UNIVERSIDAD NACIONAL AGRARIA LA MOLINA

FACULTAD DE AGRONOMÍA
PROGRAMA DE HORTALIZAS

el huerto

PRODUCTIVIDAD DE TOMATE MINIATURA (*Solanum lycopersicum* var. *cerasiforme*) BAJO PRODUCCIÓN ORGÁNICA EN INVERNADERO EN EL VALLE DE MALA

- Presentado por:

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vliruos
SHARING MINDS, CHANGING LIVES

- Patrocinadora:

Ing. Saray Siura Céspedes

JUSTIFICACIÓN

Valle de Mala

Región	Lima
Provincia	Cañete
Distrito	Mala

Está ubicado a 84 km. al sur de la ciudad de Lima

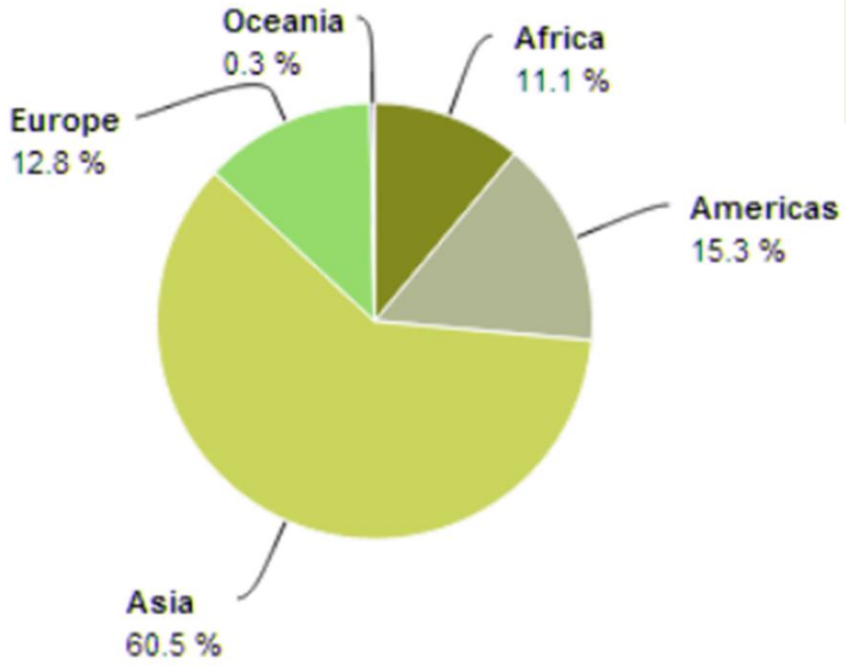
Agricultura Orgánica en el valle de mala


el huerto
18/01/2013 14

Agricultura Protegida

El cultivo de tomate

Ocupa **4.8 millones** de ha a nivel mundial
con una producción de aproximadamente **161 millones de t** en el año 2012 (FAO stats, 2013).



Tomate en el Perú	
Producción nacional	**229 356** t para el año 2012 (MINAG)
Comercialización por semana en un supermercado de lima	20 t

OBJETIVOS

- Determinar el rendimiento y calidad de once cultivares de tomate miniatura (*Solanum lycopersicum* var. *cerasiforme*) conducido bajo condiciones de invernadero.

- Determinar la productividad del tomate miniatura (*Solanum lycopersicum* var. *cerasiforme*) en un sistema de producción orgánico.

- Determinar la adaptabilidad de once cultivares de tomate cherry (*Solanum lycopersicum* var. *cerasiforme*) bajo condiciones del valle de Mala.

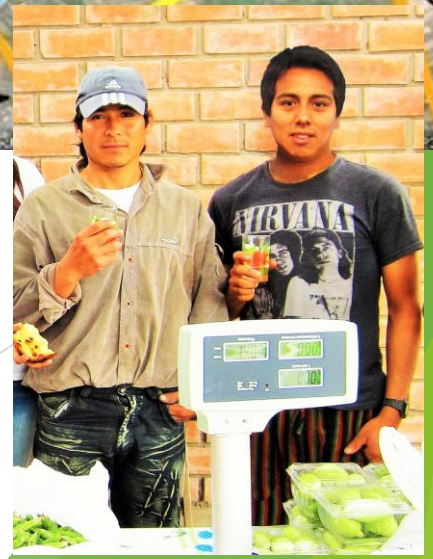
MATERIALES Y MÉTODOS

- **Área experimental:**

Fundo Manantial

Métodos de producción orgánica desde hace 14 años, con certificación orgánica, siendo uno de los primeros en lograr la certificación en el valle.

- Latitud : 12°36'49.53"S
- Longitud : 76°37'16.05"O
- Altitud : 119 m.s.n.m.



Construcción del Invernadero

- Área : 220 m2
- Tipo : Unimodular con techo a dos aguas.

- Análisis de suelo:

CARACTERÍSTICA	Suelo
pH (1:1)	7.11
C.E. (1:1) d S/m	**4.99**
$CaCO_3$ (%)	0
M.O. (%)	**1.53**
P ppm	28.2
K ppm	129
Arena (%)	35
Limo (%)	40
Arcilla (%)	25
Clase Textural	Fr.
CIC (meq/100g)	10.4
Ca^{+2} (meq/100g)	6.97
Mg^{+2} (meq/100g)	2.3
K^{+} (meq/100g)	0.56
Na^{+} (meq/100g)	0.57
$Al^{+3} + H^{+}$ (meq/100g)	0
Suma de Cationes	10.4
Suma de Bases	10.4
% Sat. De Bases	100

Características del agua de riego

CARACTERÍSTICA	AGUA DE RIEGO
pH (1:1)	6.60
C.E. d S/m	**1.13**
Calcio meq/L	1.34
Magnesio meq/L	0.27
Potasio meq/L	0.05
Sodio meq/L	8.82
SUMA DE CATIONES	10.48
Nitratos meq/L	0.01
Carbonatos meq/L	0.00
Bicarbonatos meq/L	4.57
Sulfatos meq/L	2.07
Cloruros meq/L	4.00
SUMA DE ANIONES	9.05
Sodio %	84.16
RAS	**9.83**
Boro ppm	0.71
CLASIFICACIÓN	**C3-S2**

Sistema de riego por goteo

Características climáticas durante el ensayo

MES	PROMEDIO MENSUAL	
	Temperatura (°C)	Humedad relativa (%)
Julio	16.75	93.21
Agosto	16.22	92.47
Setiembre	16.00	92.28
Octubre	17.47	87.37
Noviembre	17.84	89.07
Diciembre	19.10	91.51
Enero	26.18	81.50
Febrero	24.27	74.39
Marzo	24.73	73.53
PROMEDIO	**19.84**	86.15

METODOLOGÍA

- El diseño estadístico utilizado en el ensayo fue el de Bloques completos al azar (DBCA) con cuatro repeticiones.

TRATAMIENTOS UTILIZADOS EN EL ENSAYO

Trat.	Cultivar	Casa comercial	Procedencia
T1	Chadwick Cherry	Seeds of Change	EE UU
T2	Peacevine Cherry	Seeds of Change	EE UU
T3	Yellow Pear	Jhonny´s Seeds	EE UU
T4	Yellow Pearshaped	Gartenland	Alemania
T5	Sundrop Cherry	Botanical interests	EE UU
T6	Black Cherry	Jhonny´s Seeds	EE UU
T7	Poire Rouge	Association Kokopelli	Francia
T8	Red Pear	Gartenland	Alemania
T9	Rubin Pearl	Sperli	Alemania
T10	Red Grape	Jhonny´s Seeds	EE UU
T11	Banana Legs	Association Kokopelli	Francia

T1

T5

T9

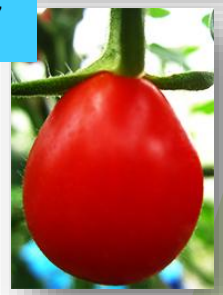
T2

T6

T10

T3

T7



T11

T4

T8

LABORES DE CULTIVO

Almácigo

Preparación del terreno

Método de bancal profundo	
Estiércol de vacuno	2.5 kg/m^2
Compost	1.25 kg/m^2
Humus de lombriz	1.5 kg/m^2
Paja	0.06 kg/m^2
Ceniza	0.18 kg/m^2


27/07/2012 10:14


24/07/2012 14:28


27/07/2012 10:17


27/07/2012 10:16

Trasplante

31 de Julio

Abonamiento de fondo	
Guano de Islas	0.013 kg/m^2

Abonamiento

Abonamiento al suelo	
Grow More	0.03 kg/m^2

Abonos foliares
Biol (20%) 4 aplicaciones
BIOAT algas marinas (1%) cada semana

Poda oportuna

Guiado

Manejo de plagas

Capsaicina	30 ml/20 l
Rotenona	20 ml/20 l
Aceite agrícola	40 ml/20 l
Ceniza	

Cosecha


14/12/2012 08:37


30/11/2012 12:31


04/12/2012 13:22

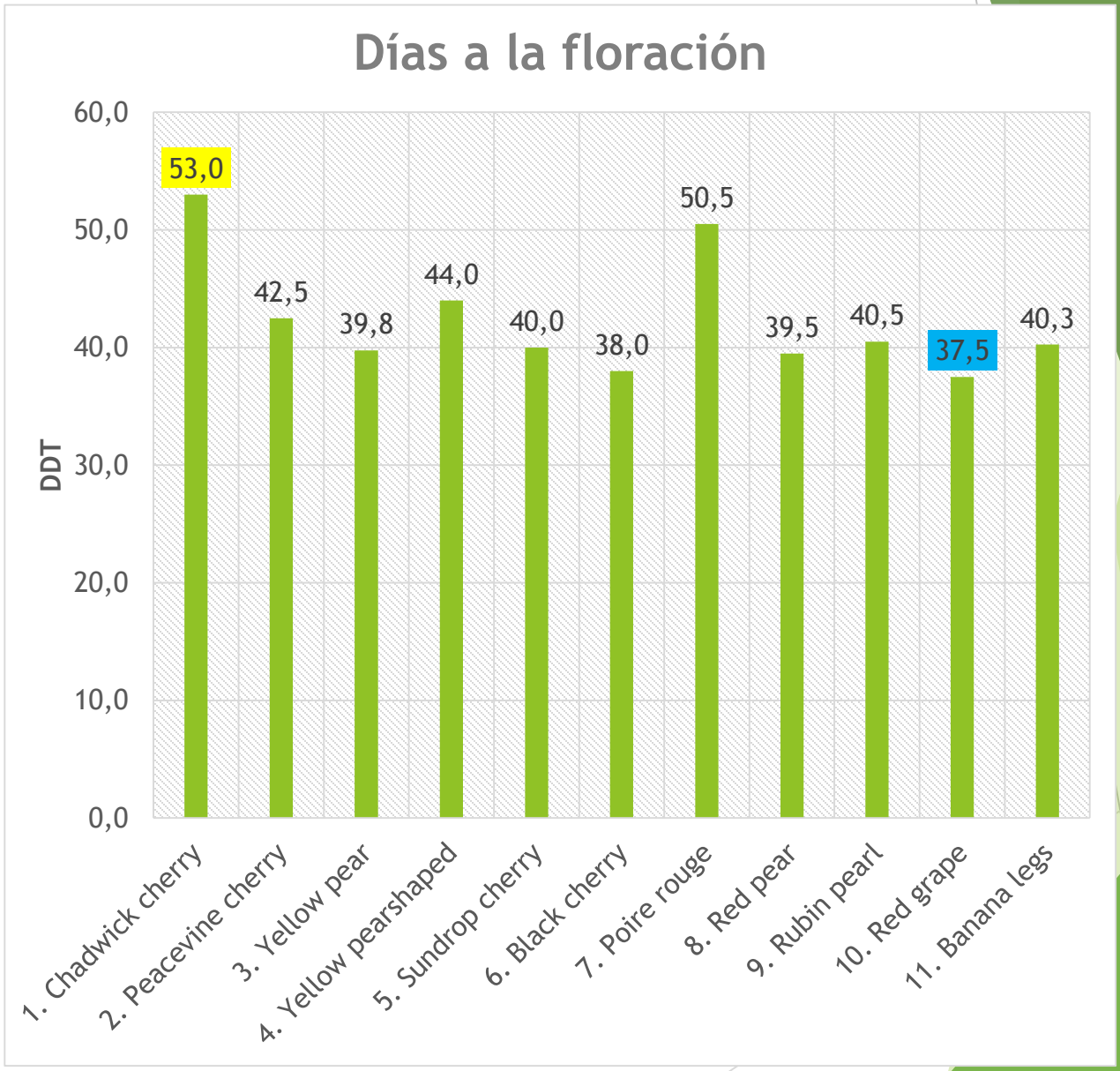

28/12/2012 10:13


14/12/2012 08:50

RESULTADOS Y DISCUSIÓN

Días a la floración

CULTIVAR	Días a la floración
Chadwick Cherry	53.00 a
Peacevine Cherry	42.50 cb
Yellow Pear	39.75 cd
Yellow Pearshaped	44.00 b
Sundrop Cherry	40.00 cd
Black Cherry	38.00 d
Poire Rouge	50.50 a
Red Pear	39.50 cd
Rubin Pearl	40.50 cd
Red Grape	37.50 d
Banana Legs	40.25 cd
PROMEDIO	**
Nivel de significación	42.3
C.V.	3.14

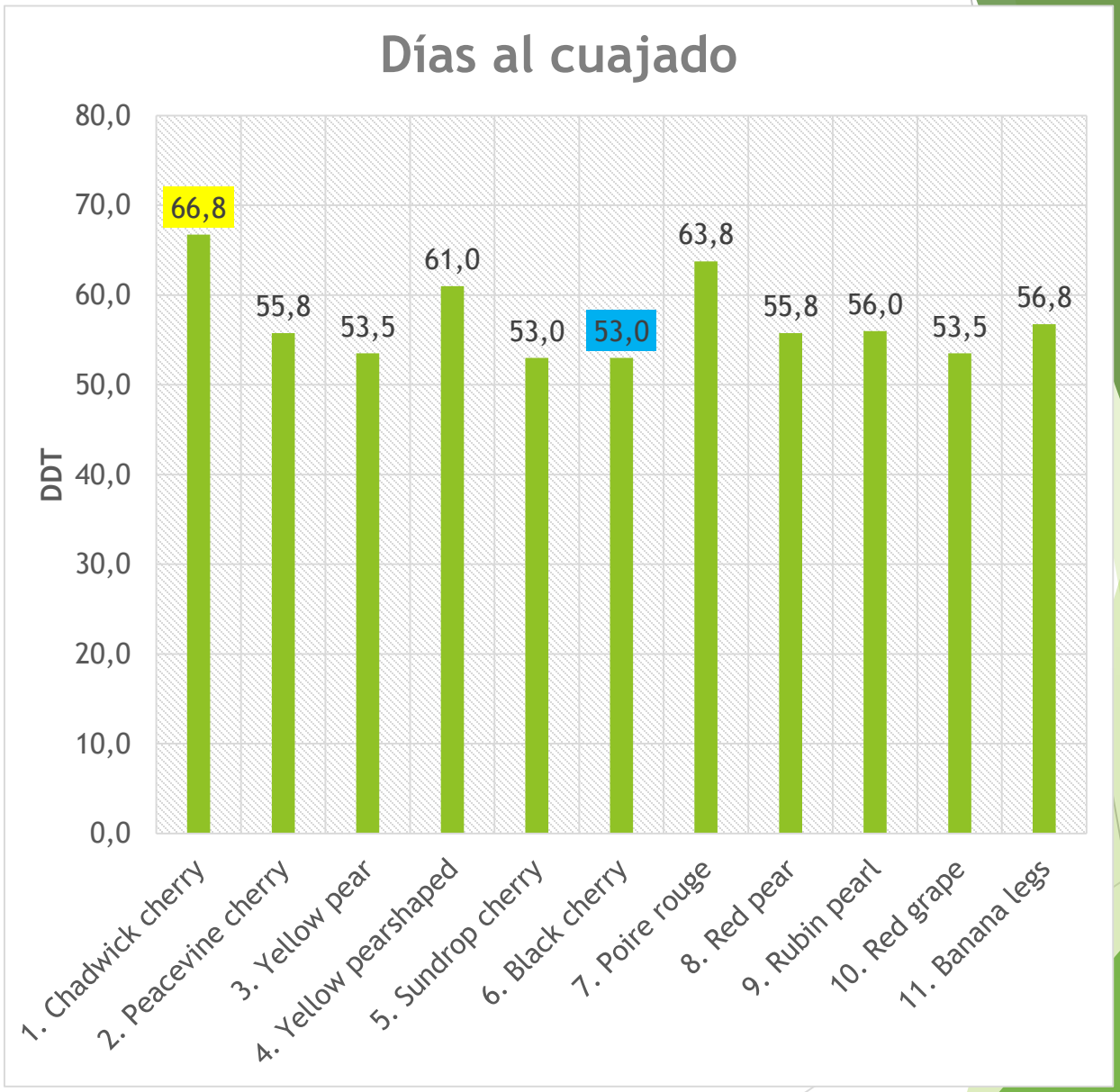


Chadwick Cherry

Red Grape

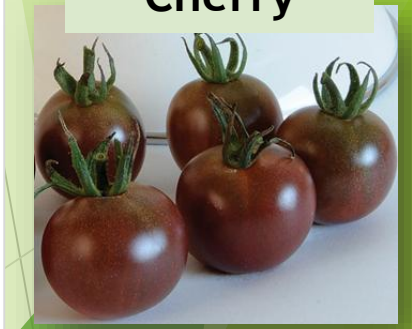
N°de días al cuajado

CULTIVAR	Días al cuajado
Chadwick Cherry	66.75 a
Peacevine Cherry	55.75 dc
Yellow Pear	53.50 dc
Yellow Pearshaped	61.00 b
Sundrop Cherry	53.00 d
Black Cherry	53.00 d
Poire Rouge	63.75 ba
Red Pear	55.75 dc
Rubin Pearl	56.00 dc
Red Grape	53.50 dc
Banana Legs	56.75 c
PROMEDIO	**
Nivel de significación	57.2
C.V.	2.40



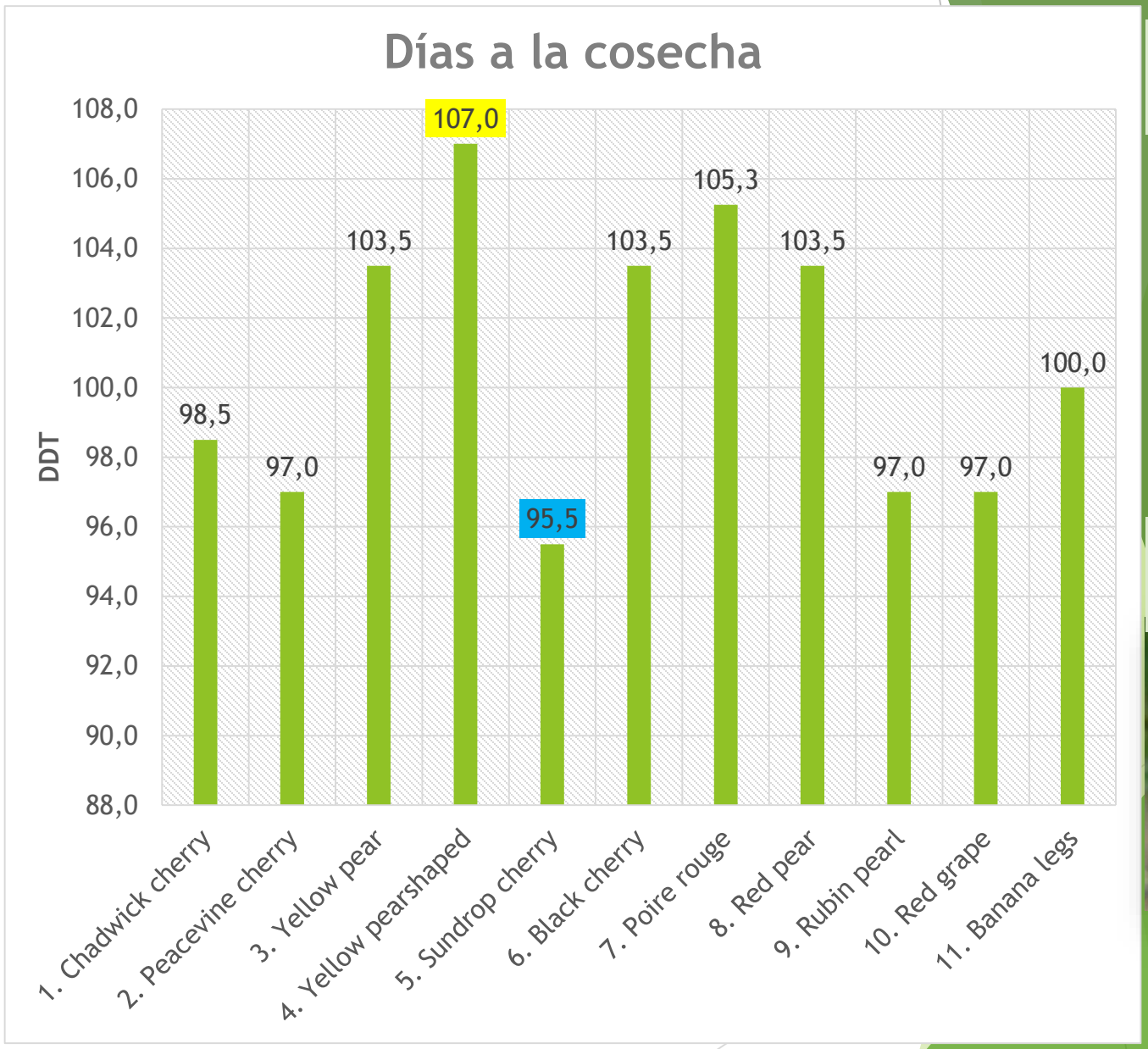
Chadwick Cherry

Black Cherry



Días a la cosecha

CULTIVAR	Días a la cosecha
Chadwick Cherry	98.5 bc
Peacevine Cherry	97.00 c
Yellow Pear	103.50 bac
Yellow Pearshaped	107.00 a
Sundrop Cherry	95.50 c
Black Cherry	103.50 bac
Poire Rouge	105.25 ba
Red Pear	103.50 bac
Rubin Pearl	97.00 c
Red Grape	97.00 c
Banana Legs	100.00 bac
PROMEDIO	**
Nivel de significación	100.7
C.V.	3.32

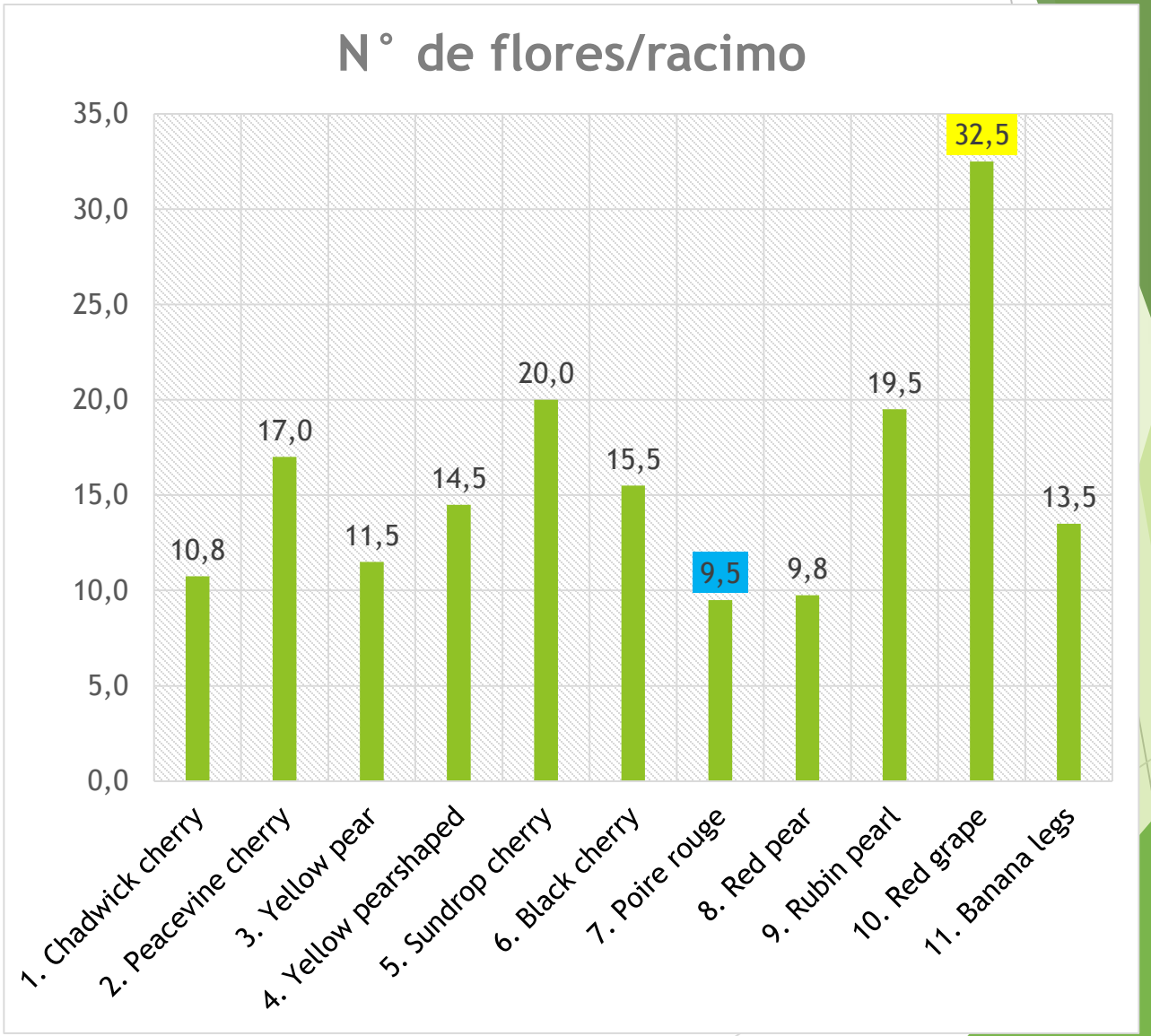


Yellow pearshaped

Sundrop Cherry

Nº de flores por racimo

CULTIVAR	N° de flores/racimo
Chadwick Cherry	10.75 fg
Peacevine Cherry	17.00 cb
Yellow Pear	11.50 fge
Yellow Pearshaped	14.50 cd
Sundrop Cherry	20.00 b
Black Cherry	15.50 cd
Poire Rouge	9.50 g
Red Pear	9.75 g
Rubin Pearl	19.50 b
Red Grape	32.50 a
Banana Legs	13.50 fde
PROMEDIO	**15.82**
Nivel de significación	**
C.V.	8.92

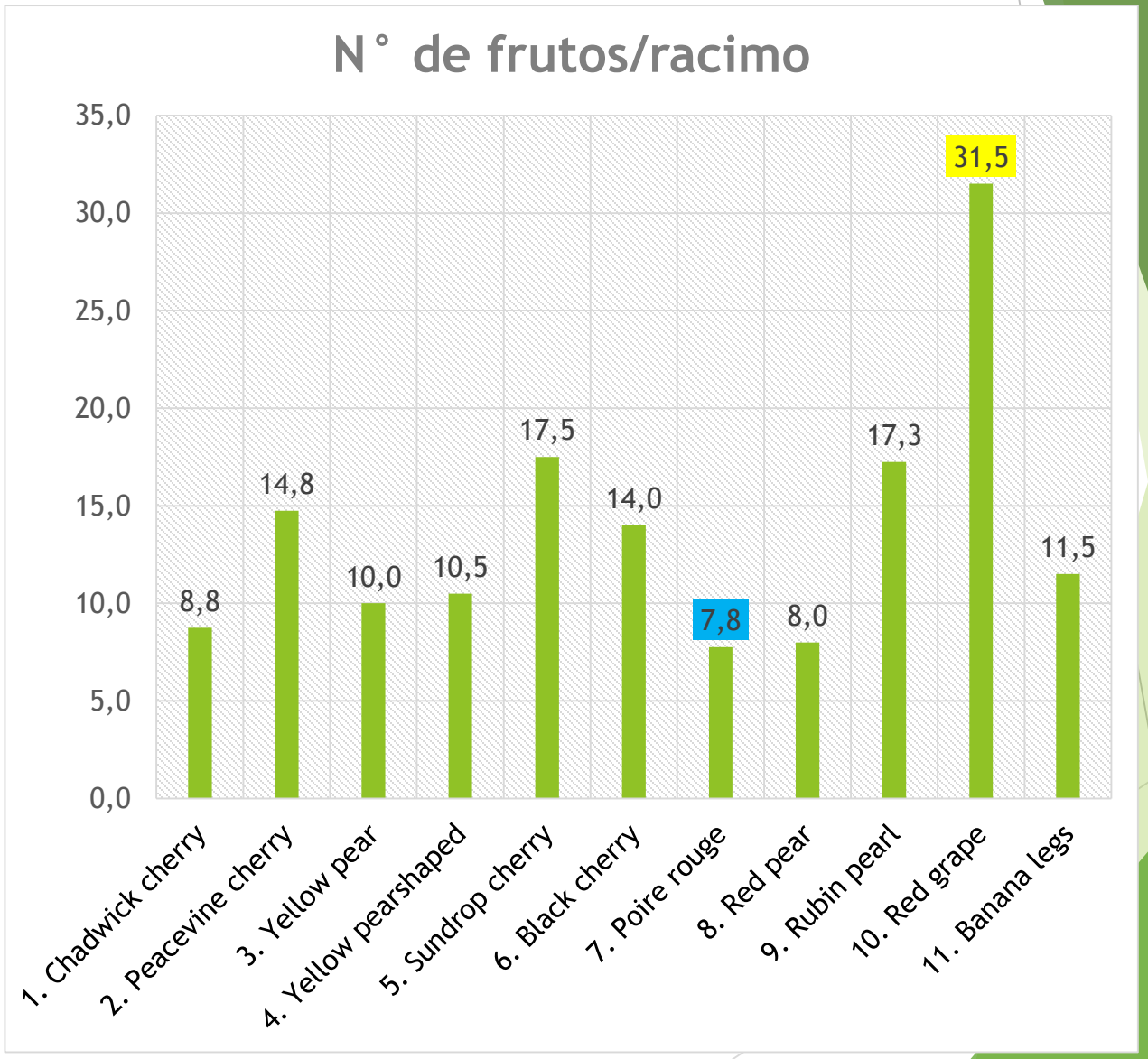


Red Grape

Poire Rouge

N° de frutos por racimo

CULTIVAR	N° de frutos/racimo
Chadwick Cherry	8.75 e
Peacevine Cherry	14.75 cb
Yellow Pear	10.00 ed
Yellow Pearshaped	10.50 ced
Sundrop Cherry	17.50 b
Black Cherry	14.00 cbd
Poire Rouge	7.75 e
Red Pear	8.00 e
Rubin Pearl	17.25 b
Red Grape	31.50 a
Banana Legs	11.5 ced
PROMEDIO	**13.77**
Nivel de significación	**
C.V.	12.86

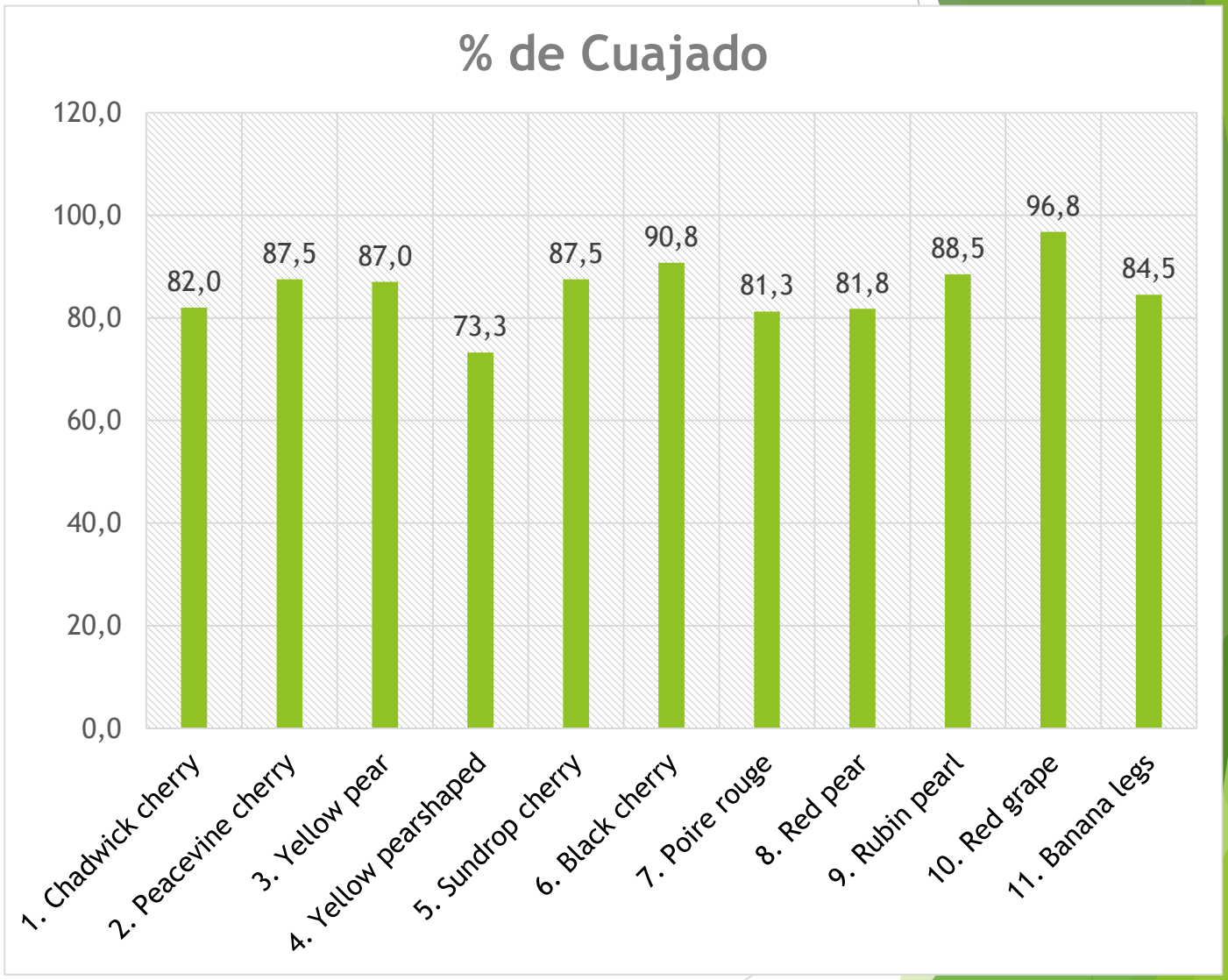


Red Grape

Poire Rouge

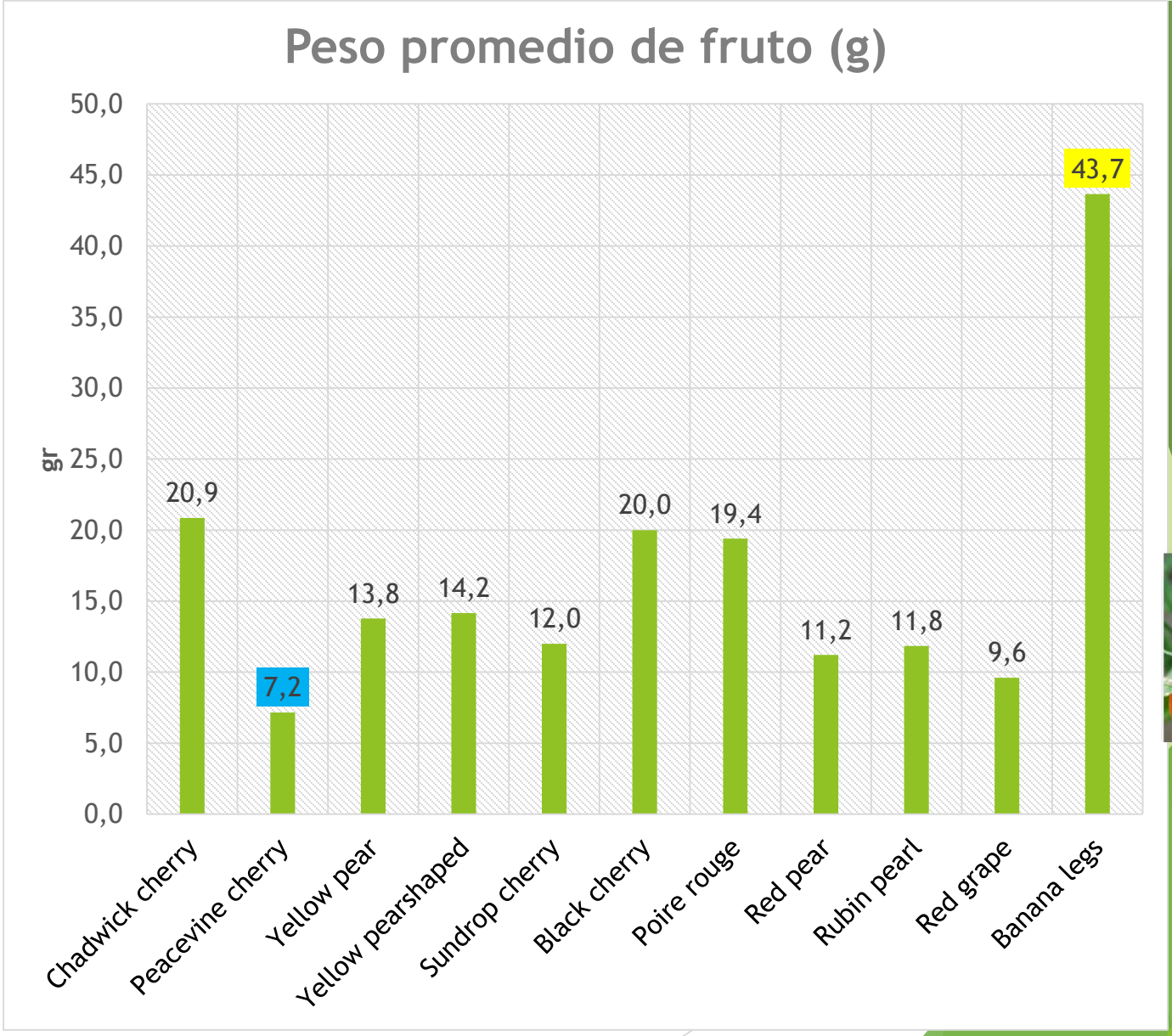
Porcentaje de cuajado

CULTIVAR	% de Cuajado
Chadwick Cherry	82.00
Peacevine Cherry	87.50
Yellow Pear	87.00
Yellow Pearshaped	73.25
Sundrop Cherry	87.50
Black Cherry	90.75
Poire Rouge	81.25
Red Pear	81.75
Rubin Pearl	88.50
Red Grape	96.75
Banana Legs	84.50
PROMEDIO	**85.52**
Nivel de significación	n.s.
C.V.	11.40

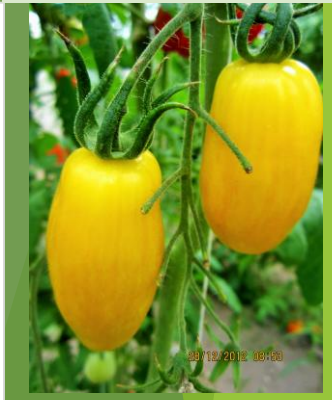


Peso promedio de fruto (g)

CULTIVAR	Peso promedio de fruto (g)
Chadwick Cherry	20.85 b
Peacevine Cherry	7.16 d
Yellow Pear	13.77 c
Yellow Pearshaped	14.16 c
Sundrop Cherry	12.00 dc
Black Cherry	20.00 b
Poire Rouge	19.40 b
Red Pear	11.21 dc
Rubin Pearl	11.84 dc
Red Grape	9.61 dc
Banana Legs	43.66 a
Nivel de significación	**
C.V.	12.24



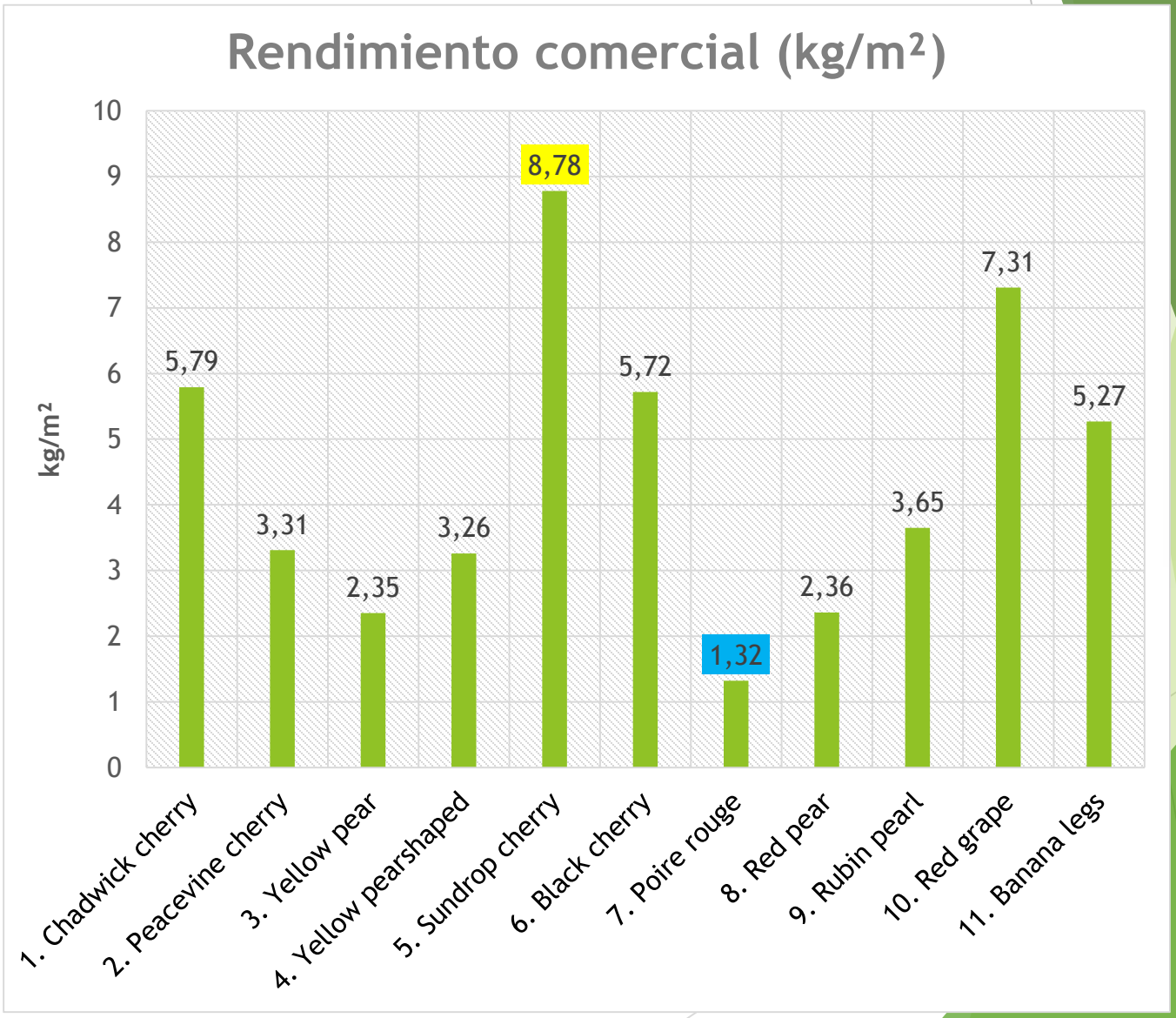
Bannana legs



Peacevine cherry

Rendimiento comercial (kg/m²)

CULTIVAR	Rdto. comercial (kg/m²)
Chadwick Cherry	5.79b
Peacevine Cherry	3.31efd
Yellow Pear	2.35ef
Yellow Pearshaped	3.26efd
Sundrop Cherry	8.78a
Black Cherry	5.72bc
Poire Rouge	1.32f
Red Pear	2.36ef
Rubin Pearl	3.65ecd
Red Grape	7.31ba
Banana Legs	5.27bcd
PROMEDIO	**4.47**
Nivel de significación	**
C.V.	19.28



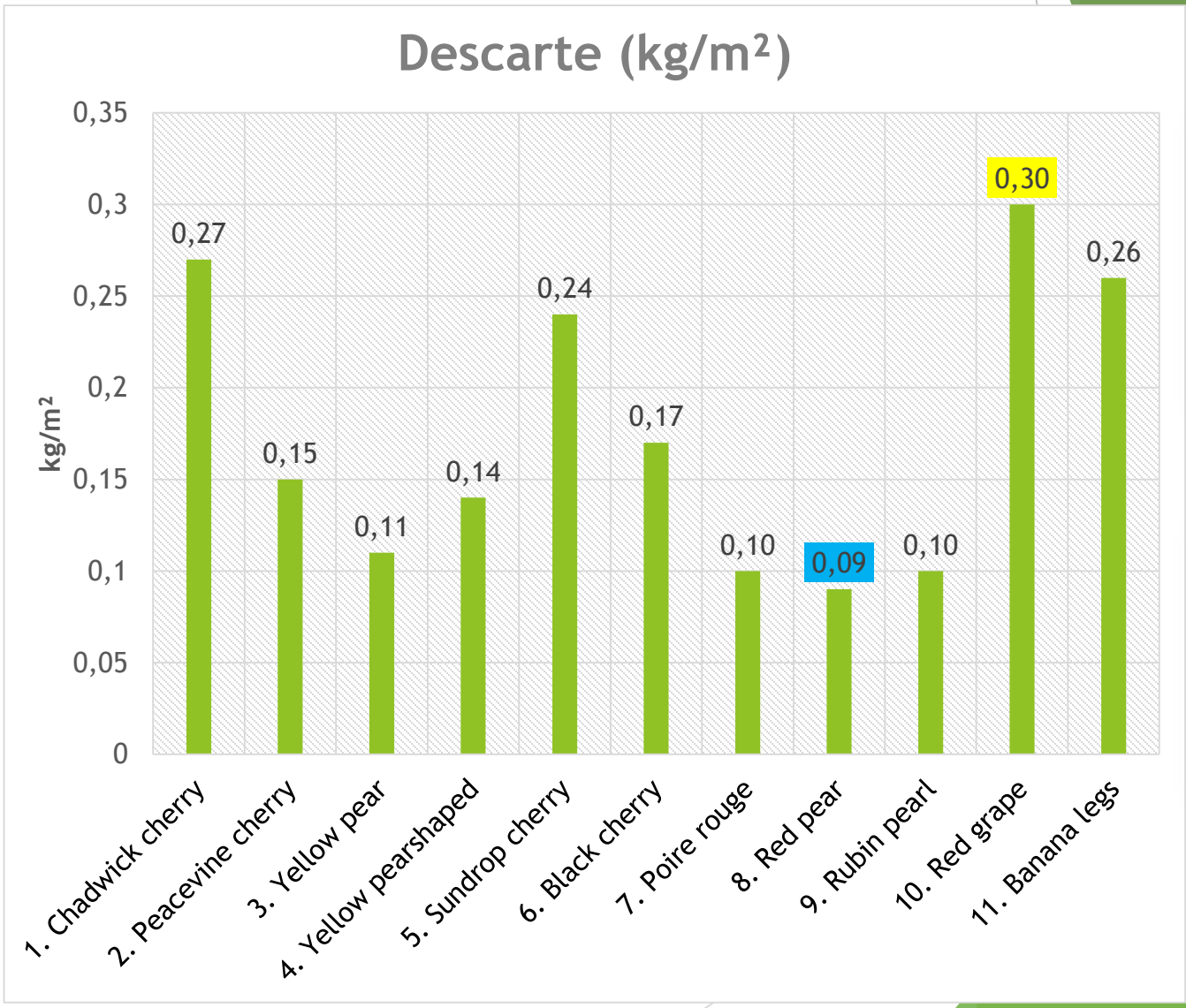
Sundrop Cherry

Red Grape

Poire Rouge

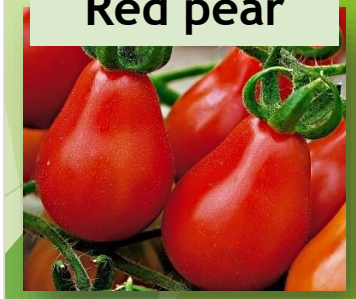
Descarte (kg/m²)

CULTIVAR	Descarte (kg/m²)
Chadwick Cherry	0.27ba
Peacevine Cherry	0.15dc
Yellow Pear	0.11d
Yellow Pearshaped	0.14dc
Sundrop Cherry	0.24bac
Black Cherry	0.17bdc
Poire Rouge	0.10d
Red Pear	0.09d
Rubin Pearl	0.10d
Red Grape	0.30a
Banana Legs	0.26ba
PROMEDIO	**0.18**
Nivel de significación	**
C.V.	26.94



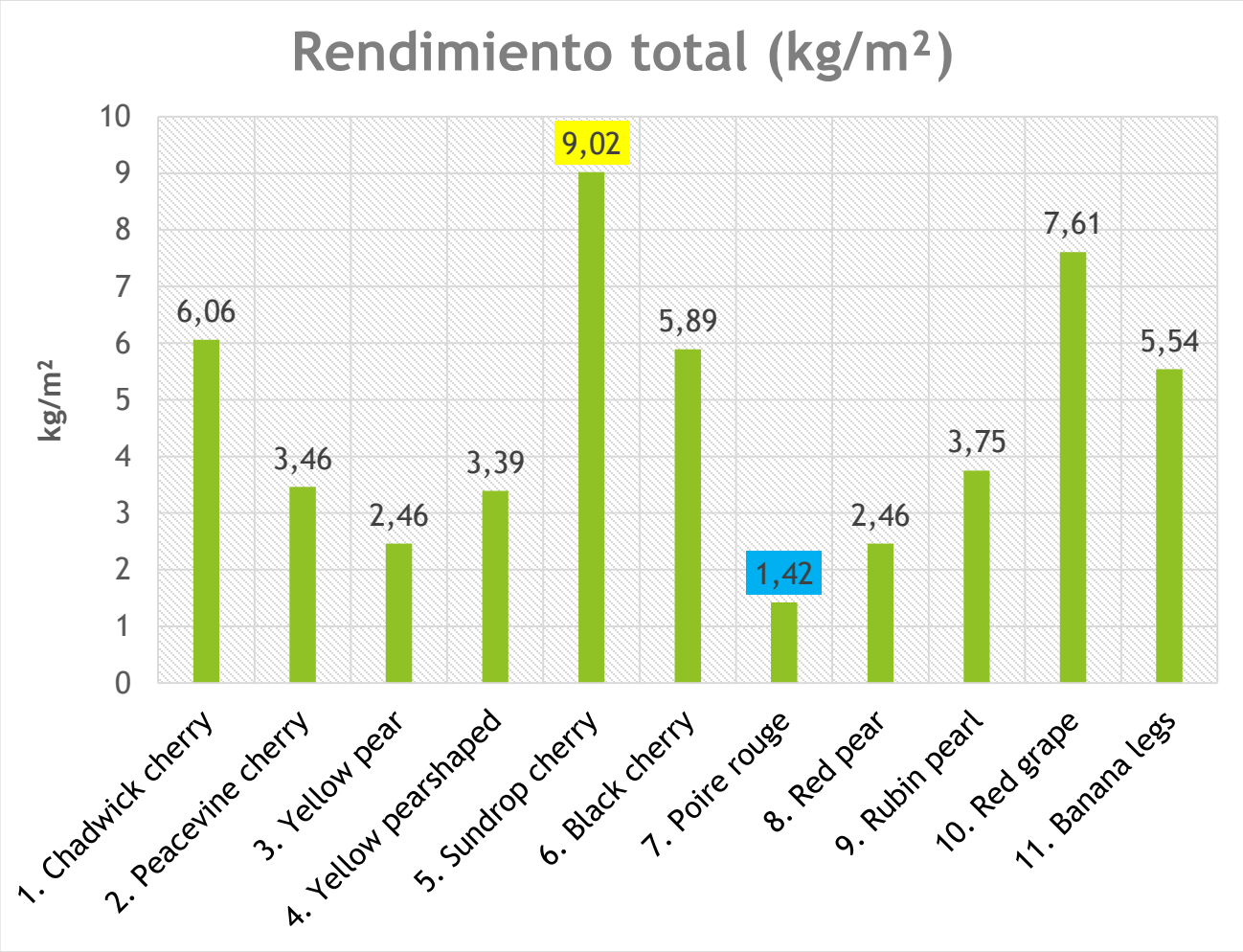
Red Grape

Red pear



Rendimiento total (kg/m²)

CULTIVAR	Rendimiento total (kg/m²)
Chadwick Cherry	6.06b
Peacevine Cherry	3.46efd
Yellow Pear	2.46ef
Yellow Pearshaped	3.39efd
Sundrop Cherry	9.02a
Black Cherry	5.89bc
Poire Rouge	1.42f
Red Pear	2.46ef
Rubin Pearl	3.75ecd
Red Grape	7.61ba
Banana Legs	5.54bcd
PROMEDIO	**4.64**
Nivel de significación	**
C.V.	18.91



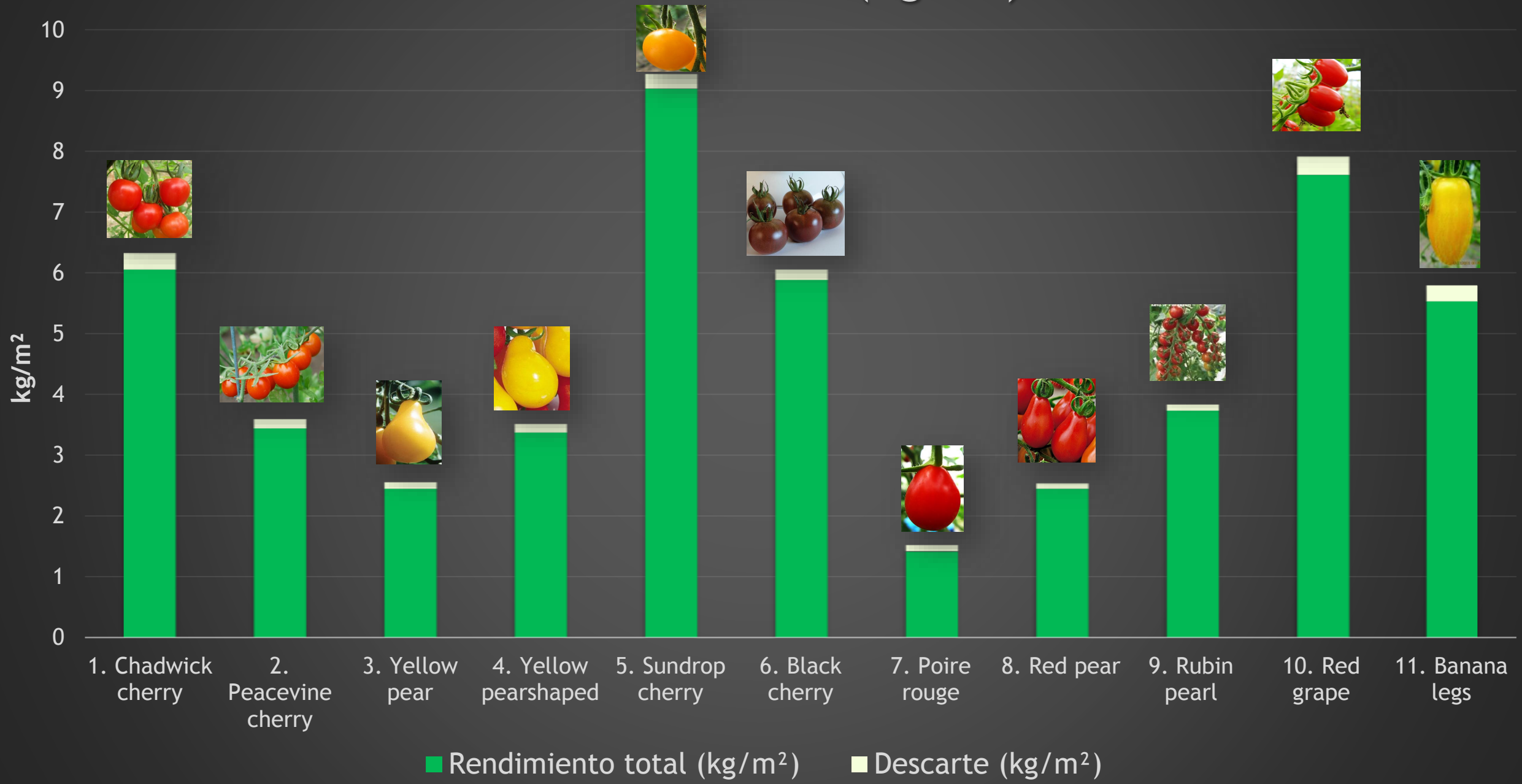
Sundrop Cherry

Red Grape

Poire Rouge

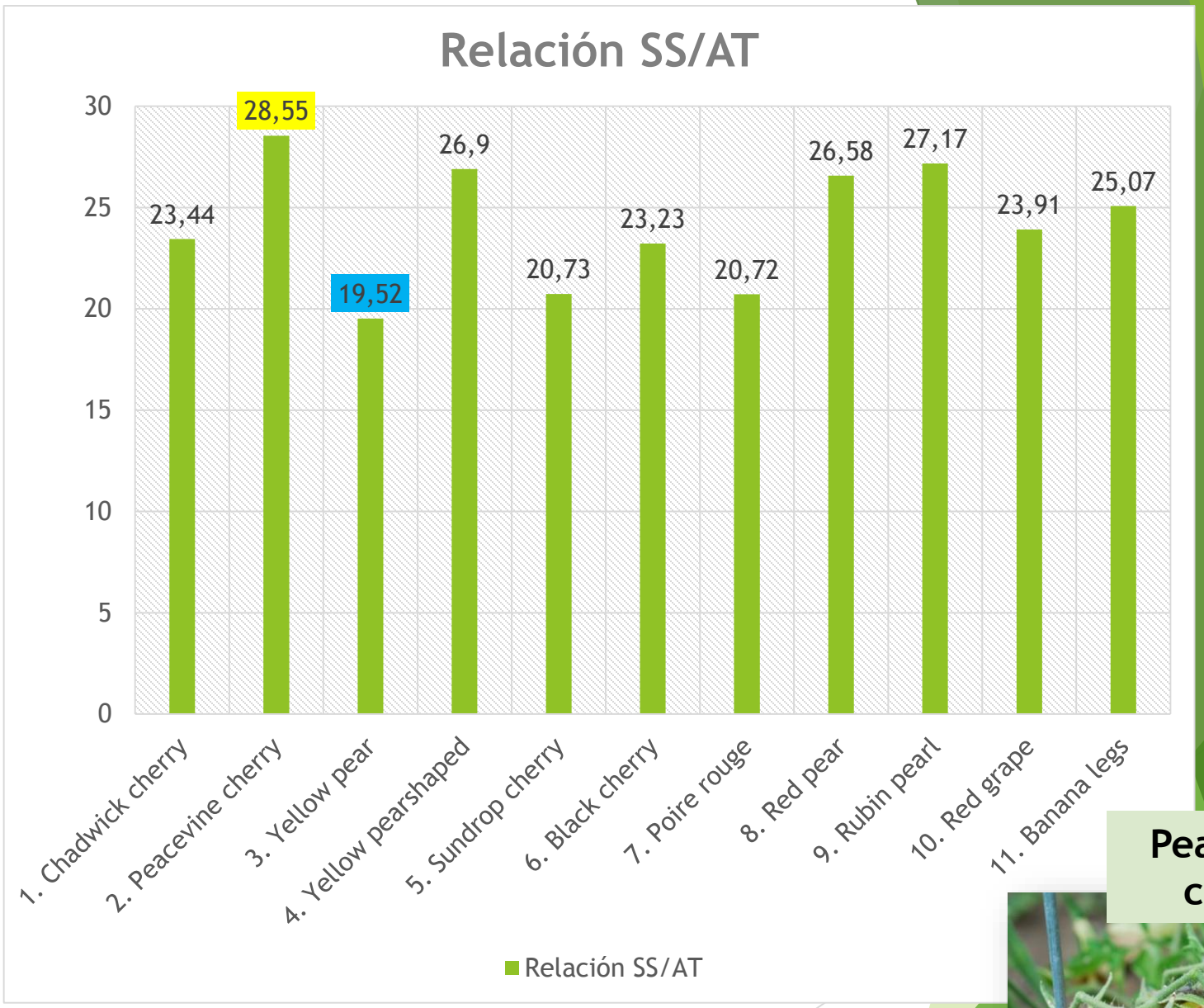
Tomate miniatura en invernadero (kg/m²)	
***Orgánico**	***Convencional**
5.2 (Márquez y Cano, 2005)	9.5 (Márquez y Cano, 2005)
1.3 – 10.8 (Arenas, 2006)	7- 10 (Brandán, 2009)

Rendimiento total (kg/m²)



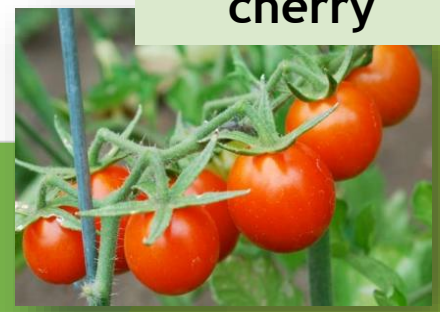
Calidad de fruto

CULTIVAR	Relación SS/AT
Chadwick Cherry	23.44 de
Peacevine Cherry	28.55 a
Yellow Pear	19.52 f
Yellow Pearshaped	26.90 ba
Sundrop Cherry	20.73 f
Black Cherry	23.23 e
Poire Rouge	20.72 f
Red Pear	26.58 bc
Rubin Pearl	27.17 ba
Red Grape	23.91 de
Banana Legs	25.07 dc
PROMEDIO	23.62
Nivel de significación	**
C.V.	2.89



En general los tomates tienen un mejor sabor cuando presentan una relación mayor o igual a 10 (Kader *et al.*).

Peacevine cherry



Análisis económico

TRATAMIENTOS	Valor bruto de la producción (Nuevos Soles/m^2)	Costos de producción (Nuevos Soles/m^2)	Utilidad neta (Nuevos Soles/m^2)	Índice de rentabilidad (%)
Chadwick Cherry	72.72	21.35	51.37	240.63
Peacevine Cherry	41.52	20.87	20.65	98.94
Yellow Pear	29.52	21.02	8.50	40.45
Yellow Pearshaped	40.68	21.76	18.92	86.99
Sundrop Cherry	108.24	21.23	87.01	409.83
Black Cherry	70.68	21.07	49.61	235.46
Poire Rouge	17.04	20.77	-3.73	-17.97
Red Pear	29.52	20.94	8.58	40.99
Rubin Pearl	45.00	24.18	20.82	86.13
Red Grape	91.32	21.65	69.67	321.83
Banana Legs	66.48	21.46	45.02	209.81

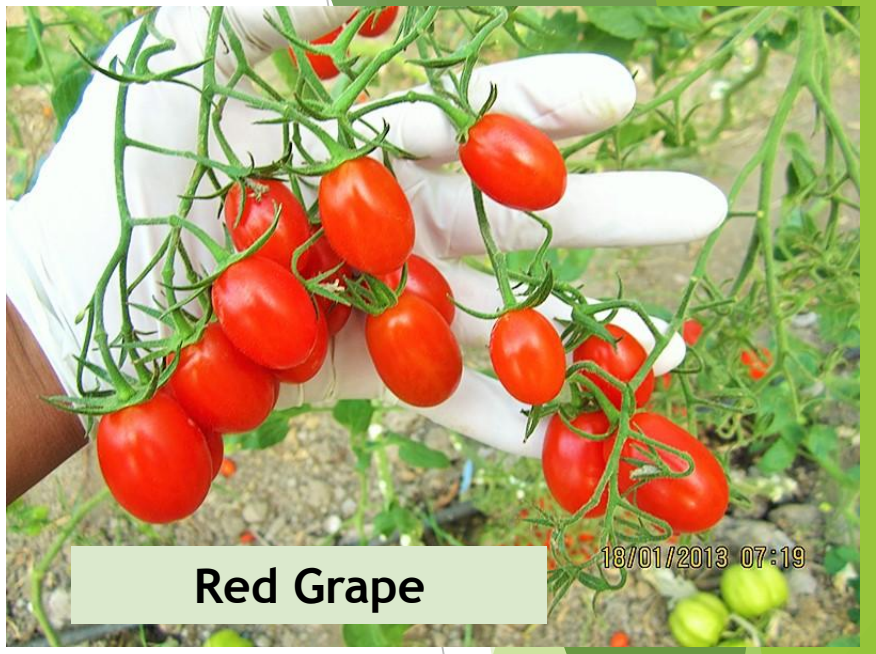
Sundrop Cherry

Poire Rouge

CONCLUSIONES

- Se hallaron diferencias estadísticas altamente significativas para el rendimiento de los 11 cultivares de tomate miniatura, siendo los **cultivares Sundrop Cherry (9.02 kg/m²) y Red Grape (7.61 kg/m²)** los que obtuvieron los mayores rendimientos.

- La calidad interna de los frutos en cuanto a pH, porcentaje de sólidos solubles, acidez titulable y la relación sólidos solubles/acidez titulable) presentó diferencias estadísticas altamente significativas. Se destaca el alto valor en la relación entre Sólidos Solubles/Acidez Titulable, valor relacionado directamente con el sabor.



- La mayor rentabilidad se obtuvo con el cultivar **Sundrop Cherry (409.83%)** seguido de los cultivares, **Red Grape (321.83%),** Chadwick Cherry (240.63%) y Black Cherry (235.46%).
- La producción orgánica de tomate miniatura en invernadero en el valle de Mala muestra un alto potencial productivo y de rentabilidad, con altas posibilidades de su introducción en el mercado.

Red Grape

Sundrop Cherry

Potential Production of Organic Greenhouse Tomato (*Solanum lycopersicum*) by Small Farmers on the Coast of Peru.

Saray Siura, Ximena Reynafarje, Yvan Calero & Alicia Barreda

The Vegetable Crops Research Program. La Molina National Agrarian University, Lima, Peru

Tomato (*Solanum lycopersicum* L.) is one of the most consumed vegetables in Peru with an average yield of 16 t ha^{-1} in open field production [1]. Tomatoes are cropped in the coastline throughout the year, generating production loss by recurrent pests and diseases, which are increased by temperature and high humidity. This in turn causes an excessive use of agrochemicals, which generates a threat of toxicity, higher production costs and negative environmental impacts [2]. Therefore, the objectives of this study were to evaluate sustainable management practices, such as crop rotation, soil microorganism's inoculation, green manure incorporation and cultivar selection in rustic greenhouses by small farmers in Peruvian Coastline.

Demonstrative greenhouses were installed at Mala Valley and La Molina University (*El Huerto*). Training courses with small vegetable farmers were organized in order to teach alternatives management practices such as construction of small greenhouses using rustic materials, pruning, tutoring, cultivar selection, and alternatives pest control methods, growing season, crop rotation and green manure incorporation. These practical courses were organized to help farmers reduce pesticides use, obtain lower production costs and to benefit with new market opportunities. After the training phase finished, farmers pilot plots follow ups were performed to see how farmers are willing to adopt sustainable management practice.

Methods and Results

Three experiments were carried between 2011 and 2013 under organic greenhouses production; plants were sown reaching a density of two plants/m^2 with drip irrigation system. Experiments were: (a) Effect of compost and buckwheat (*Fagopyrum esculentum*) and crotalaria (*Crotalaria juncea*) incorporation; (b) Use of commercial lactic acid bacteria and (c) Evaluation of cherry tomato cultivars for gourmet markets. These experiments were designed to demonstrate the viability of small greenhouse horticulture using alternative management practices, which can improve small farmer's income, health conditions and be sustainable for the environment.

Production increased from 8.94 to 10.1 kg m^{-2} when compost was used before planting; when crotalaria (*Crotalaria juncea*) or buckwheat (*Fagopyrum esculentum*) were incorporated to soil, yields obtained were 9.24 and 9.84 kg m^{-2} reaching higher values than treatment without incorporation 8.56 kg m^{-2}. A trial with cherry cultivars (*Solanum lycopersicum* var. *cerasiforme*) obtained yields up to 8 kg m^{-2}. The use of commercial lactic acid bacteria (*Azospirillum, Azotobacter, Lactobacillus*) before planting increased tomato yield from 8.3 to 9.32 kg m^{-2}.

In the three experiments, we observed that compost and green manure incorporation improved the yields and quality of tomato production in organic greenhouses. A study evaluating the effect of green manure incorporation obtained similar results in six experiments performed between 1993 & 1995 [3].

Sustainable practices such as determination of the adequate growing season, crop rotation and association reduces the appearances of plagues lowering the excessive use of pesticides [4]. Practical courses and follow-ups show the interest among farmers to learn and share experiences about alternative management practices in order to increase yields and reduce the excessive use of pesticides.

In recent years, peruvian market for organic products has substantially grown driven by the rise of the local cuisine and the generation of new export markets for fresh products, such as tomato. The local market for organic products reaches between 13.1 and 23.2 million U.S. dollars per year [5]. Introduction of new tomato cultivars with gourmet potential, represent an opportunity for small farmers to improve their incomes by accessing new specialized markets.

We concluded that organic greenhouse tomato production using green manure incorporation; compost, lactic acid bacteria and introduction of new cultivars by small vegetable farmers are sustainable alternatives to improve the productivity and quality of the organic tomato crop in the peruvian coastline.

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