South Western Free State cultivar trial under irrigation at Petrusburg in 2018

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The South Western Free State potato production region produces about 3% of the country's commercial potatoes on 1 473 hectares (2019 crop year). The most prominent cultivars produced for commercial consumption (table and processing) in the region's main crop are Sifra (80%), Innovator (9%) and Mondial (5%). Petrusburg falls in South Africa's dry continental area (Figure 1) and for the past five years has had an average annual rainfall of 409 mm. The region experiences very hot summers and very cold winters with the possibility of frost from June to August. In 2017, frost was recorded as late as November.

The cultivar trial at Petrusburg was laid-out in a randomised block design with three replicates per cultivar. In Table 1 additional technical information regarding the trial is provided. Soil samples were taken prior to planting to determine the soil nutritional status of the trial site (Table 2).

As the cultivar trial includes cultivars with short and long growth periods, the growth periods can influence the eventual yield of some cultivars. The length of growth periods is subject to the nature of the season, but is regarded as the time elapsing between emergence and natural die-off. Table 3 sets out how these growth periods differ between cultivars.

Stand and the number of haulms per seed tuber influence tuber size and yield. The number of eyes per tuber are cultivar dependent and determine the number of sprouts that develop per tuber. The plant readiness of seed tubers is very important in this regard because ideal optimum plant readiness normally result in seed tubers sprouting better and thus producing more stems per sprout. The plant readiness of the seed tubers at planting time of the trial as well as the stand percentage and haulm count that are observed later in the growing period, are indicated in Table 3.

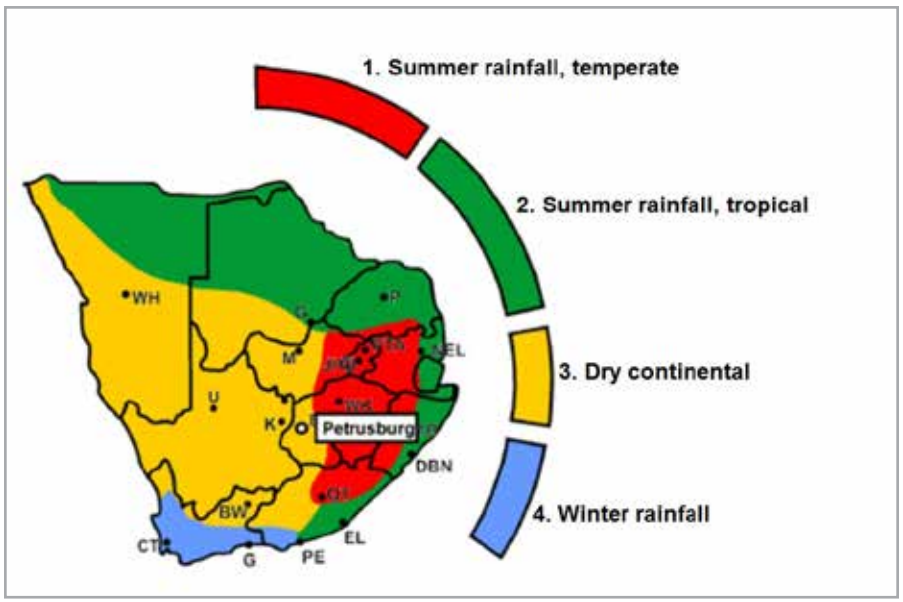


Figure 1: Location of Petrusburg in the South Western Free State production region.

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

Farm:	Lushof Boerdery		
Farmer:	Mr Johan Odendaal		
Planting date:	21 August 2018		
Harvesting date:	22 January 2019		
Irrigation / Dryland:	Irrigation		
Double or single rows:	Double rows		
Foliage die-off:	Chemically		
In-between row spacing:	0.9 m		
Trial site:	18 m^2		
Plant population:	37 037 plants / hectare		
Fertilising program			
	Nutritional value:		
	N (kg/ha)	P (kg/ha)	K (kg/ha)
Prior to planting	220	154	130
Tuber initiation (top fertilising)	50	-	-
Total	270	154	130

The evaluation of new cultivars as in the Petrusburg cultivar trial provides results on, inter alia, yield and marketing index. The marketing index of the relevant cultivars is determined by classing and sorting each cultivar according to quality and size group (e.g. class 1 large or class 2 large-medium). In this trial, each one of the three replicates are classed and sorted in the pack house. Price comparisons are then made based on market prices obtained at the time of the harvesting. The performance of new cultivars cannot be based on one specific season as climate may differ from one year to the next. It is therefore preferable that cultivars are tested over a number of seasons.

As with any other crop temperature, availability of water (whether it be through proper irrigation scheduling or rainfall) and heat units, are important factors that have a significant influence during the potato plant's growth period. These factors are therefore taken into account when the performance of cultivars is evaluated. Relevant daily and long term weather data were obtained from a chosen ARC weather station as close as possible to the trial site.

The rainfall for the 2018 season (Figure 2) initially reflected good rainfall (emergence to tuber initiation). This was followed by significantly lower (than the normal long term average) rainfall for November to January (tuber bulking to maturity).

The minimum and maximum temperatures are indicated in Figure 3. From planting on 21

Table 2: Soil nutritional status prior to planting.

Bulk density (kg.m^{-3})	pH (KCl)	P-Bray					% of CEC[1]			
		P	K	Ca	Mg	Na	K	Ca	Mg	Na
		(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	%	%	%	%
1140	5.67	2	166	442	173	112	9.35	48.66	31.31	10.68

[1]*CEC = Cation Exchange Capacity*

Clay (%)	18	Silt (%)	1	Sand (%)	68

August until around middle September temperatures below zero were recorded. No frost damage was recorded during this early stage of development. From end September until harvesting day (22 January) numerous days with temperatures above 30°C, and even days higher than 35°C, were recorded. It is a well-known fact that when temperatures rise this high, little to no tuber growth takes place. This is the result of carbohydrates being utilised for increased respiration instead of tuber growth. At exceptionally high temperatures the stomas will close to preserve moisture and no respiration will consequently take place.

The accumulation of heat units during a growth period is a cardinal factor in the development of the plant. The trend of heat units available for this cultivar trial at Petrusburg, appears to be close to the trend in respect of the long term data on heat units (Figure 4).

Yield data collected during the harvesting day are subjected to statistical processing using the GenStat®

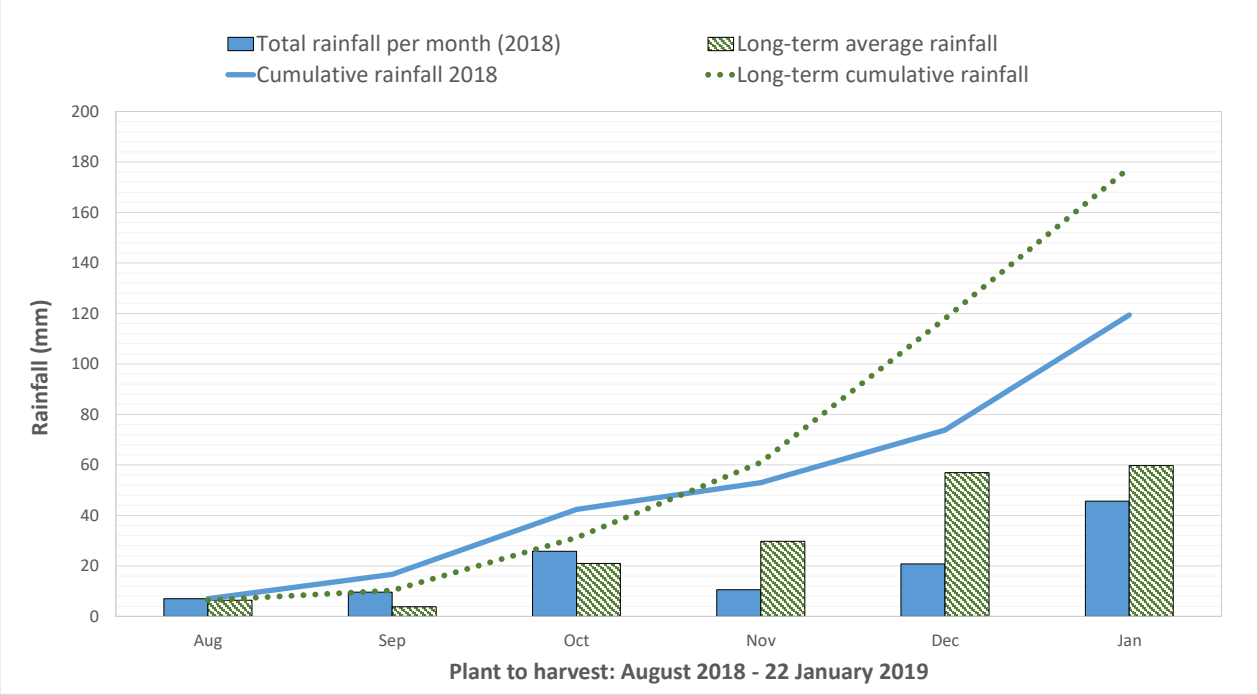


Figure 2: Rainfall (2018 season) and long term average rainfall.

Table 3: Characteristics regarding growth period, plant readiness, stand (%) and haulm count for the relevant cultivars.

Cultivar	Growth period (Days)[1]		Plant readiness[2]	Stand (%)	Haulms per plant	Haulms per hectare
El Mundo	Medium	(90-100)	3	88	4.8	142 222
Essenza	-	-	2	94	3.0	104 444
Fandango	Medium to long	(120)	3	97	5.8	207 370
FPD2002	-	-	1	82	4.4	133 629
FPD2003	-	-	2	94	3.2	111 407
FPD3001	-	-	2	91	4.6	155 037
FPD3003	-	-	2	79	3.2	93 630
Georgina	Medium	(90-110)	3	88	4.0	130 370
Jelly	Medium to long	(90-110)	2	73	2.8	75 704
Labadia	Short to medium	(100)	2	100	3.0	111 111
Lanorma	Short	(80-90)	3	97	3.8	136 518
Markies	Medium	(110)	1	94	2.8	97 481
Mondeo	Medium	(110)	3	94	2.8	97 481
Mondial	Short to medium	(95-110)	2	94	3.8	132 296
Panamera	Medium	(90-110)	2	97	1.8	64 667
Rumba	Medium	(90-110)	3	88	3.2	104 296
Sifra	Short to medium	(90-100)	2	85	2.4	75 555
Taisiya	Short to medium	(100)	3	82	3.4	103 259
Tyson	Short to medium	(90-100)	2	91	2.4	80 889
Valor	Medium	(100-110)	2	91	3.4	114 592

[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.*

program. Die Tukey test of least significant differences (LSD) was used to separate the average. The cultivar effect during this trial (Figure 5) was statistically significant ($p<0.05$) and the coefficient of variation was low (8.7%). These factors indicate that the trial was very well executed and that the results are therefore trustworthy. The yield of each of the cultivars is divided by the trial average (the trial average of all the cultivars is taken as 100%). By this a yield index is created and each cultivar's performance is determined in terms yield as a percentage of the trial average.

The average yield of the trial for the 2018 season was 63.84 t/ha which is higher than the trial average for the previous three cultivar trials (52.46 t/ha). The cultivars Mondeo, Valor and Fandango attained the highest yields (Figure 5). Mondeo, Valor and Sifra attained the highest marketing index which can be ascribed to a higher yield of large tubers as well good quality. Size group distribution and grading are indispensable evaluations when the marketability of a cultivar is considered (Figures 6 and 7). The main reasons for downgrading were taken into account when the potatoes were classed (Table 4). Moth damage as well as soft rot were a continuous major reason for down-marking. This can be ascribed to an extremely high moth incidence in the region for the specific season. Damage to tubers by moths probably

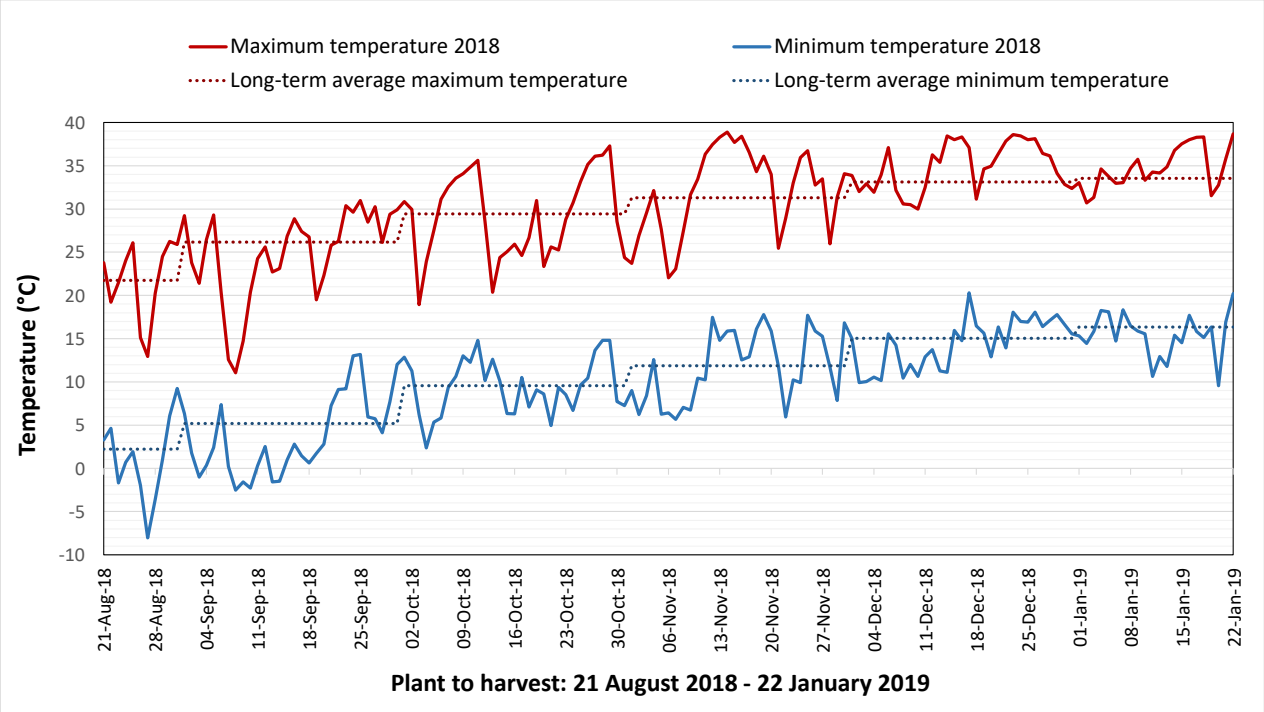
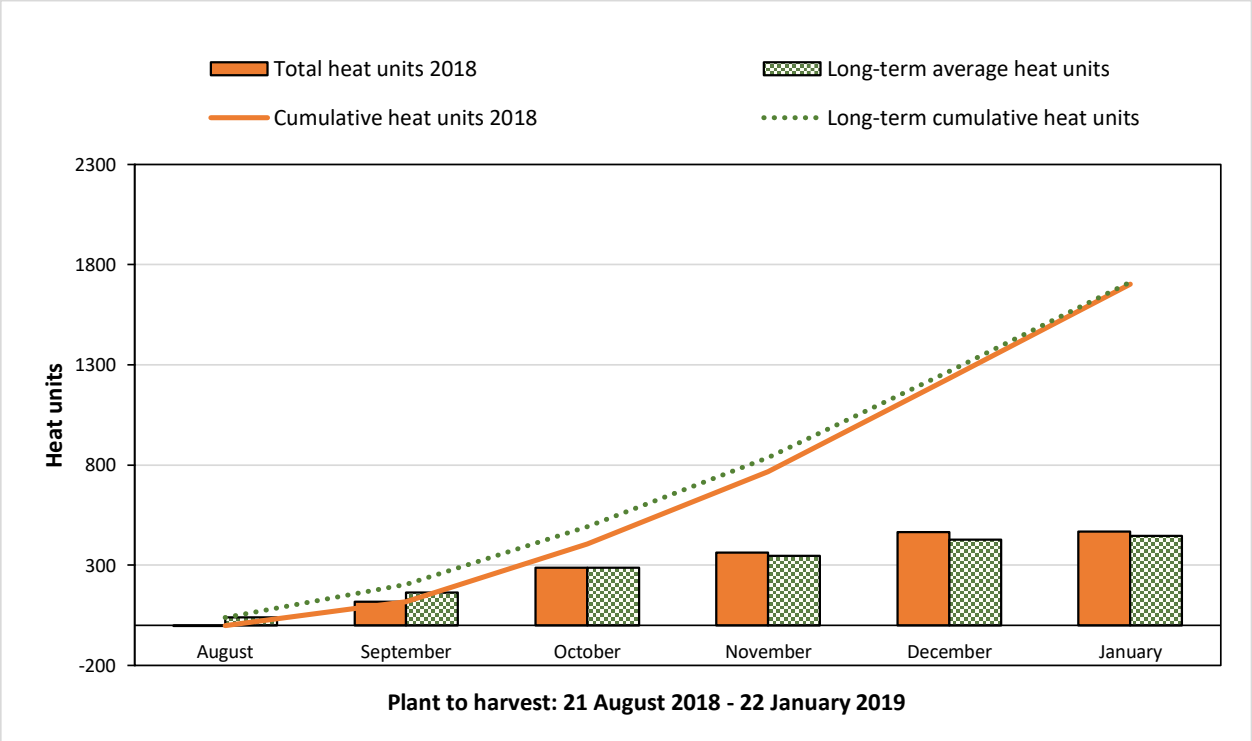
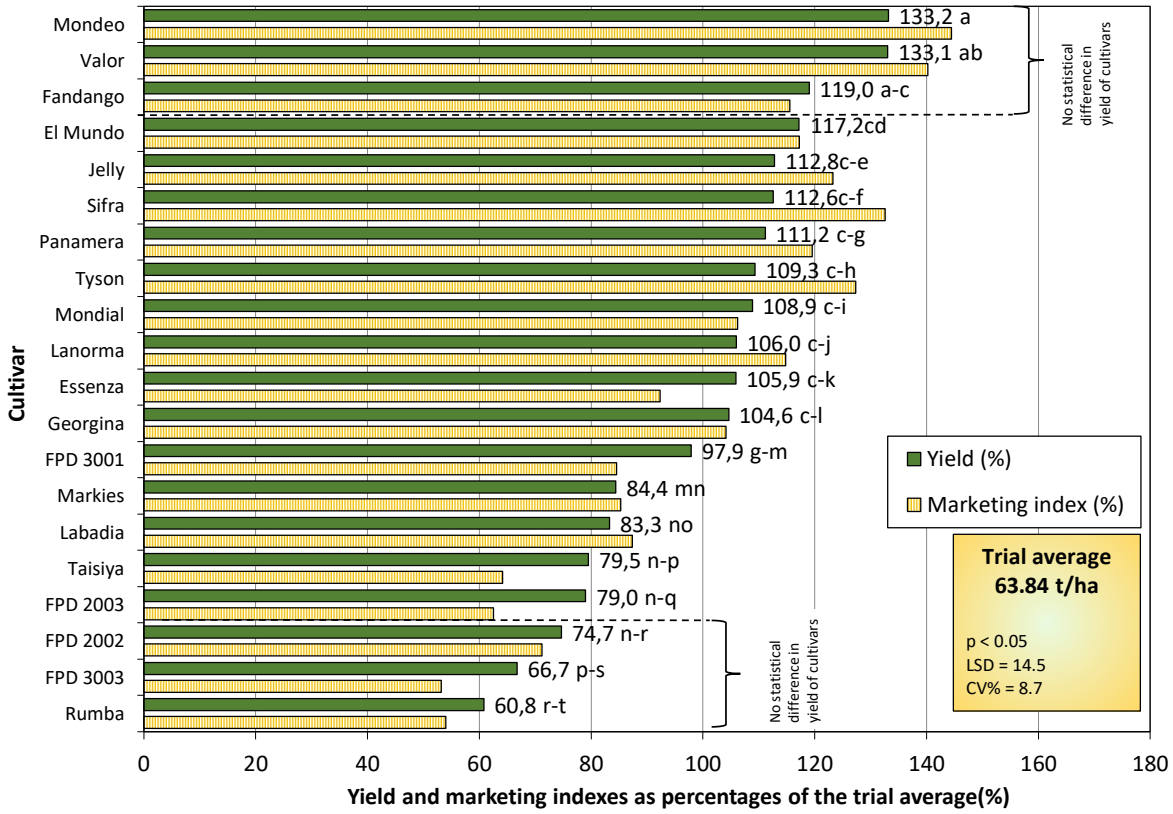


Figure 3: Minimum and maximum temperatures (2018 season) as well as long term temperatures.



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

Figure 4: Heat units (2018 season) as well as long term average heat units.



**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.

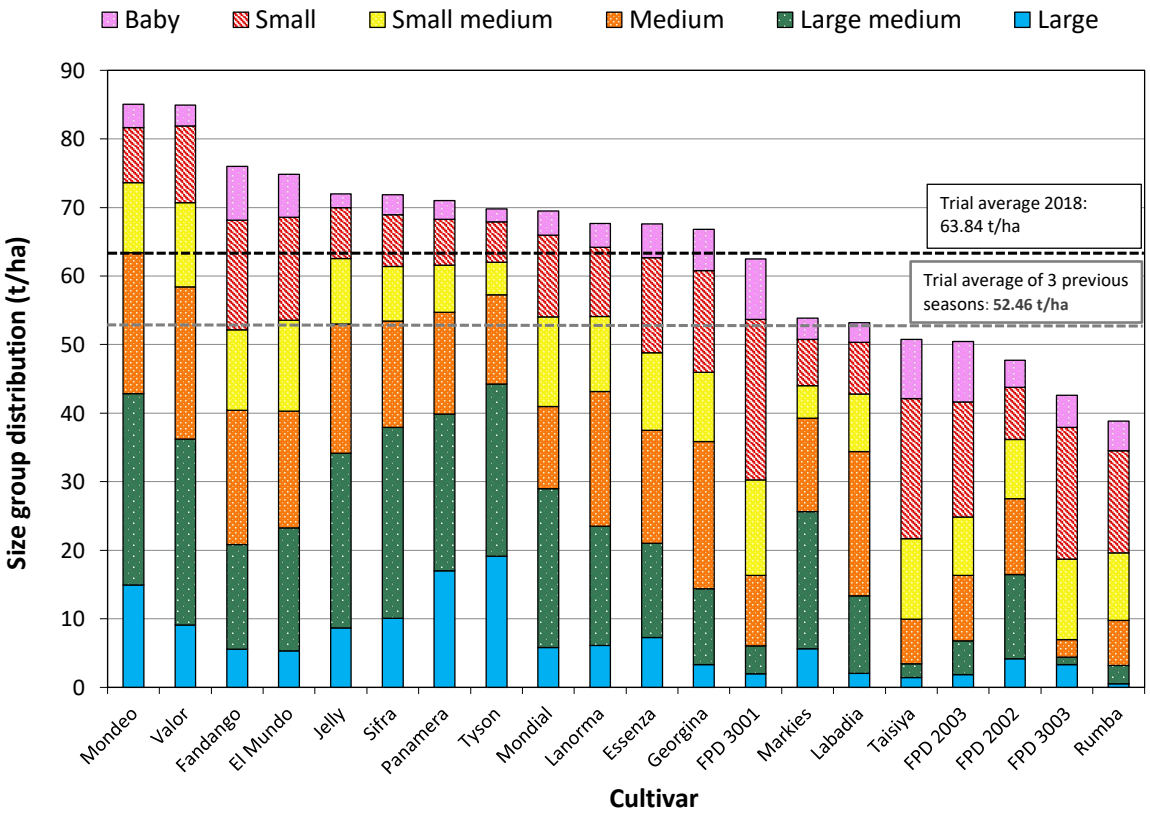


Figure 6: Size group distribution of each relevant cultivar.

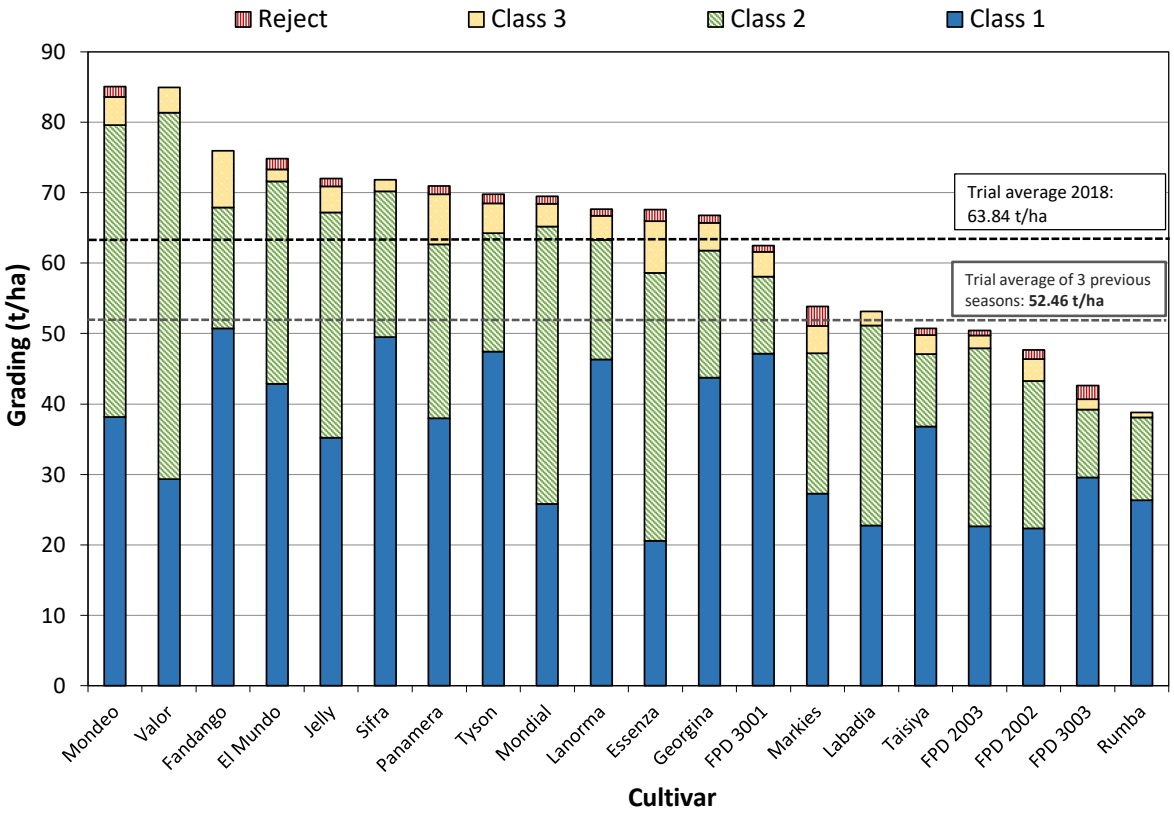


Figure 7: Grading of each relevant cultivar.

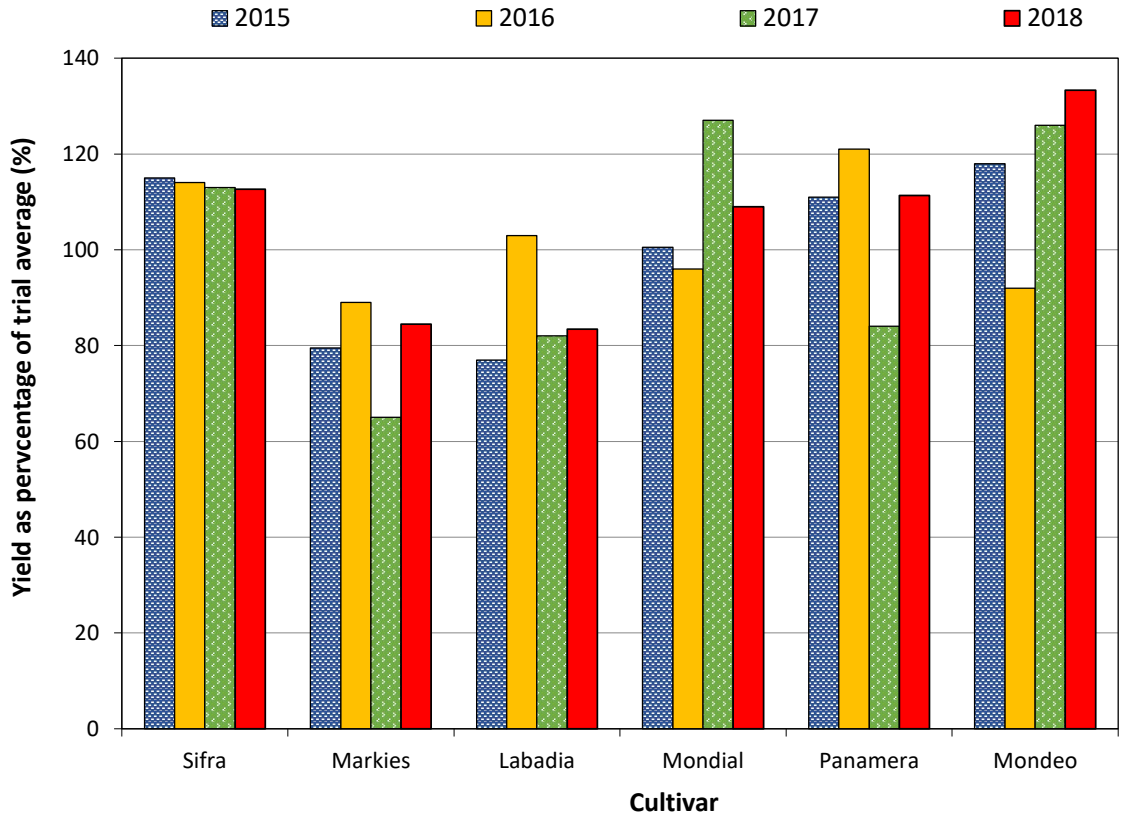


Figure 8: Performance of cultivars included in the trial for four years (expressed as percentage of the trial average).

gave access to bacteria which led to soft rot.

Due to the nature of seasons, the performance of cultivars fluctuates from one season to the next – purely because the climate between seasons differ. It is therefore important to take into account the consistency in performance of cultivars over a number of seasons. At present Sifra shows by far the least variation for 2015 to 2018 in the Petrusburg cultivar trial (Figure 8).

In conclusion, when the internal quality of potatoes is considered, the processing characteristics can also be evaluated. To comply with the processing requirements, cultivars must comply with a chip colour norm of >50 and a specific gravity (SG) of ≥1.075 (Table 5). Various cultivars complied with the chip colour and a specific gravity requirements.

Table 4: Main reasons for down-marking.

Cultivar	Nematode	Common scab	Moth	Rhizoctonia	Soft rot	Silver scurf/ black dot*
El Mundo	x		x		**x**	
Essenza			x		x	
Fandango			x		x	
FPD2002	x		x		x	x
FPD2003			x		x	
FPD 3001		x	x		x	
FPD3003	x		x		x	
Georgina	x	x	x		x	
Jelly			x		x	
Labadia	x		x		x	
Lanorma	x		x		x	
Markies		x	x		x	
Mondeo	x		x		x	
Mondial			x		x	
Panamera			x		x	x
Rumba	x		x			
Sifra			x			
Taisiya	x		x			
Tyson			x	x	**x**	
Valor			x		x	

**anthracnosis*

Table 5: Processing characteristics of cultivars (conducted by ARC Roodeplaat).

Cultivar	Chip colour[1]	SG[2]	Dry matter (%)[3]
El Mundo	57.0	1.073	18.7
Essenza	46.0	1.080	20.1
Fandango	50.0	1.070	18.0
FPD2002	55.0	1.073	18.8
FPD2003	53.0	1.081	20.4
FPD 3001	57.0	1.085	21.2
FPD3003	60.0	1.086	21.5
Georgina	56.0	1.067	17.5
Jelly	53.0	1.084	21.0
Labadia	52.0	1.074	18.9
Lanorma	58.0	1.072	18.5
Markies	55.0	1.076	19.4
Mondeo	52.0	1.072	18.5
Mondial	55.0	1.078	19.8
Panamera	56.0	1.082	20.6
Rumba	57.0	1.087	21.6
Sifra	55.0	1.084	21.1
Taisiya	56.0	1.072	18.6
Tyson	43.0	1.074	18.9
Valor	52.0	1.083	20.9

[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 in this calculated value.