bray	Ammonium acetate				% of CEC[1]			
	P	K	Ca	Mg	Na	K	Ca	Mg	Na
	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	%	%	%	%
4.2	38.3	109.2	298.7	48.6	15.8	11.54	61.53	16.69	2.83

[1] *CEC = Cation Exchange Capacity*

Fertiliser program:			
	Nutritional value:		
	N (kg/ha)	P (kg/ha)	K (kg/ha)
Total	270	154	130

Table 3: Characteristics regarding growth period, plant readiness, stand (%) and haulm count for each cultivar in 2018/2019.

Cultivar	Growth period (Days)[1]		Plant readiness[2]	Stand (%)	Haulms per plant	Haulms per hectare
Alverstone Russet	Medium to long	(110-115)	3	100	6.3	279 997
Bikini	-	-	2	100	4	177 776
Challenger	Medium	(110)	3	100	5.5	244 442
Fandango	Medium to long	(120)	3	100	6.1	271 108
Georgina	Medium	(90-110)	3	100	5.8	257 775
Jelly	Medium to long	(120)	3	100	4.2	186 665
Lanorma	Short	(80-90)	3	100	3.8	168 887
Mondial	Short to medium	(95-100)	3	100	4.5	199 998
Panamera	Short to medium	(95-100)	3	100	2.8	124 443
Rumba	Medium	(90-110)	4	100	4.2	186 665
Sifra	Short to medium	(90-100)	2	100	4.2	186 665
Taisiya	Short to medium	(100)	3	100	4.6	204 442
Tyson	Short to medium	(90-100)	3	100	4	177 776
Valor	Medium	(100-110)	3	100	4.9	217 776

[1] *General guidelines and categories (days from emergence to natural foliage die-off, depending on the season): Short = 70-90 days; Short to Medium = 80-100 days; Medium = 90-110 days; Medium to Long = 90-120; Long = 90-140 days.*

[2] *Plant readiness of seed potatoes: 1 – Fresh; 2 – Slightly fresh; 3 – Plant ready; 4 – Slightly old; 5 – Old.*

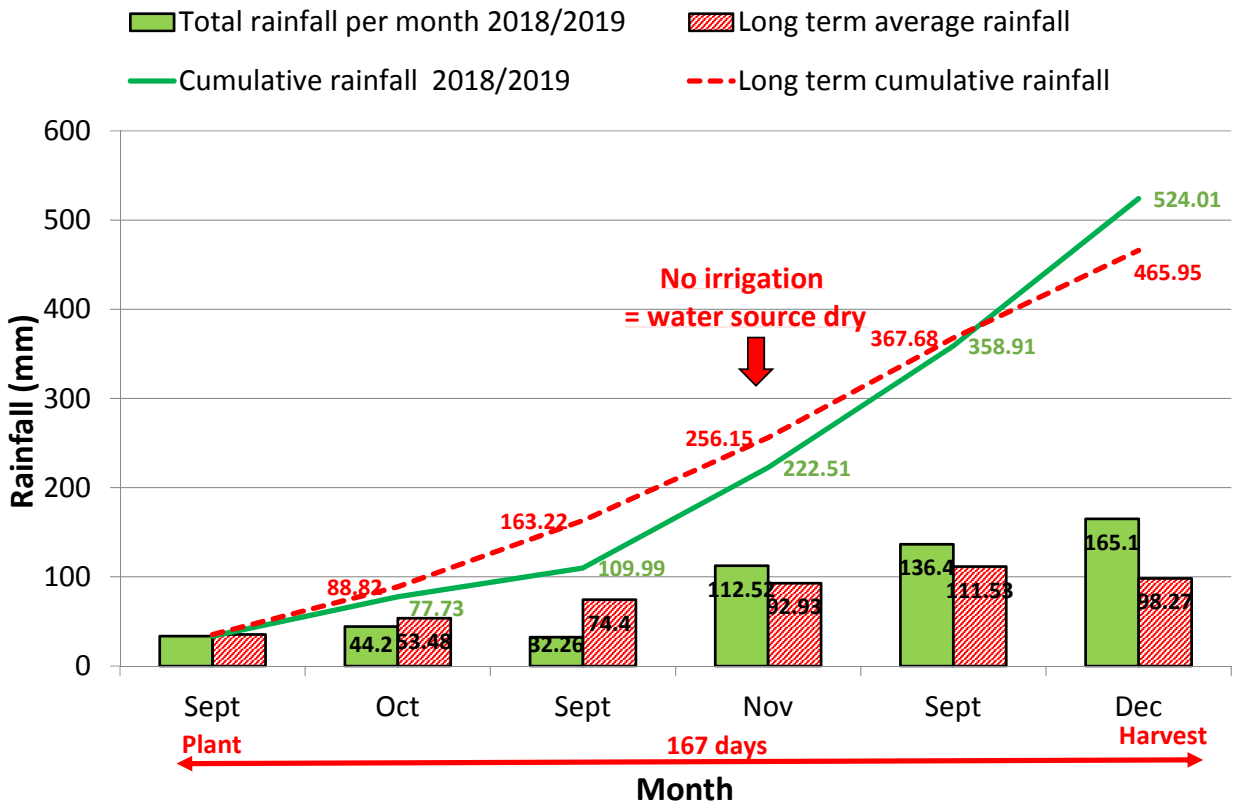


Figure 2: Rainfall during the growth season (2018/2019) as well as the long term average rainfall.

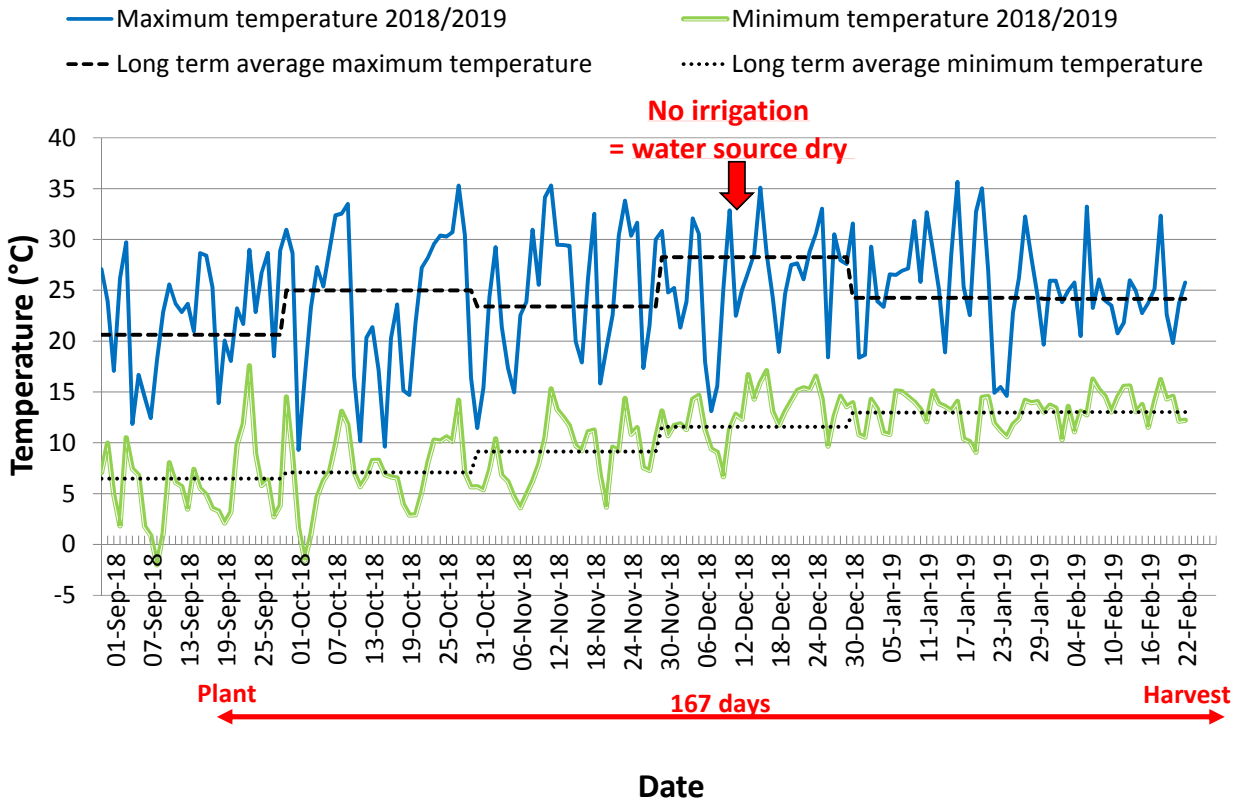
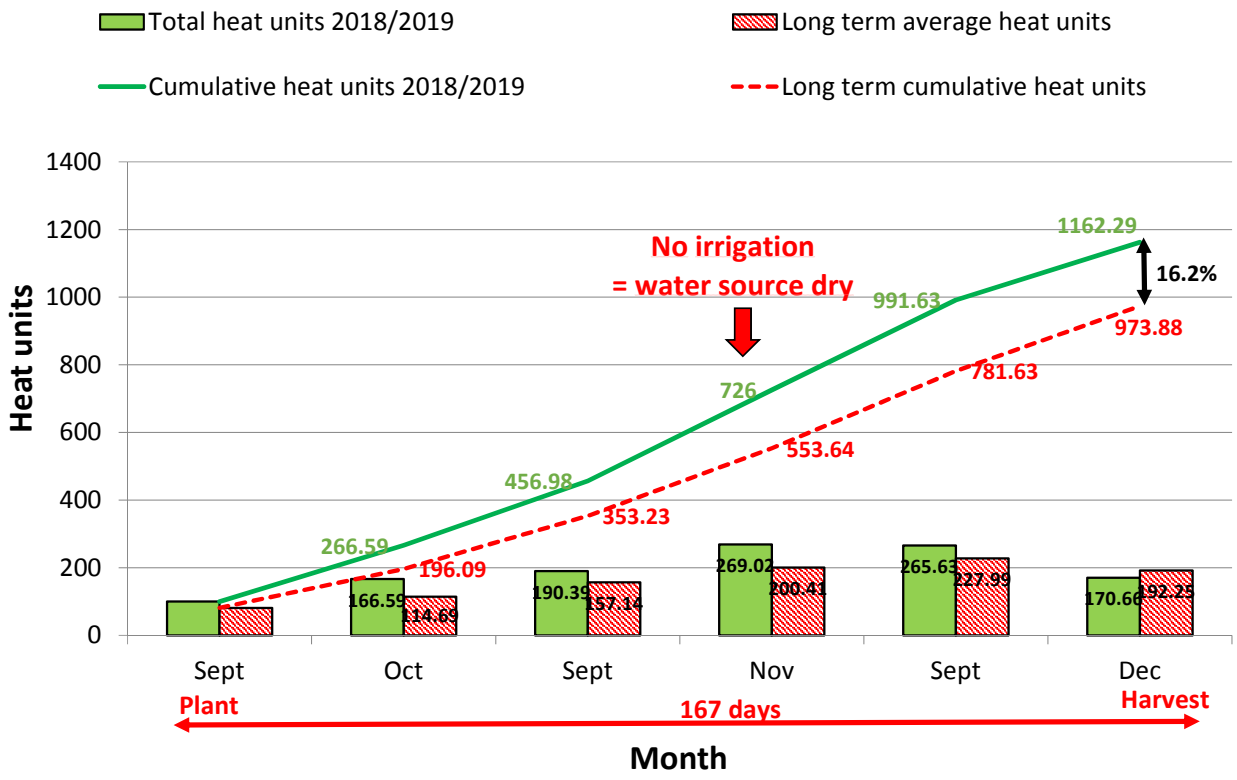


Figure 3: Minimum and maximum temperatures (°C) during the growth season (2018/2019) as well as long term.



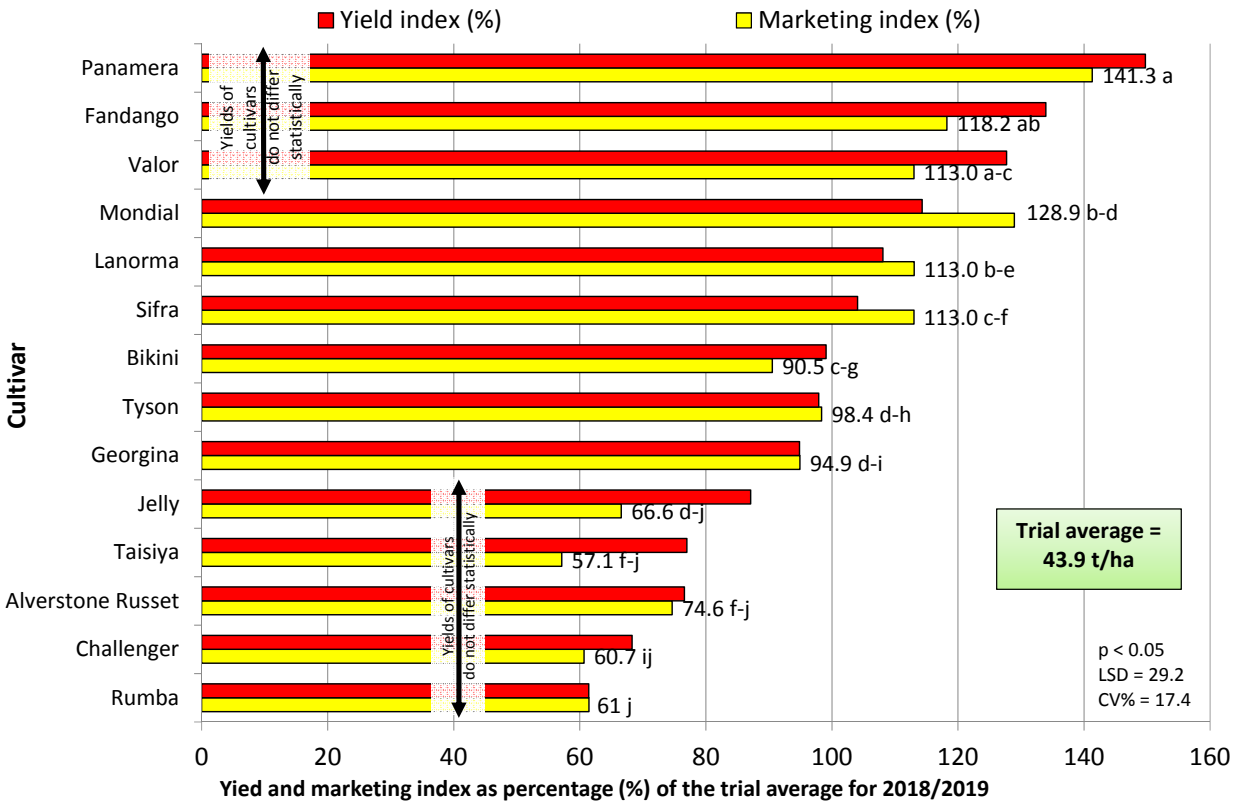
**Total heat units specifically determined for potatoes (threshold temperature = 5°C) as a crop [calculated from hourly data].*
Figure 4: Heat units during the growing season (2018/2019) as well as long term average.

determine the adaptability of new cultivars in the Ugie 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 differ from season to season. The daily and long term weather data were obtained from the ARC's Maclear : Waterbron stasion (-31.05693, 28.36807).

During the first three months (September to November) of the 2018/2019 growing season the area received significantly less rain compared to the long term average (Figure 2). However, from December to February more rain fell compared to previous years. From date of planting until harvesting date (128 days) it cumulatively rain 524.01 mm in comparison with the normal long term pattern of about 465.95 mm.

The minimum and maximum temperatures (Figure 3) for the 2018/2019 growing season followed the same pattern as in previous years. Typical to the area's climate, the maximum temperatures varied from 10°C up to 35°C. Early in the season the minimum temperature dropped to below 0°C. During the growth season both the minimum and maximum temperatures varied significantly and were between 30-35°C for a number of days. When the temperature rises above 29°C, very little or even no tuber growth will occur because the carbohydrates are used for respiration. The number of days the plants experienced temperatures above 29°C were in total 35 during the course of the season. The minimum temperature was also slightly higher compared with previous years during September to December.

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 cumulative heat units for the 2018/2019 growing season were continuously slightly higher compared to the long term data. This can be ascribed to the fact that from September up until January the heat units were slightly higher compared to previous years (Figure 4). At the end of



**Values followed by the same letter do not significantly differ from one another.*
Figure 5. Total yield and marketing index per cultivar as percentage of the trial average.

the season the long term data's cumulative heat units were 16.2% lower than the cumulative heat units for relevant year's growth 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 2018/2019 trial (Figure 5) was statistically significant in respect of yield ($p<0.05$), whilst the coefficient of variation was acceptable (17.4%). 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 yields of the individual cultivars are 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 (43.9 t/ha) for the 2018/2019 growth season was 8.5 t/ha lower compared to the trial average of the previous two years (52.4 t/ha). The famers attained about the same yield in his commercial plantings. The reason for the lower yield can possibly be ascribed to the fact that the irrigation water (dam) dried-up in the middle of the growth season together with extreme temperatures. However, there is an interesting observation when the current year's results are compared with that of the previous year. Notwithstanding the fact that it rain only 267 mm last year, a yield of 87.9t/ha was still attained under irrigation. During the trial year it rained 524 mm, but as a result of the water source (dam) that dried-up in the middle of the season, the yield was only 43.9 t/ha, which is about half compared to the previous year. In respect of the 2018/2019 trial (Figure 5) the cultivars Panamera, Fandango and Valor attained the highest yields. Higher yields than the trial average (43.9 t/ha) were attained by the cultivars Panamera, Fandango, Valor, Mondial, Lanorma and Sifra.

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 a marketing index based on the average market prices for the specific day. The yield multiplied by the

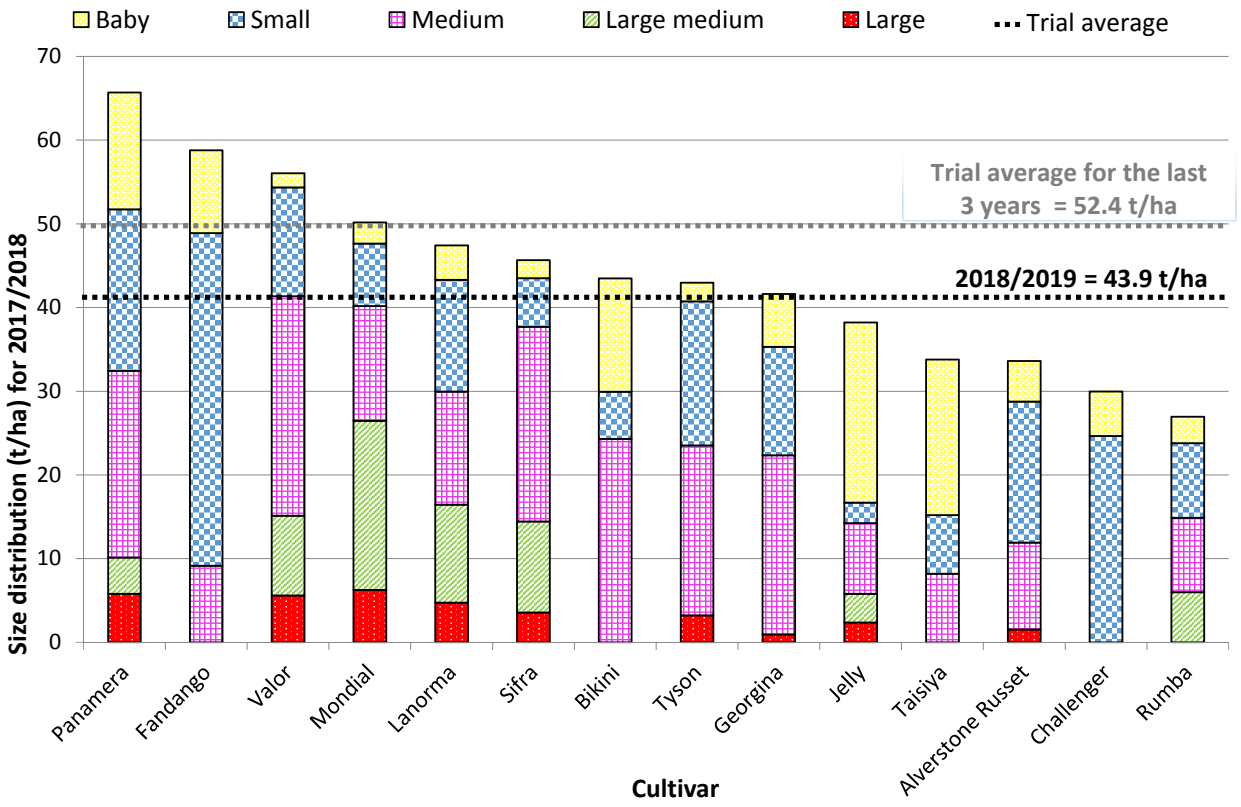


Figure 6. Size group distribution of each cultivar.

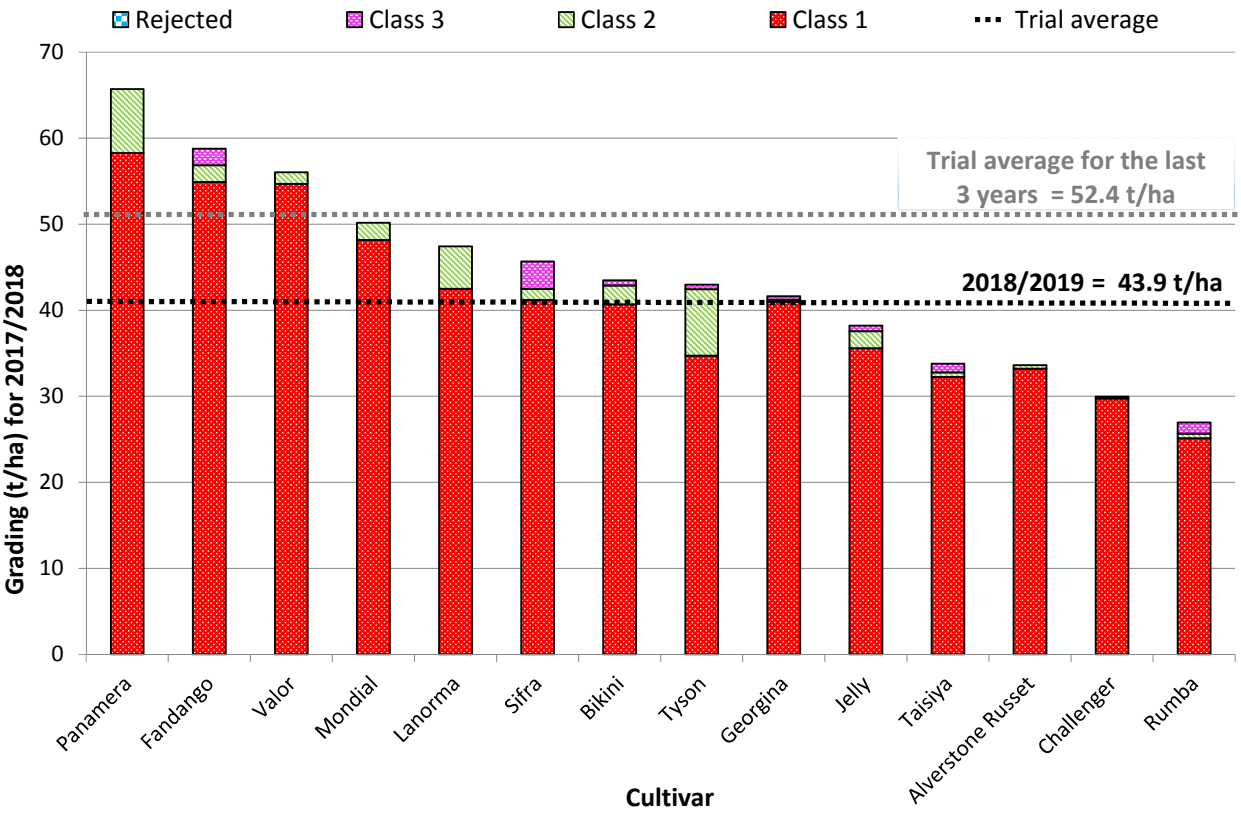


Figure 7. Grading of each cultivar.

Table 4: Main reasons for down-marking during the 2018/2019 Ugie harvest.

Cultivar	Malformation	Common scab	Nutsedge	Moth	Eelworm	Insect damage	Abraded	Greening
Alverstone Russet				X				
Bikini	X					X		
Challenger					X			
Fandango	X			X				
Georgina		X				X		
Jelly							X	X
Lanorma	X							
Mondial	X							
Panamera	X							
Rumba		X	X					
Sifra	X	X						
Taisiya	X					X		
Tyson	X							
Valor			X					

current price, which is determined by the size group distribution and the grading, gives the marketing index (Figure 5). Panamera attained the highest marketing index, which can be ascribed to a high yield, a high percentage large size group distribution (Figure 6) and class 1 (Figure 7) delivered by the cultivar. Although Mondial did not attain the highest yield, it reflected the second highest marketing index as a result of a high percentage large and large-medium size group distribution and class 1. Panamera and Modial had no class 3 and reject potatoes. Taisiya reflected the lowest marketing index, primarily because the cultivar had a low yield combined with no large tubers and a high percentage class 2 and 3 grading. As size group distribution and grading are also used to class potatoes, they are important factors to take into account in order to ensure an optimum economically marketable yield. In Figure 6 the size group distribution are indicated, in Figure 7 the grading of the yields and in Table 4 die main reasons for down-marking of the respective cultivars.

The LINTUL-POTATO-DSS plant growth model was used to determine the potential yield of the control cultivar, Mondial. Potential yield is defined as the theoretical upper yield limit in a situation where water, nutrients and biological factors are optimal for the season in which the trial had grown. The information allows us to evaluate how the actual trial yield attained compares with simulated potential yields. The difference between the potential and actual trial yield refers to the yield gap. It illustrates how optimal producers make use of their environment and available resources to attain high yields. The ratio between actual yield (43.9 t/ha) and potential yield (125 t/ha) is 35% as a result of extremely dry conditions during the first part of the season.

A significantly high number of malformed tubers were found because of secondary growth. Secondary growth symptoms appear on tubers when the optimum conditions under which they are formed and developed, are interrupted by for example heat, drought and nutritional shortages which lead to a tuber growth stoppage. When the stress condition ends, tuber growth is resumed, especially close to

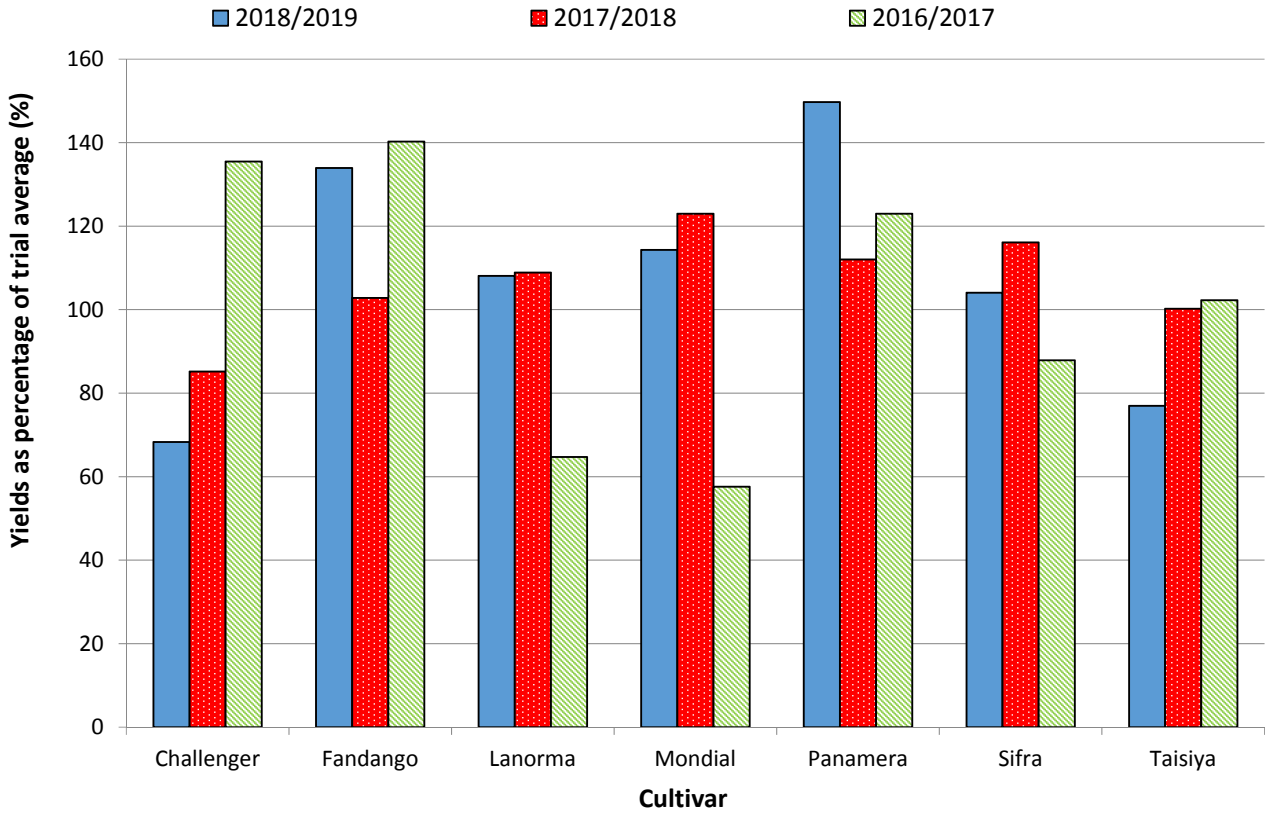


Figure 8. Performance of cultivars over three years as percentage of the trial average.

the eyes, which gives the tubers a knobby uneven appearance that is referred to a 'secondary growth'. The reason for the high percentage malformation in the trial can thus be ascribed to a combination of heat stress, drought and nutritional shortages in the middle of the season because of the drying-up of the water source in the middle of the season that made the application of top fertilisation impossible.

It is also important to take note of the cultivars' ability to perform consistently, notwithstanding climatic fluctuations over time. In Figure 8 the three year data for the cultivar trials in the Ugie production area is given. It would seem that the cultivars Sifra, Panamera and Taisiya showed the least variation of the 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 include important factors such as cooking and processing characteristics, specific gravity (SG) as well as internal defects (hollow heart, brown fleck and vascular bundle discolouration) that are summarized in Table 5. In respect of the 2018/2019 growth season the cultivars Alverstone Russet, Challenger, Georgina, Jelly, Mondial, Rumba, Sifra and Tyson complied with the chip colour norm of >50 for processing. In the case of specific gravity (SG) only the cultivars Alverstone Russet, Challenger, Jelly and Rumba complied with the norm of ≥1.075 for processing. As far as internal defects are concerned brown fleck was found in Bikini, Georgina and Valor.

Figure 9: Flesh colour and internal quality of yield for 2010 /2019 at Ugie

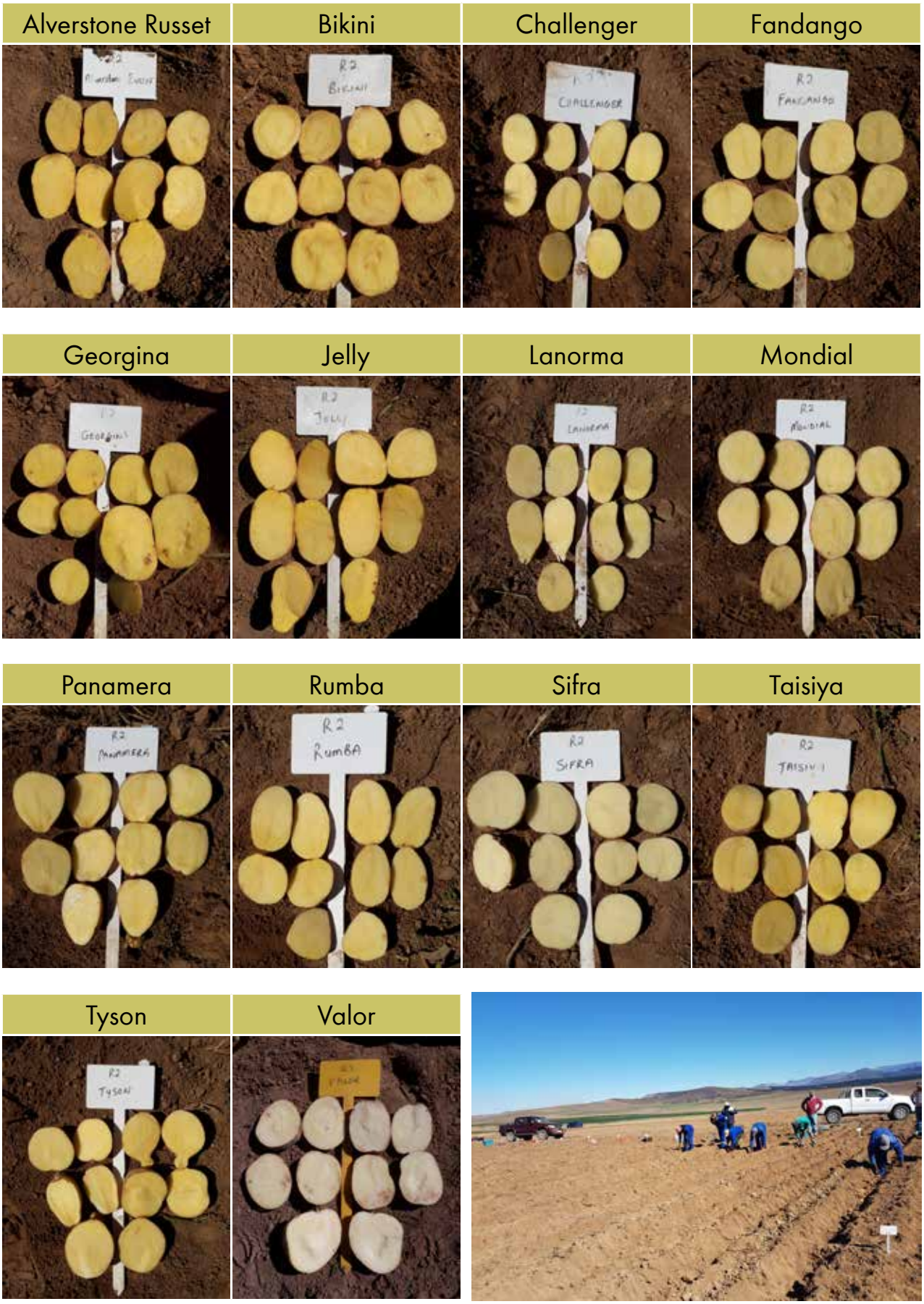


Table 5. Cooking and processing characteristics and internal quality of yields for 2018/2019 (Conducted by ARC Roodeplaat).

Cultivar	Chip colour[1]	SG[2]	Dry matter (%)[3]	Hollow heart (%)	Brown fleck (%)
Alverstone Russet	54	1.078	19.70	-	-
Bikini	44	1.060	16.02	-	√
Challenger	51	1.075	19.13	-	-
Fandango	46	1.068	17.66	-	-
Georgina	51	1.055	14.95	-	√
Jelly	56	1.076	19.29	-	-
Larnoma	43	1.072	18.59	-	-
Mondial	51	1.067	17.56	-	-
Panamera	46	1.056	15.14	-	-
Rumba	57	1.076	19.41	-	-
Sifra	53	1.069	17.93	-	-
Taisiya	48	1.066	17.21	-	-
Tyson	52	1.068	17.72	-	-
Valor	48	1.073	18.67	-	√

[1]Chip colour with value >50 and without defects are acceptable for the crisp industry.

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

[3]The 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)