KwaZulu-Natal cultivar trial under irrigation at Cedara in 2017/2018

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The KwaZulu-Natal production region produces about 5% (based on the 2016 crop year) of the total potato production in South Africa. This region produces potatoes for the table market, as well as seed potatoes. The main cultivars for seed potatoes as well as for the table and processing markets are Mondial, Valor and Sifra. The Cedara production area has two plantings per annum. The summer planting takes place between August and January whereas the winter planting is done from February to July. The trial was conducted at Cedara College (S29° 32′ 15 33, E30° 16′ 09 19) which is situated about 16 km from Pietermaritzburg and 12 kilometres from Howick in KwaZulu-Natal. Cedara lies in the damp midland mist zone (900 – 1400 m above sea level). The typography at Cedara is generally hilly, with slopes of up to 16% with the average slope being about 7% with a high percentage arable land of which 47% is suitable for cultivation purposes. Cedara is situated in a summer rainfall area with an average annual rainfall of between 838-1140 mm (Figure 1). Summers are moderately warm whereas the winters are cold with concomitant frost. Frost intensity is regarded as light to moderate with an average of three to nine days of frost that can occur over a period of 35 to 70 days, depending on the altitude above sea level. The soil at Cedara consists of a relatively deep loamy soil that is extremely alkaline and very

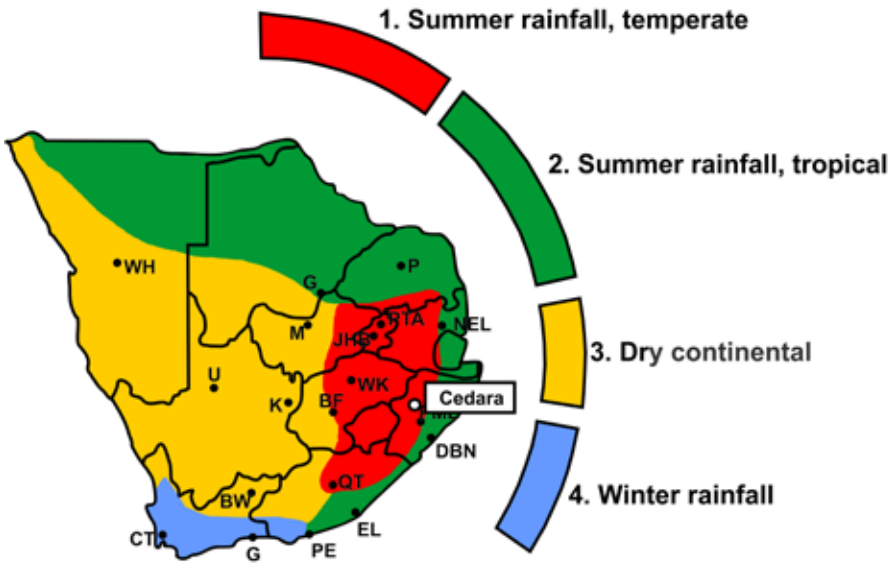


Figure 1: Location of Cedara in the KwaZulu-Natal production region

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

Institution:	Cedara College		
Planting date:	21 September 2017		
Harvesting date:	2 February 2018		
Irrigation / Dryland:	Irrigation		
Double or single rows:	Double rows		
Foliage die-off:	Naturally		
In-between row spacing:	0.9 m		
In-row spacing:	0.30 m		
Trial site per unit:	9 m^2		
Plant population:	37 037 plants/hectares		
Fertilising program:			
	Nutritional value:		
	N (kg/ha)	P (kg/ha)	K (kg/ha)
Total	239.58	110	146.3

acid-like. Fertility is low, but the physical characteristics are favourable. 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.

Representative soil samples were drawn before planting and analysed to determine the soil nutritional status of the trial site. The results of the soil analysis for this trial are indicated Table 2.

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 3).

Yield and tuber size are also influenced by the number of main stems per area and thus by the number of seed potatoes planted as well as the number of haulms per seed potato. On the other hand the number of haulms per seed potato depend on the number of eyes, 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 sprouts per eye

Table 2: Results of soil analysis for Cedara (2017/2018) cultivar trial prior to planting.

Gross density (kg.m^{-3})	pH (KCl)	P-Bray	Ammonium asetate				% of CEC[1]			
		P	K	Ca	Mg	Na	K	Ca	Mg	Na
		(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	%	%	%	%
1080	4.72	16	154	788	160	21	6.88	68.7	22.81	1.61

[1] *CEA = Catione exchange capacity*

Clay (%)	34
Silt (%)	23
Sand (%)	43

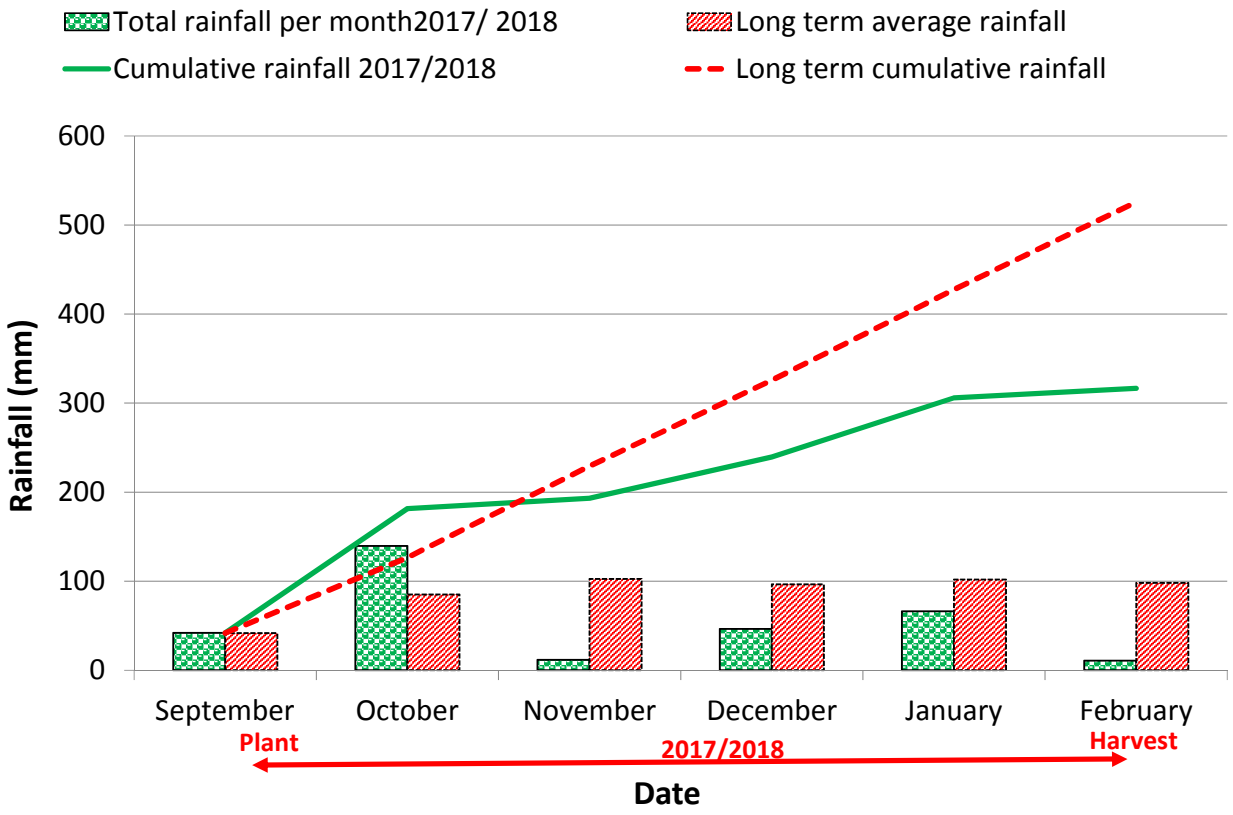


Figure 2: Rainfall during the growing season (2017/2018) as well as the long term average rainfall.

Table 3: Characteristics regarding growing period, plant readiness, stand (%) and haulm count for each cultivar in 2017/2018.

Cultivar	Growing period (Days)[1]		Plant readiness[2]	Stand (%)	Haulms per plant	Haulms per hectare
Bonnata	Medium	(90-110)	4	97	4.9	176 037
El Mundo	Medium	(90-100)	3	100	7.1	262 963
Electra	Medium	(110)	3	100	4.5	166 667
Essenza	-	-	3	100	3.5	129 630
Fandango	Medium to long	(120)	3	100	6.9	255 555
Georgina	Medium	(90-110)	5	85	4.3	135 370
Jelly	Medium to long	(120)	4	97	4.5	161 667
Labadia	Short to medium	(100)	3	100	3.3	122 222
Libertie	Medium	(90-110)	5	91	4.1	138 185
Lanorma	Short	(80-90)	4	91	4.1	138 185
Mondeo	Medium	(90-110)	3	88	6.5	211 852
Mondial	Short to medium	(95-100)	2	100	4	148 148
Panamera	Short to medium	(95-100)	2	97	2.4	86 222
Rumba	Medium	(90-110)	4	97	5.2	186 815
Sifra	Short to medium	(90-100)	2	97	3.4	122 148
Taisiya	Short to medium	(100)	3	100	4.5	166 667
Valor	Medium	(100-110)	3	100	3	111 111

[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.

and the number of haulms per sprout are influenced by the plant readiness of the seed potatoes. It is also important to note that the number of eyes vary between cultivars. The cultivars, plant readiness of seed potatoes, stand (%) and haulm count of this 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 determine the adaptability of new cultivars in the Cedara 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 and long term weather data was obtained from the ARC's Cedara station (-29.35419, 30.26498) on the premises.

The cumulative rainfall at the beginning of the growing season (October = 145 mm and November = 135 mm), i.e. during the tuber initiation and vegetative growth period, was higher than the long term data (Figure 2). During February (skin sit) more rain was received compared to the long term data. As far as the cumulative rainfall is concerned the measured rainfall was slightly higher early in the growing season (October to December) compared to the long term data. For January and February the measured cumulative rainfall was below the long term cumulative rainfall. The minimum and maximum temperatures (Figure 3) for the 2017/2018 growing season followed the same pattern as the long term data. However, during the last three months the minimum temperature was lower compared to the long term data. During the growing season the minimum and maximum temperatures varied significantly and were between 30-37°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.

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 2017/2018 growing season were constantly significantly lower (39.7%) compared to the long term average heat units and are indicated in Figure 4.

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 2017/2018 trial (Figure 5) was statistically highly significant in respect of yield ($p<0.01$), whilst the coefficient of variation was acceptable (23.4%). 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 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 trial attained an average yield of 60.1 t/ha for the 2017/2018 growing season. In respect of the 2017/2018 trial (Figure 5) the cultivars Essenza, Electra and Taisiya attained the highest yields, whereas Libertie and Rumba delivered the poorest yields. Higher yields than the trial average (60.1 t/ha) were attained by the cultivars Essenza, Electra, Taisiya, Fandango, Valor, Mondeo, Panamera 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 current price, which is determined by the size group distribution and the grading, gives the marketing index (Figure 5). Although Electra did not attain the highest yield, it did attain the highest which can be ascribed to a high percentage large potatoes (Figure 6) and class 1 potatoes (Figure 7) delivered by the cultivar. Liberty attained the lowest marketing index because the cultivar had a low yield and also a low percentage large size group distribution (Figure 6). 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 optimal

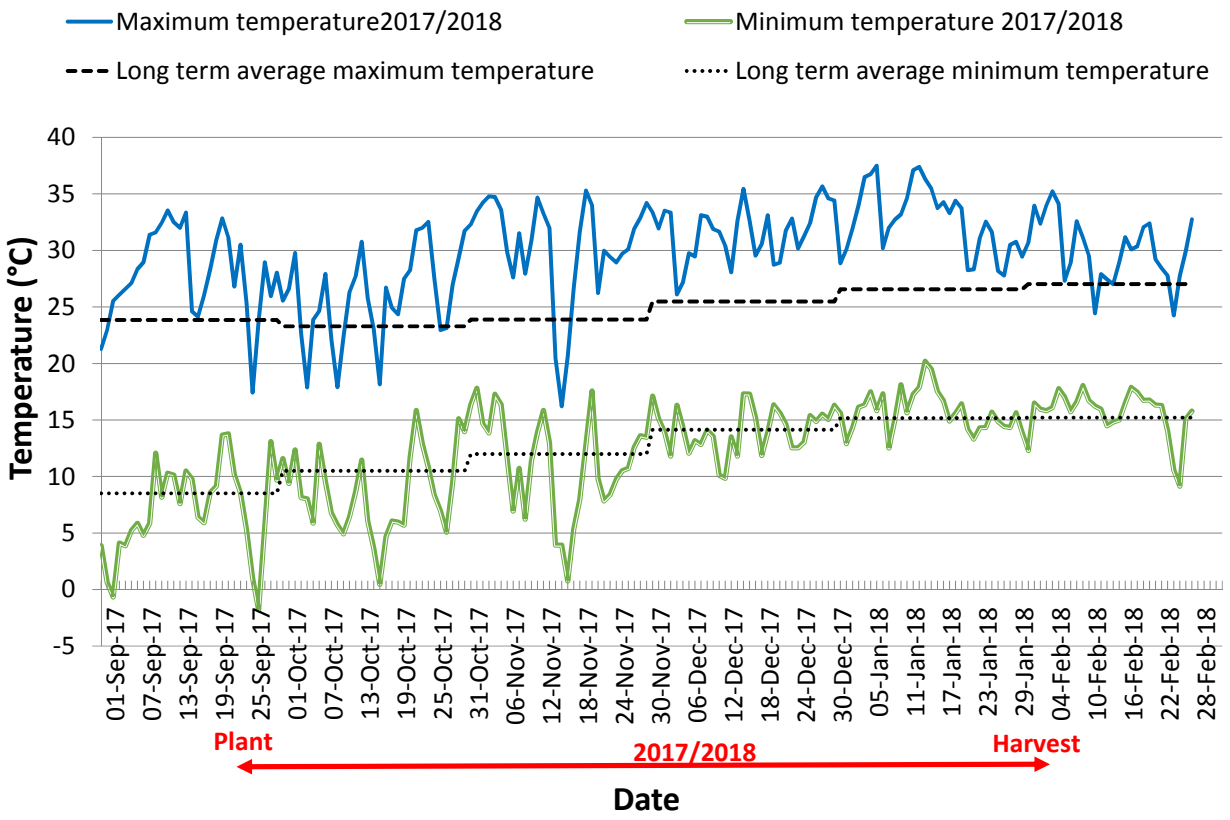
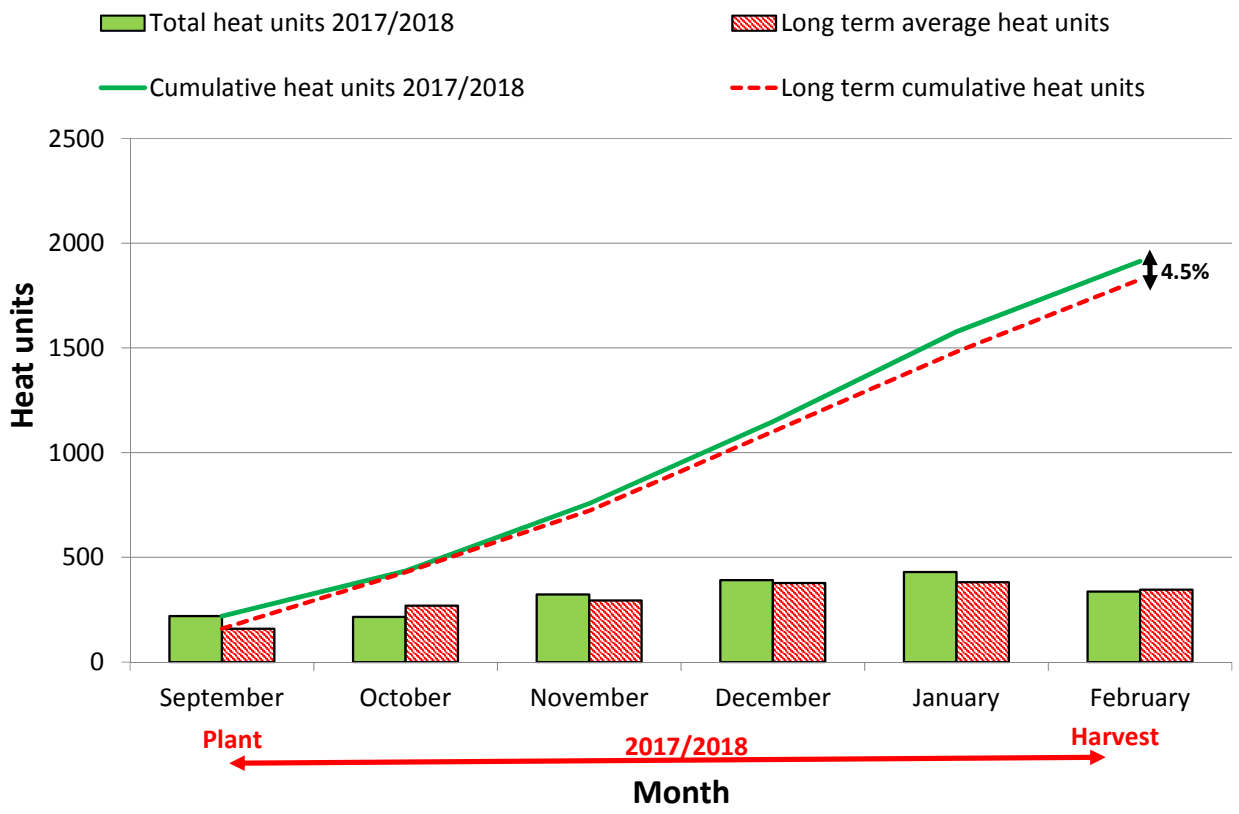
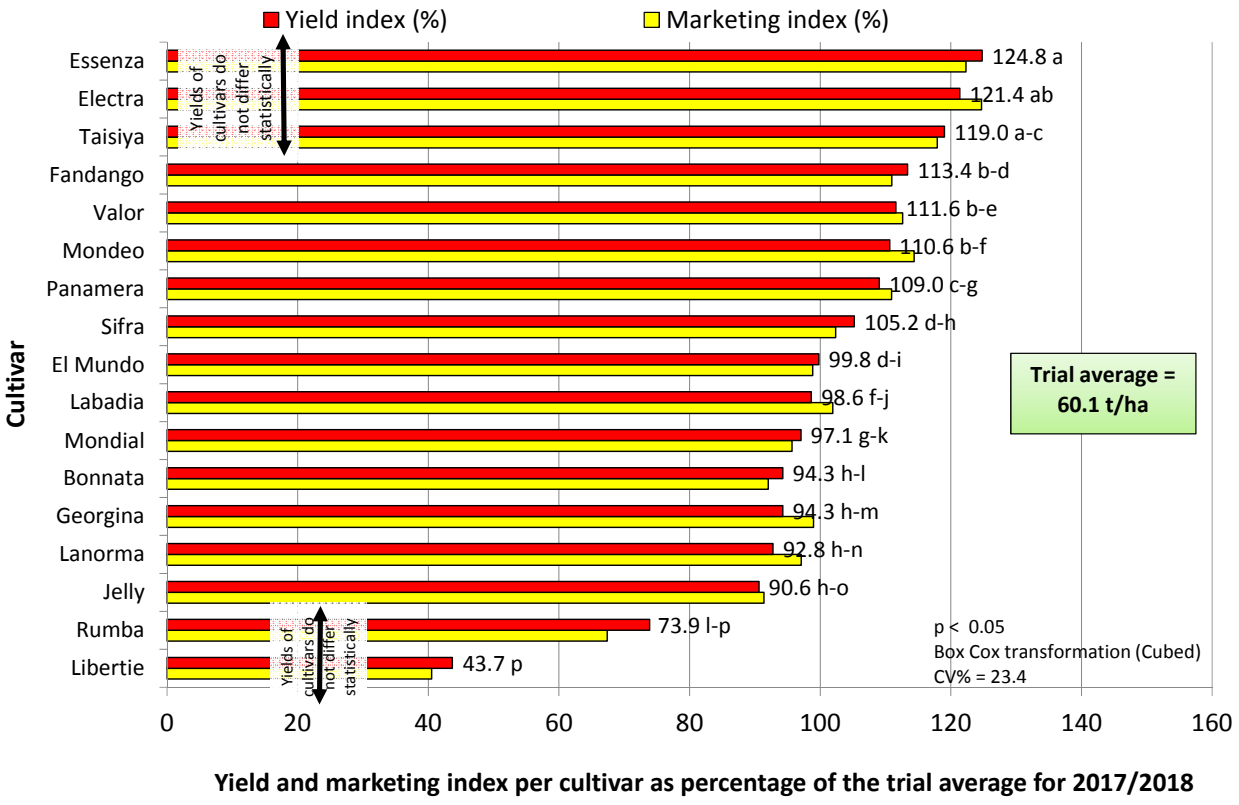


Figure 3: Minimum and maximum temperatures (°C) during the growing season (2017/2018) as well as long term.



**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 (2017/2018) as well as long term average.



Yield and marketing index per cultivar as percentage of the trial average for 2017/2018

**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.

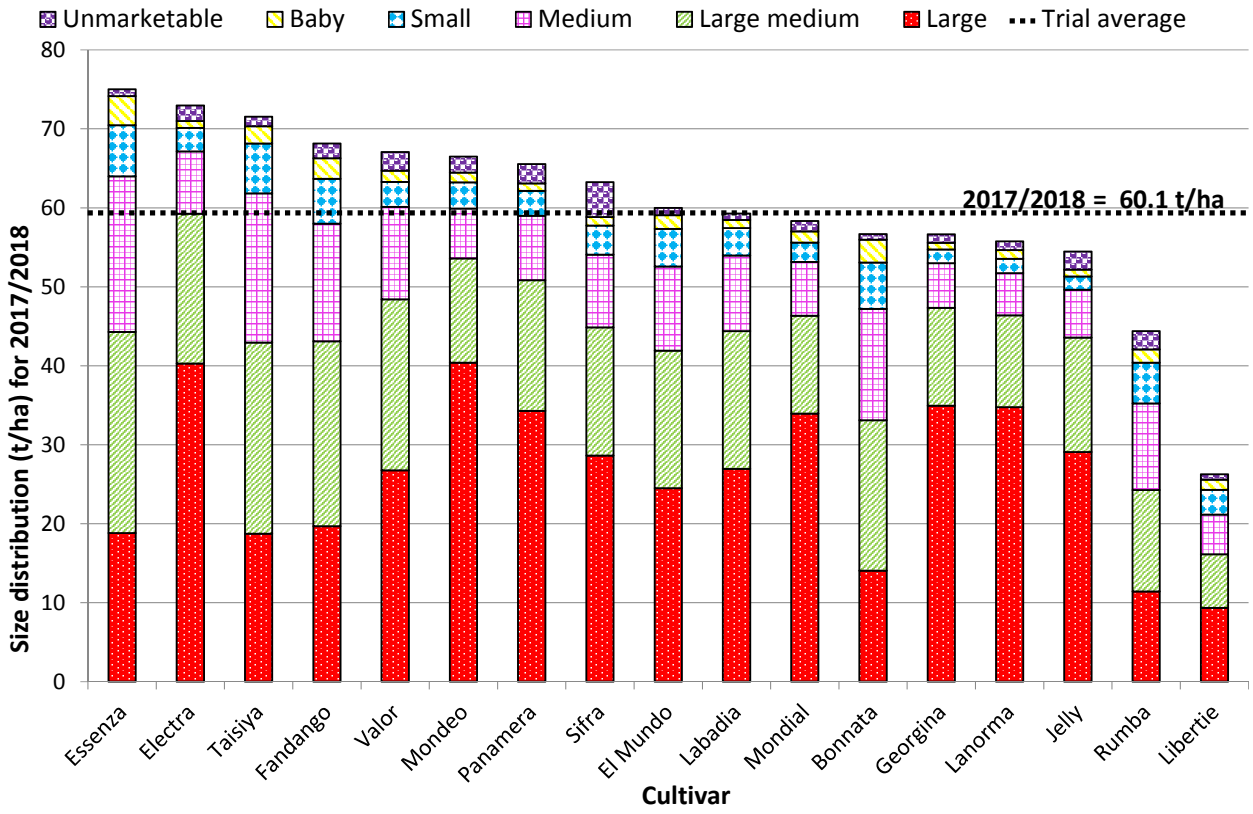


Figure 6. Size group distribution of each cultivar during final harvesting.

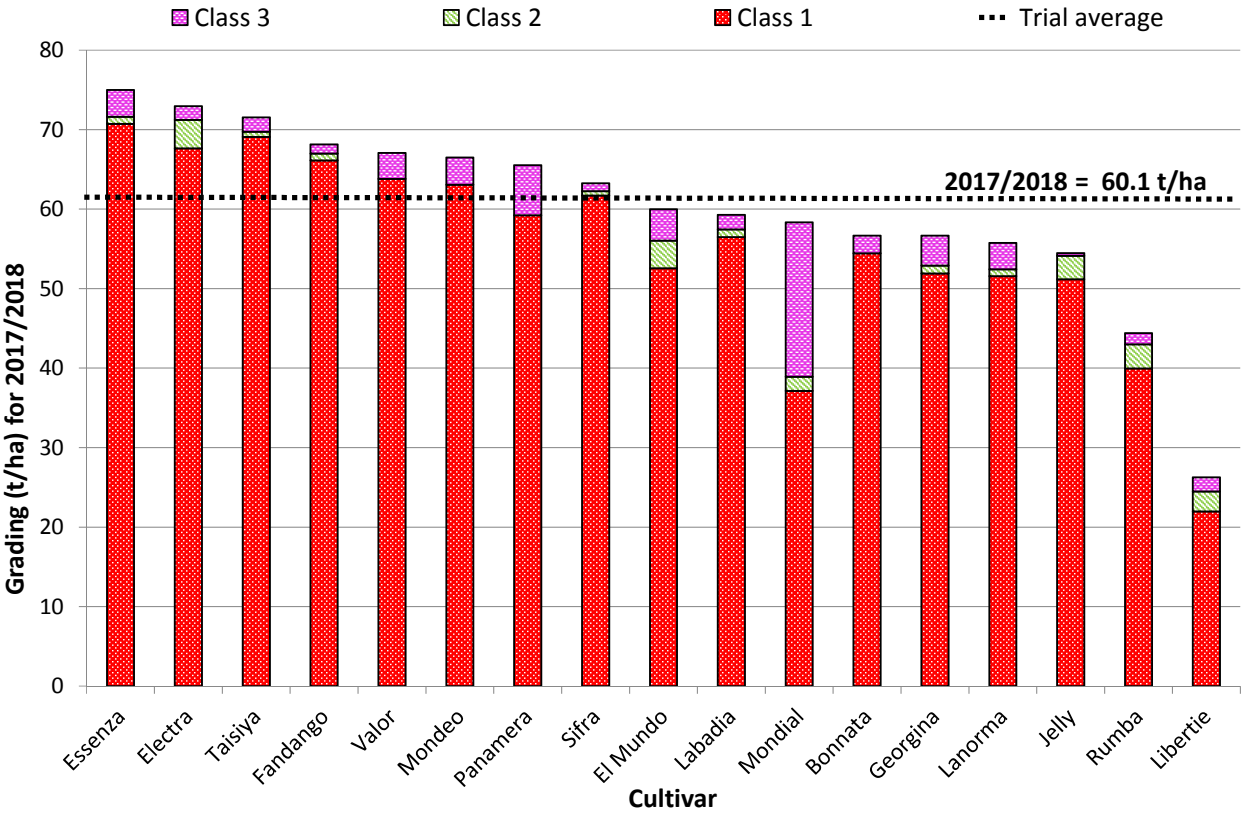


Figure 7. Grading of each cultivar during final harvesting.

Table 4: Main reasons for downgrading during the 2017/2018 Cedara harvesting.

Cultivar	Main reasons for downgrading					
	Insect damage	Abraded	Mechanical damage	Malformation	Growth cracks	Greening
Bonnata			x			
El Mundo		x				x
Electra	x		x			
Essenza			x			
Fandango			x			
Georgina		x		x		x
Jelly		x	x			
Labadia		x				
Libertie	x					
Lanorma			x			x
Mondeo	x		x			
Mondial		x			x	
Panamera		x				
Rumba	x			x		
Sifra		x	x			
Taisiya		x	x			
Valor	x	x				

economically marketable yield. In Figure 6 the size group distribution is indicated, in Figure 7 the grading of the yields and in Table 4 the main reasons for downgrading the different cultivars.

The LINTUL-POTATO-DSS plant growth model was used to calculate the potential potato yield of the control cultivar, Mondial. Potential yield can be defined as the theoretical top yield limit in a situation where water, nutrients and biological factors are at

Table 5. Cooking and processing characteristics and internal quality of yield for 2017/2018 (conducted by the ARC Roodeplaat).

Cultivar	Chip colour[1]	SG[3]	Dry matter (%)[3]	Hollow heart (%)	Brown fleck (%)
Bonnata	55	1.079	19.92	-	-
El Mundo	52	1.065	17.09	-	-
Electra	52	1.063	16.67	-	-
Essenza	48	1.075	19.05	-	√
Fandango	33	1.072	18.44	-	-
Georgina	35	1.066	17.18	-	-
Jelly	49	1.081	20.49	-	-
Labadia	50	1.074	18.91	√	-
Libertie	48	1.065	17.11	-	-
Lanorma	51	1.070	18.19	-	-
Mondeo	42	1.078	19.71	-	-
Mondial	47	1.070	18.08	-	-
Panamera	55	1.049	13.61	-	-
Rumba	56	1.096	23.63	√	-
Sifra	51	1.072	18.57	-	-
Taisiya	43	1.069	17.79	-	-
Valor	53	1.079	20.00	-	-

[1]Chip colour with a value of >50 and without defects is 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)

an optimum for the season during the trial's growing season. This allows us to evaluate how the actual yield attained in the trial compares with simulated potential yields. The difference between the potential and actual trial yield refers to the yield gap. The ratio between the actual yield (58.3 t/ha) and potential yield (120.9 t/ha) is 48%.

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. During the 2017/2018 growing season the cultivars Bonnata, Electra, El Mundo, Labadia, Lanorma, Panamera, Rumba, Sifra and Valor complied with the chip colour norm of >50 for processing. As far as specific gravity (SG) is concerned, the cultivars Bonnata, Essenza, Jelly, Mondeo, Rumba and Valor complied with the norm of ≥1.075 for processing. In the case of internal defects brown fleck occurred in Essenza and hollow heart in Labadia and Rumba.