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INTERNATIONAL POTATO CENTER



Final Report

Potato clones with genes for defence against bacterial diseases

A collaborative project with
the Weizmann Institute of Science
Rehovot, Israel

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Executive summary

Thirty-four transgenic plants of the potato genotypes Achirana-INTA, Désirée, LT-9 and TS-10 produced at the Weizmann Institute of Science were evaluated at CIP for resistance to bacterial pathogens in laboratory and field conditions. The foreign gene inserted was the sarcotoxin-IA gene whose product shown to have bactericidal effect. The expression of this gene was driven by either a tuber-specific promoter (*pat*) or a root-specific promoter (*tob*).

Damage by *Erwinia carotovora* subsp. *carotovora* in laboratory conditions was significantly less than non-transgenic controls for one Désirée line and three TS-10 lines. However, when these plants were grown in a naturally infected field with *Ralstonia solanacearum*, none of the transgenic lines tested proved to present resistance to bacterial diseases.

As these results shown moderate levels of resistance in controlled laboratory conditions but not in the field, new strategies focussing on increasing the expression of the sarcotoxin-IA gene should be undertaken to confer a significant level of resistance to bacterial diseases in potato.

Project objective

The main objective of this collaborative project with CIP was to evaluate the resistance to bacterial diseases of transgenic potato plants with high expression levels of the sarcotoxin-IA gene from the flesh fly *Sarcophaga peregrina*.

The transformation of potato genotypes was done by Prof. Esra Galun and his group at the Weizmann Institute of Science (Department of Plant Genetics, Israel). The "best" transgenic plants (high expressers of sarcotoxin-IA gene) were transferred to CIP to be evaluated for their resistance level to potato bacterial pathogens in laboratory conditions (Crop Protection Department) and in the field (Crop Improvement and Genetic Resources Department) under the responsibility of Dr. Ali Golmirzaie.

Potato clones with genes for defence against bacterial diseases

Four potato genotypes (Achirana-INTA, Désirée, LT-9 and TS-10) were selected from CIP's in vitro genebank and transferred to the Weizmann Institute of Science (Israel) for plant transformation, because of their importance in potato breeding programs and their susceptibility to major bacterial diseases. As control for disease evaluations, Cruza-148, Molinera and Yana Puna were included as a reference set with various levels of resistance to bacterial diseases (Table 1).

Transgenic potato lines (Désirée, TS-10, Achirana INTA and LT-9 genotypes) bearing the **sarcotoxin-IA** gene were received from the laboratory of Prof. Esra Galun (The Weizmann Institute of Science, Israel): 12 of them had the gene that was driven by the tuber-specific *patatin* promoter —PS lines— and 22 by the root-specific *tob* promoter —TS lines— (Table 2).

1. Evaluation of potato tubers by descriptors. Crop Improvement and Genetic Resources Department.

In vitro transgenic plants were propagated and transferred to Jiffy-7 pots in a growing chamber. After two weeks, plants were transferred to 8-inch plastic pots for potato tuberization in greenhouse. After 90 days, tubers were harvested and analyzed by morphological descriptors according Huamán *et al.* (1977). The most evident modification was observed for TS-1 transgenic line (Désirée), which had dark pink homogeneously distributed in tubers (control had white-cream in addition to principal pink color). Additionally, tubers for this line were round shape while control was long-oblong; the flesh color was the same that control. See Table 3. This result for TS-1 was repeatedly observed for in vitro plantlets and plants growing in greenhouse.

2. Laboratory experiment with *Erwinia carotovora* subsp. *carotovora*, isolate CIP-400.

Crop Protection Department. Bacteriology Laboratory

These transgenic potato lines were evaluated for resistance to bacterial wilt caused by *Erwinia carotovora* subsp. *carotovora* in the laboratory. Tubers were produced in 8-inches pots. Five to ten tubers were assayed per clone. Tubers were cut in half and each section was inoculated with 5×10^8 or 2.5×10^9 ufc/ml of CIP-400 bacterial strain. The inoculation was done in a cylindrical hole (3-mm diameter and 2-mm deep) produced with a core borer N° 3 in the middle of the exposed medulla, and placing 20- μ l of bacterial culture. Infected tubers were then incubated in a wet chamber at 25°C for two days. At that time, rotted mass was eliminated and intact mass was weighted. This allowed us to calculate the Rotting Relative Percentage (RRP):

$$\text{RRP} = \frac{\text{Total weight} - \text{Intact tuber weight}}{\text{Total weight}} \times 100$$

Data were mathematically transformed using the Arc Seno square root of RRP, and analyzed by SAS (Statistical Analysis System) software.

All evaluated lines showed rotting. However, the transgenic lines Désirée (TS-14) and TS-10 (PS-8, PS-9, PS-6), resulted to be less susceptible than untransformed control (Figure 1). Unfortunately, untransformed Achirana-INTA was not included in laboratory experiments due to insufficient tuber quantities after harvest, but low rotting values for PS-12 and PS-1 were also obtained. Yana Puna genotype was included as moderately resistant control (Table 4).

Table 1. Potato genotypes selected from CIP's in vitro genebank for plant transformation, and their response to bacterial diseases. Other control genotypes were analyzed as controls.

CIP number	Genotype	Response to bacterial disease		
		Black leg	Bacterial wilt	Soft rot
720088	Achirana-INTA	S	S	S
800048	Désirée	S	MR	S
379706.34	LT-9	S	S	-
386626.51	TS-10	-	-	-
720118	Cruza-148	S	R	S
800222	Molinera	S	MR	S
703321	Yana Puna	R	-	R

S = susceptible

MR = moderately resistant

R = resistant

Source: Pathogen Test List collection, CIP.

Table 2. Transgenic potato lines bearing the sarcotoxin I-A gene driven by *pat* (PS lines) or *tob* (TS lines) promoter, received by CIP from The Weizmann Institute of Science and evaluated under laboratory or field conditions.

Line	Genotype	Evaluations	
		Laboratory	Field
PS-1	Achirana-INTA	✓	✓
PS-7	Achirana-INTA	✓	✓
PS-10	Achirana-INTA	X	✓
PS-11	Achirana-INTA	X	✓
PS-12	Achirana-INTA	✓	✓
PS-13	Achirana-INTA	✓	✓
PS-2	TS-10	✓	✓
PS-3	TS-10	✓	✓
PS-4	TS-10	✓	✓
PS-6	TS-10	✓	✓
PS-8	TS-10	✓	✓
PS-9	TS-10	✓	✓
TS-9	Achirana-INTA	✓	✓
TS-12	Achirana-INTA	✓	✓
TS-22	Achirana-INTA	✓	✓
TS-1 ^(*)	Désirée	X	X
TS-2	Désirée	✓	✓
TS-3	Désirée	✓	✓
TS-4	Désirée	✓	✓
TS-5	Désirée	✓	✓
TS-6	Désirée	X	✓
TS-10	Désirée	✓	✓
TS-14	Désirée	✓	✓
TS-15	Désirée	✓	✓
TS-16	Désirée	✓	✓
TS-21	Désirée	✓	✓
TS-23	Désirée	✓	✓
TS-24	Désirée	✓	✓
TS-29	LT-9	✓	✓
TS-11	TS-10	✓	✓
TS-20	TS-10	✓	✓
TS-26	TS-10	✓	✓
TS-27	TS-10	✓	✓
TS-28	TS-10	✓	✓

✓ = Evaluated; X = Not evaluated

^(*) This line was not adapted neither laboratory, greenhouse or field conditions.

Table 3. Evaluation of transgenic potato tubers by descriptors. Tuber skin, shape and flesh have been evaluated according Huamán *et al.* (1977).

Line	Phenotype tubers			Comments
	Skin	Shape	Flesh	
Achirana-INTA lines				
Control	1187	603	100	<ul style="list-style-type: none"> • Skin was white-cream for all lines; in addition, color was pale in control (1187) and medium color intensity in transgenic lines (1287). Purple color was distributed as small spots and was present in all tuber lines. • No differences were observed on shape (oblong, no rare shapes and shallow depth of tuber eyes) neither flesh (white without secondary color).
PS-1	1287	603	100	
PS-7	1287	603	100	
PS-10	1287	603	100	
PS-11	1287	603	100	
PS-12	1287	603	100	
PS-13	1287	603	100	
TS-9	1287	603	100	
TS-12	1287	603	100	
TS-22	1287	603	100	
Désirée lines				
Control	5211	703	100	<ul style="list-style-type: none"> • Skin was pink color with white-cream as secondary color in control (5211). TS-1 was dark pink without secondary color (5300); other tubers were dark pink with white-cream as secondary color located on tuber eyes (5311). • Shape was long-oblong and medium depth of tuber eyes in control and almost all lines (703); only TS-1 line had round tuber shape (203). • The flesh in control was white without secondary color (100); some transgenic lines had cream colored flesh (200).
TS-1	5300	203	100	
TS-2	5211	703	200	
TS-3	5211	703	200	
TS-4	5211	703	200	
TS-5	5211	703	100	
TS-6	5311	703	100	
TS-10	5311	703	200	
TS-14	5311	703	100	
TS-15	5311	703	100	
TS-16	5311	703	100	
TS-21	5211	703	100	
TS-23	5211	703	100	
TS-24	5211	703	100	

(Continues ...)

Table 3. Evaluation of transgenic potato tubers by descriptors. Tuber skin, shape and flesh have been evaluated according Huamán *et al.* (1977). (Cont.)

Line	Phenotype tubers			Comments
	Skin	Shape	Flesh	
LT-9 lines				
Control	2100	613	200	<ul style="list-style-type: none"> • There was no change on skin: palid yellow without secondary color (2100). • On shape, no change was observed on depth of tuber eyes (shallow), but control was oblong (613) and TS-29 was long-oblong (703). • Regarding flesh, it was cream color in control (200) and white in TS-29 (100).
TS-29	2100	703	100	
TS-10 lines				
Control	2100	603	200	<ul style="list-style-type: none"> • On skin all tubers were pale yellow color without secondary color (2100). • On shape, all tubers were oblong with shallow depth of eyes (603), except TS-11 which had medium depth of eyes (605). • The flesh was cream color with no secondary color for all tubers (200).
PS-2	2100	603	200	
PS-3	2100	603	200	
PS-4	2100	603	200	
PS-6	2100	603	200	
PS-8	2100	603	200	
PS-9	2100	603	200	
TS-11	2100	605	200	
TS-20	2100	603	200	
TS-26	2100	603	200	
TS-27	2100	603	200	
TS-28	2100	603	200	

Reference: Huamán, Z.; Williams, J. T.; Salhuana, W. and Vincent, L. 1977. A list of descriptors for the cultivated potato and for the maintenance and distribution of germplasm collection. Annex I of the Report of the Planning Conference on the utilization of the Genetic Resources of the Potato II. International Potato Center, Lima, Perú.

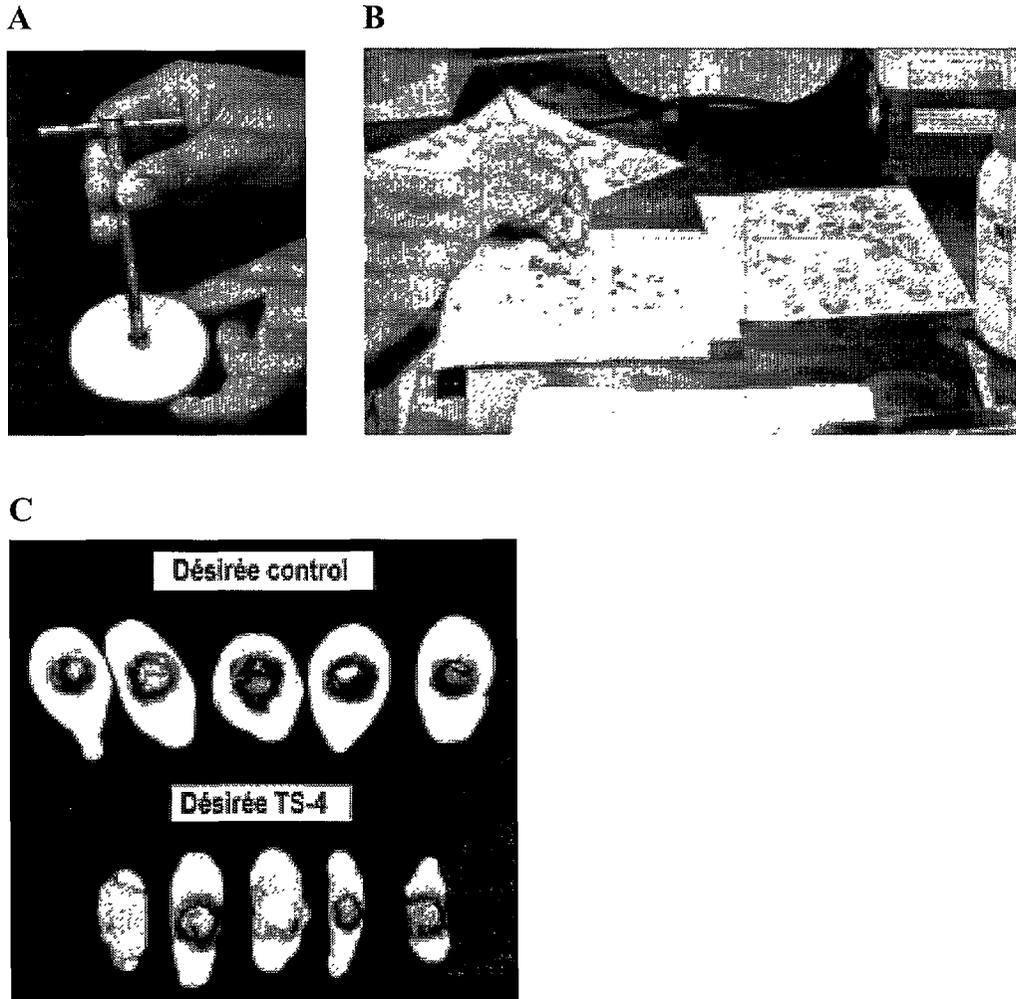


Figure 1. Inoculation of potato tubers with CIP-400 isolate of *Erwinia carotovora* subsp. *carotovora*. **A:** Cylindrical hole in a half potato tuber, **B:** Evaluation of rotting, **C:** Damage by bacteria at 5×10^8 ufc/ml on tubers.

Table 4. Rotting Relative Percentage (RRP) of transgenic potato tubers bearing the sarcotoxin I-A gene inoculated with two concentrations of *Erwinia carotovora* subsp. *carotovora*.

Transgenic line	Rotting Relative Percentage	
	Inoculum concentration	
	5 x 10 ⁸ ufc/ml	2.5 x 10 ⁹ ufc/ml
<u>Désirée lines</u>		
Control (S)	9.7 d	10.5 f
TS-14	4.0 c	3.9 b
<u>TS-10 lines</u>		
Control (S)	10.8 e	14.2 g
PS-8	2.9 b	3.8 b
PS-9	4.1 c	5.6 d
PS-6	4.2 c	4.7 c
<u>Achirana-INTA lines</u>		
PS-12	2.6 b	6.7 e
PS-1	3.6 c	4.8 c
Yana Puna (MR, control)	0.12 a	0.49 a

Values followed by the same letter are not significantly different at probability level P = 0.05 according to Waller-Duncan statistical test. S = susceptible; MR = moderately resistant.

**3. Field trial in a *Ralstonia solanacearum*, Biovar 1 (race 1)-natural infected field at San Ramón CIP station, Perú.
Crop Protection Department. Bacteriology Laboratory
Crop Improvement and Genetic Resources Department.**

A field experiment was done with several transgenic potato plants bearing the sarcotoxin-IA gene, at the CIP experimental station in San Ramón, Perú (tropical weather, 800 m above sea level). This is a suitable location for the field trials because fields are naturally infested with *Ralstonia solanacearum* Biovar 1 (Race 1) and the absence of relatives of the potato in this environment (Figure 3). Sprouts from potato tubers were planted in the field (November 7, 1998), following a random block design with 4 repetitions. Five tubers per line were used per repetition, which allowed us to evaluate 20 plants per transgenic clone. Untransformed Désirée, TS-10, Achirana-INTA and LT-9 were included in this trial as control plants. A maize row to identify the field trial was surrounding the field and, as biosafety measure, flowering buds were periodically eliminated during the trial (Figure 3). The field trial was performed according CIP's biosafety regulations approved by the Ministry of Agriculture of Perú, in coordination with SENASA, the Agrarian Sanitary National Service (Figure 5).

Evaluations of the progress of the disease on foliage were done every 15 days. After 4 evaluations, all of the transgenic and untransformed lines displayed foliar wilting typical of *Ralstonia solanacearum* disease.

At harvest on February 15 of 1999, the following data were evaluated: the percentage of surviving plants, the number of surviving plants per row, the average number of tubers per surviving plant and the average weight for each tuber. Data were analyzed using the Waller-Duncan test and Dunnett's t test. For statistical reasons of the mathematical model, for TS-29, the only one LT-9 transgenic line, only the Dunnett's t test was applied.

The bacterial population on field-damaged tubers was not statistically different on non-transgenic control plants. The only difference was observed for PS-12 and PS-10 lines, which showed higher average number of tubers per surviving plant in comparison to Achirana-INTA and the non-transformed control. However, the average weight for each tuber of these two lines was no significantly different from non-transgenic control

plants (tubers from PS-12 and PS-10 weighted less than control). Actually, PS-12 and PS-10 lines produced more tubers than control, but smaller.

For other evaluations, no significant differences were found between transgenic lines and their respective untransformed control.

Pictures from field trial are showed in Figure 6 (Achirana-INTA), Figure 7 (Désirée), Figure 8 (LT-9) and Figure 9 (TS-10).

4. Discussion and conclusion

Bacterial pathogens are responsible of one of the major diseases affecting the potato. Host plant resistance is low among known potato varieties and breeding lines. A genetic engineering approach offers to introduce specific genes coding bactericidal proteins directly into potato varieties. The group of S. Natori identified one of these proteins in larvae of the flesh fly *Sarcophaga peregrina* in 1977, and named it sarcotoxin-IA. By using the sarcotoxin-IA gene under the control of either a tuber-specific (*pat*) or a root-specific (*tob*) promoter, it was introduced via *Agrobacterium tumefaciens* into four potato varieties by the Weizmann Institute of Science. The lines expressing the highest level of expression of the sarcotoxin-IA gene were sent to CIP for disease resistance evaluation.

The research carried out in laboratory tests at the International Potato Center revealed several transgenic lines of the genotypes Désirée, TS-10 and Achirana-INTA as promising ones for bacterial resistance. TS-14 (Désirée genotype), and PS-6, PS-8 and PS-9 (TS-10 genotype) lines displayed significantly less damage than non-transgenic controls when tubers were infected with either 5×10^8 ufc/ml or 2.5×10^9 ufc/ml cultures of the potato pathogenic bacteria *Erwinia carotovora* subsp. *carotovora*. This observation coincides with the expected high expression in tubers conferred by the patatin promoter used in the PS lines. However, all transgenic lines field tested displayed damages on stems and tubers caused by another potato pathogen, *Ralstonia solanacearum* (formerly known as *Pseudomonas solanacearum*). No significant differences with non-transgenic control plants were observed in the field.

In our field experiments obviously plants were exposed not only to bacterial pathogens but also to other pathogens including opportunist pests and pathogens. Hence, the conditions prevailing in our field trials are much more stringent than laboratory conditions where single pathogen at minute doses can be tested. This result show how important is the field-testing and that such experiment needs to be conducted over several years and on a large scale.

The morphology of the 34 lines from the Weizmann Institute of Science was evaluated in the greenhouse and in the field. No important differences were observed between transgenic and non-transgenic plants. Only one line (TS-1 Désirée) displayed reduced foliage and small tubers. This line grew as a weak and small plant under in vitro

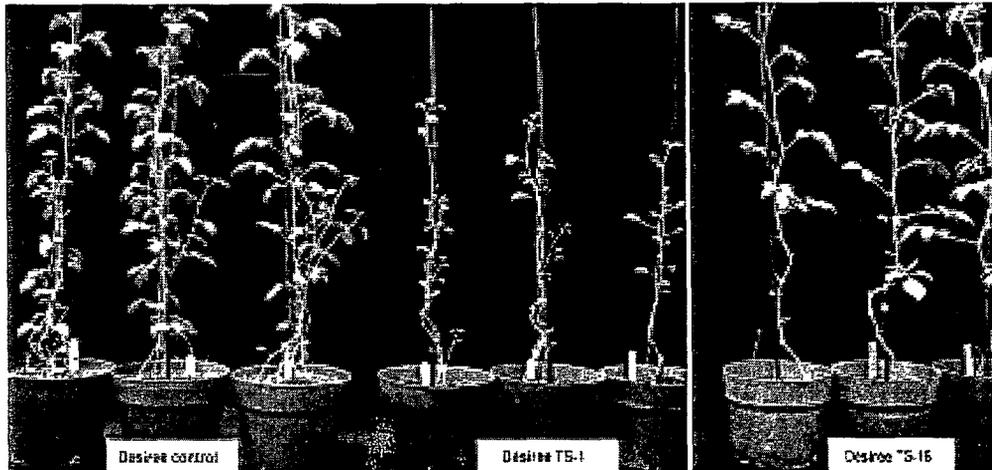
conditions and when taken to the greenhouse, same anomalies were observed. There were no significant differences between the other 33 transgenic lines and non-transgenic control. The observed difference cannot be ascribed to the gene itself or its specific expression because of low frequency. It is likely due to the regeneration process itself rather than the sarcotoxin gene, as this process is known to confer phenotypic variability in such frequency.

Several reports from other authors have demonstrated the usefulness of the sarcotoxin-IA gene to confer resistance to bacterial diseases. Our laboratory results confirm the effectiveness of this gene as a candidate to confer bacterial resistance in potato. However, levels of resistance were not high enough to protect the potato under field conditions where the transgenic lines were affected by bacterial wilt. As this disease caused by *R. solanacearum* is the most serious bacterial disease of potato in warm regions of the world (it affects more than 30 plant families, including potato, tobacco, tomato, eggplant and chili), we suggest to redesign the strategy of expression of antibacterial proteins. The use of other promoters, the introduction of secretory signals in the gene constructs or the combination of several antibacterial proteins and peptides are few possibilities to engineer higher levels of resistance to bacteria.

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- Nakajima, Y., Qu, X. M. and Natori, S. 1987. Interaction between liposomes and sarcotoxin IA, a potent antibacterial protein of *Sarcophaga peregrina* (flesh fly). *Journal of Biological Chemistry*, 262: 1665-1669.
- Natori, S. 1977. Bactericidal substance induced in the hemolymph of *Sarcophaga peregrina* larvae (flesh fly). *Journal of Insect Physiology*, 23: 1169-1173.
- Sheerman, S. and Beva, M. W. 1988. A rapid transformation method for *Solanum tuberosum* using *Agrobacterium tumefaciens*. *Plant Cell Reports*, 7: 13-16.

A



B

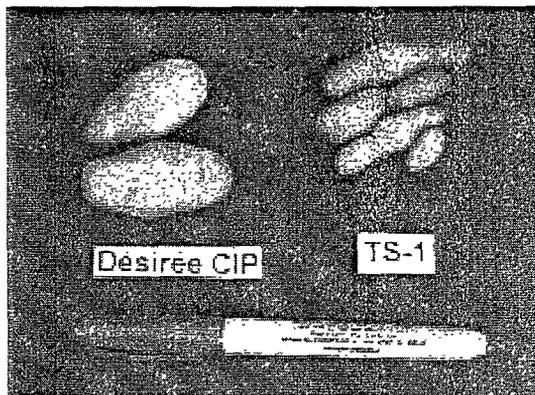


Figure 2. Greenhouse performance of transgenic plants. **A:** Plants of the genotype Désirée (control, TS-1 and TS-16). **B:** Tubers from Désirée control and TS-1 line, produced in 8-inches pots.

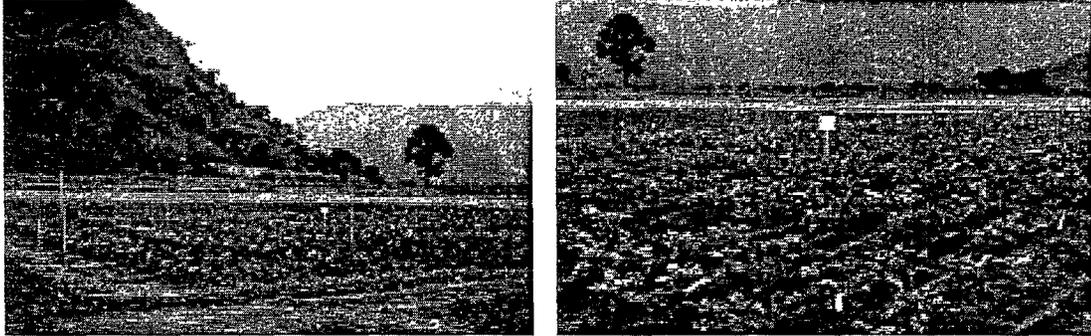


Figure 3. Views of the field trial in San Ramón. November 24th, 1998. Planting was done on November 7th, 1998.



Figure 4. Transgenic potato field on January 18th, 1999. A general view (left) and flower buds removal (right). Note the maize row surrounding the field trial and patches where very susceptible lines were destroyed by bacteria.



Figure 5. CIP scientist responsible for experiments with transgenic plants explains to the officer from SENASA (Agrarian Sanitary National Service of the Peruvian Ministry of Agriculture) how plant material was identified in the field. CIP San Ramón station (November 25th, 1998).

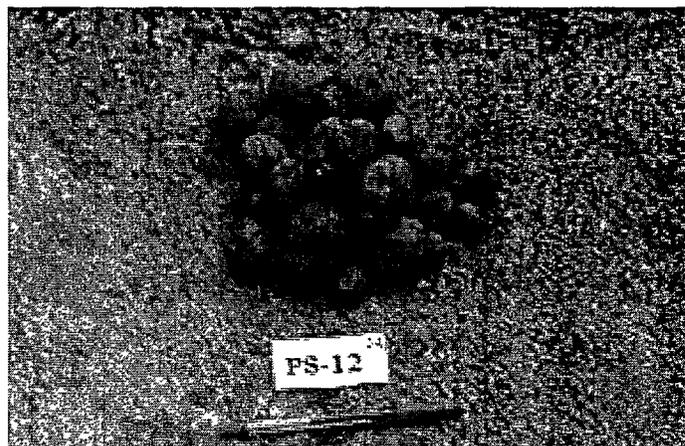
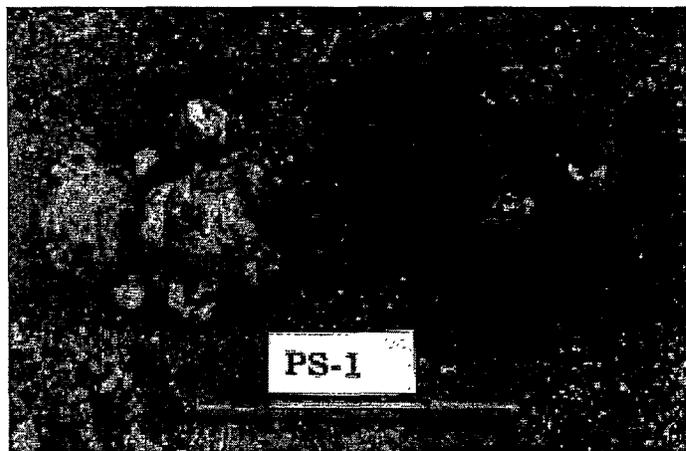
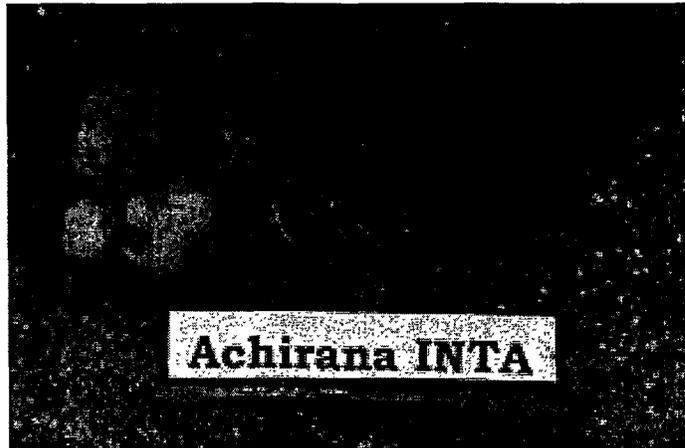


Figure 6. Harvest of the field trial (CIP San Ramón station, February 15, 1999): Achirana-INTA potato plants.

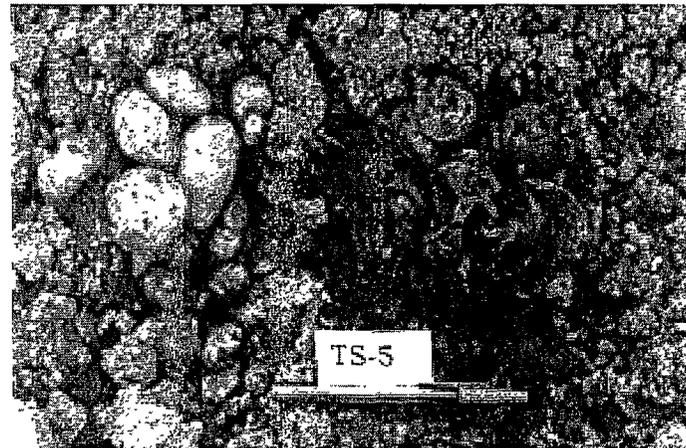
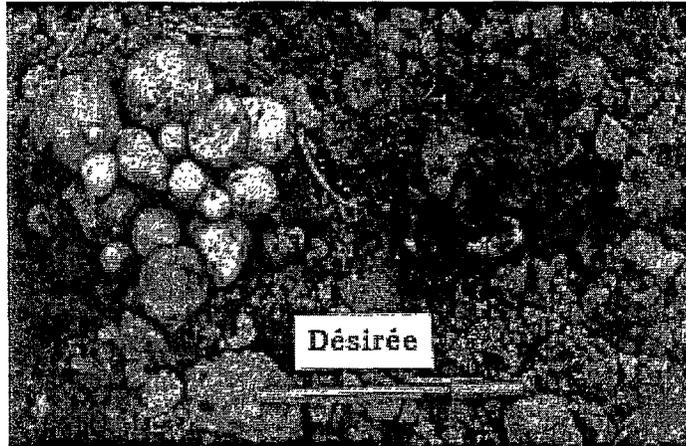


Figure 7. Harvest of the field trial (CIP San Ramón station, February 15, 1999): Désirée potato plants.

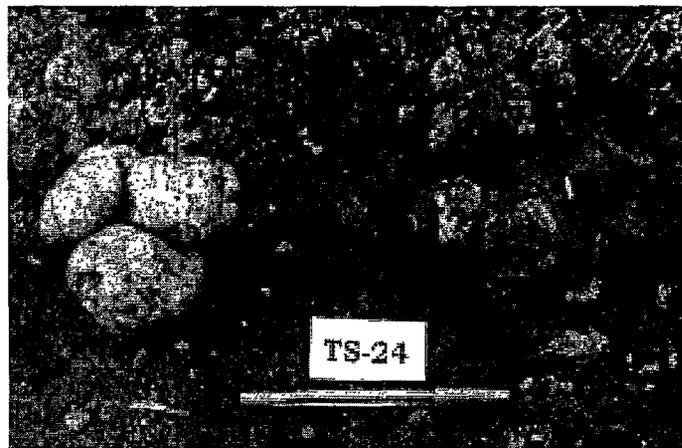
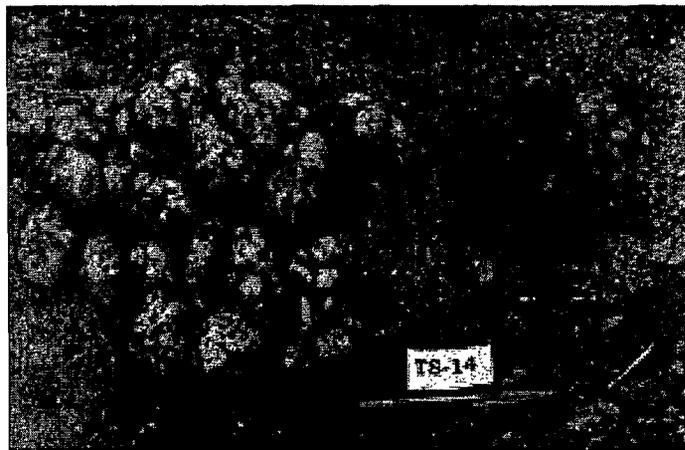


Figure 7. Harvest of the field trial (CIP San Ramón station, February 15, 1999): Désirée potato plants. (*Cont.*)

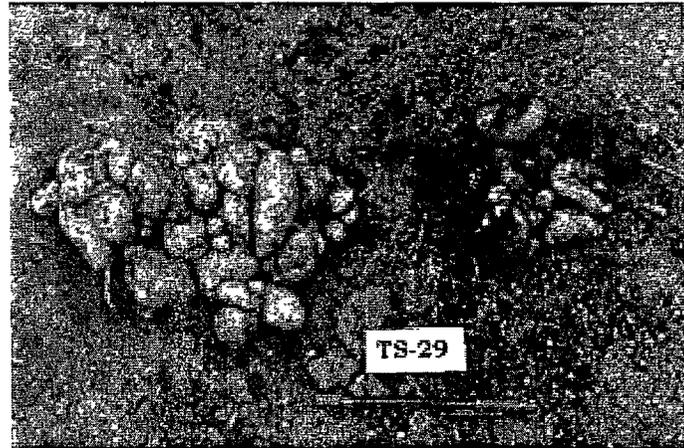
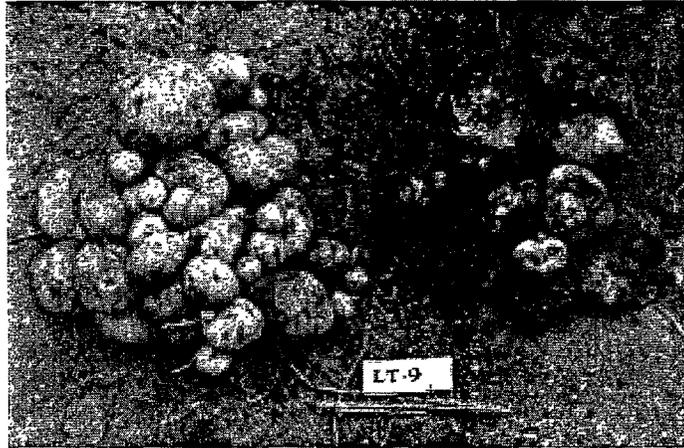


Figure 8. Harvest of the field trial (CIP San Ramón station, February 15, 1999): LT-9 potato plants.

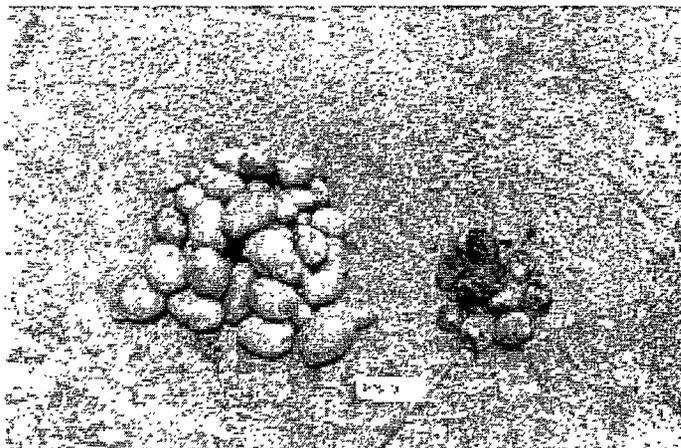
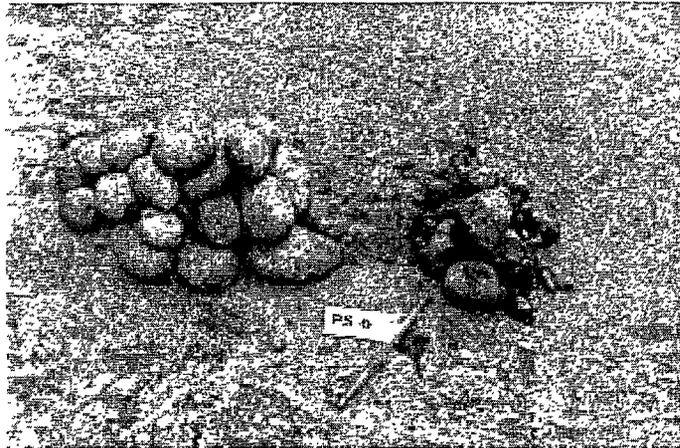


Figure 9. Harvest of the field trial (CIP San Ramón station, February 15, 1999): TS-10 potato plants.

APPENDIX

Table A-1.- Harvest data for **control potato genotypes** analysed after growth in a *Ralstonia solanacearum*-infested field. **Waller-Duncan** test. N = number of sowed rows (5 sowed plants per row). Means with the same letter are not significantly different.

a) Variable: surviving percentage of plants
(Pr > F 0.1156; minimum significant difference: 40.745)

Grouping	Mean	N	Line
A	62.50	8	Control TS-10
A	60.00	8	Control LT-9
A	55.00	8	Control Achirana-INTA
A	55.00	4	Control Molinera
A	45.00	8	Control Désirée
A	22.50	8	Control Cruza-148

b) Variable: Number of surviving plants per row
(Pr > F 0.1156; minimum significant difference: 2.0372)

Grouping	Mean	N	Line
A	62.50	8	Control TS-10
A	60.00	8	Control LT-9
A	55.00	8	Control Achirana-INTA
A	55.00	4	Control Molinera
A	45.00	8	Control Désirée
A	22.50	8	Control Cruza-148

c) Variable: Average number of tubers per surviving plant
(Pr > F 0.1466; minimum significant difference: 8.4159)

Grouping	Mean	N	Line
A	10.688	8	Control Désirée
A	9.838	8	Control TS-10
A	9.196	8	Control LT-9
A	7.668	4	Control Molinera
A	4.420	8	Control Achirana-INTA
A	3.979	8	Control Cruza-148

d) Variable: Average weight for each tuber
(Pr > F 0.0331; minimum significant difference: 38.592)

Grouping	Mean	N	Line
A	67.61	8	Control LT-9
B	49.21	8	Control Achirana-INTA
B	46.01	4	Control Molinera
B	35.77	8	Control TS-10
B	34.63	8	Control Désirée
B	12.90	8	Control Cruza-148

Table A-2.- Harvest data for **control potato genotypes** analysed after growth in a *Ralstonia solanacearum*-infested field. Dunnett's t test for **Achirana-INTA** compared to other genotypes. N = number of sowed rows (5 sowed plants per row). Comparisons significant at the 0.05 level are indicated by ***. Critical value of Dunnett's t: 2.63519).

a) Variable: Surviving percentage of plants

Line comparison		Difference between means	Simultaneous 95% confidence interval	
Control TS-10	- Control Achirana-INTA	7.50	-32.03	47.03
Control LT-9	- Control Achirana-INTA	5.00	-34.53	44.53
Control Molinera	- CONTROL ACHIRANA-INTA	0.00	-48.41	48.41
Control Désirée	- CONTROL ACHIRANA-INTA	-10.00	-49.53	29.53
Control Cruza-148	- CONTROL ACHIRANA-INTA	-32.50	-72.03	7.03

b) Variable: Number of surviving plants per row

Line comparison		Difference between means	Simultaneous 95% confidence interval	
Control TS-10	- Control Achirana-INTA	7.50	-32.03	47.03
Control LT-9	- Control Achirana-INTA	5.00	-34.53	44.53
Control Molinera	- Control Achirana-INTA	0.00	-48.41	48.41
Control Désirée	- Control Achirana-INTA	-10.00	-49.53	29.53
Control Cruza-148	- Control Achirana-INTA	-32.50	-72.03	7.03

c) Variable: Average number of tubers per surviving plant

Line comparison		Difference between means	Simultaneous 95% confidence interval	
Control Désirée	- Control Achirana-INTA	6.268	-1.729	14.264
Control TS-10	- Control Achirana-INTA	5.418	-2.579	13.414
Control LT-9	- Control Achirana-INTA	4.776	-3.220	12.773
Control Molinera	- Control Achirana-INTA	3.248	-6.546	13.041
Control Cruza-148	- Control Achirana-INTA	-0.441	-8.438	7.555

d) Variable: Average weight for each tuber

Line comparison		Difference between means	Simultaneous 95% confidence interval	
Control LT-9	- Control Achirana-INTA	18.40	-22.46	59.26
Control Molinera	- Control Achirana-INTA	-3.20	-53.25	46.85
Control TS-10	- Control Achirana-INTA	-13.44	-54.30	27.43
Control Désirée	- Control Achirana-INTA	-14.58	-55.44	26.29
Control Cruza-148	- Control Achirana-INTA	-36.31	-77.17	4.56

Table A-3.- Harvest data for **control potato genotypes** analysed after growth in a *Ralstonia solanacearum*-infested field. Dunnett's t test for **Désirée** compared to other genotypes. N = number of sowed rows (5 sowed plants per row). Comparisons significant at the 0.05 level are indicated by ***. Critical value of Dunnett's t: 2.63519).

a) Variable: Surviving percentage of plants

Line comparison			Difference between means	Simultaneous 95% confidence interval	
Control	TS-10	- Control	Désirée	17.50	-22.03 57.03
Control	LT-9	- Control	Désirée	15.00	-24.53 54.53
Control	Achirana-INTA	- Control	Désirée	10.00	-29.53 49.53
Control	Molinera	- Control	Désirée	10.00	-38.41 58.41
Control	Cruza-148	- Control	Désirée	-22.50	-62.03 17.03

b) Variable: Number of surviving plants per row

Line comparison			Difference between means	Simultaneous 95% confidence interval	
Control	TS-10	- Control	Désirée	0.8750	-1.1014 2.8514
Control	LT-9	- Control	Désirée	0.7500	-1.2264 2.7264
Control	Achirana-INTA	- Control	Désirée	0.5000	-1.4764 2.4764
Control	Molinera	- Control	Désirée	0.5000	-1.9206 2.9206
Control	Cruza-148	- Control	Désirée	-1.1250	-3.1014 0.8514

c) Variable: Average number of tubers per surviving plant

Line comparison			Difference between means	Simultaneous 95% confidence interval	
Control	TS-10	- Control	Désirée	-0.850	-8.847 7.147
Control	LT-9	- Control	Désirée	-1.491	-9.488 6.505
Control	Molinera	- Control	Désirée	-3.020	-12.814 6.774
Control	Achirana-INTA	- Control	Désirée	-6.268	-14.264 1.729
Control	Cruza-148	- Control	Désirée	-6.709	-14.705 1.288

d) Variable: Average weight for each tuber

Line comparison			Difference between means	Simultaneous 95% confidence interval	
Control	LT-9	- Control	Désirée	32.98	-7.89 73.84
Control	Achirana-INTA	- Control	Désirée	14.58	-26.29 55.44
Control	Molinera	- Control	Désirée	11.38	-38.67 61.43
Control	TS-10	- Control	Désirée	1.14	-39.72 42.01
Control	Cruza-148	- Control	Désirée	-21.73	-62.60 19.13

Table A-4.- Harvest data for **control potato genotypes** analysed after growth in a *Ralstonia solanacearum*-infested field. Dunnett's t test for **LT-9** compared to other genotypes. N = number of sowed rows (5 sowed plants per row). Comparisons significant at the 0.05 level are indicated by *******. Critical value of Dunnett's t: 2.63519).

a) Variable: surviving percentage of plants

Line comparison		Difference between means	Simultaneous 95% confidence interval	
Control TS-10	- Control LT-9	2.50	-37.03	42.03
Control Achirana-INTA	- Control LT-9	-5.00	-44.53	34.53
Control Molinera	- Control LT-9	-5.00	-53.41	43.41
Control Désirée	- Control LT-9	-15.00	-54.53	24.53
Control Cruza-148	- Control LT-9	-37.50	-77.03	2.03

b) Variable: Number of surviving plants per row

Line comparison		Difference between means	Simultaneous 95% confidence interval	
Control TS-10	- Control LT-9	0.1250	-1.8514	2.1014
Control Achirana-INTA	- Control LT-9	-0.2500	-2.2264	1.7264
Control Molinera	- Control LT-9	-0.2500	-2.6706	2.1706
Control Désirée	- Control LT-9	-0.7500	-2.7264	1.2264
Control Cruza-148	- Control LT-9	-1.8750	-3.8514	0.1014

c) Variable: Average number of tubers per surviving plant

Line comparison		Difference between means	Simultaneous 95% confidence interval	
Control Désirée	- Control LT-9	1.491	-6.505	9.488
Control TS-10	- Control LT-9	0.641	-7.355	8.638
Control Molinera	- Control LT-9	-1.529	-11.323	8.265
Control Achirana-INTA	- Control LT-9	-4.776	-12.773	3.220
Control Cruza-148	- Control LT-9	-5.218	-13.214	2.779

d) Variable: Average weight for each tuber

Line comparison		Difference between means	Simultaneous 95% confidence interval	
Control Achirana-INTA	- Control LT-9	-18.40	-59.26	22.46
Control Molinera	- Control LT-9	-21.60	-71.65	28.45
Control TS-10	- Control LT-9	-31.84	-72.70	9.03
Control Désirée	- Control LT-9	-32.98	-73.84	7.89
Control Cruza-148	- Control LT-9	-54.71	-95.57	-13.84 ***

Table A-5.- Harvest data for **control potato genotypes** analysed after growth in a *Ralstonia solanacearum*-infested field. Dunnett's t test for **TS-10** compared to other genotypes. N = number of sowed rows (5 sowed plants per row). Comparisons significant at the 0.05 level are indicated by ***. Critical value of Dunnett's t: 2.63519).

a) Variable: surviving percentage of plants

Line comparison		Difference between means	Simultaneous 95% confidence interval	
Control LT-9	- Control TS-10	-2.50	-42.03	37.03
Control Achirana-INTA	- Control TS-10	-7.50	-47.03	32.03
Control Molinera	- Control TS-10	-7.50	-55.91	40.91
Control Désirée	- Control TS-10	-17.50	-57.03	22.03
Control Cruza-148	- Control TS-10	-40.00	-79.53	-0.47 ***

b) Variable: Number of surviving plants per row

Line comparison		Difference between means	Simultaneous 95% confidence interval	
Control LT-9	- Control TS-10	-0.1250	-2.1014	1.8514
Control Achirana-INTA	- Control TS-10	-0.3750	-2.3514	1.6014
Control Molinera	- Control TS-10	-0.3750	-2.7956	2.0456
Control Désirée	- Control TS-10	-0.8750	-2.8514	1.1014
Control Cruza-148	- Control TS-10	-2.0000	-3.9764	-0.0236 ***

c) Variable: Average number of tubers per surviving plant

Line comparison		Difference between means	Simultaneous 95% confidence interval	
Control Désirée	- Control TS-10	0.850	-7.147	8.847
Control LT-9	- Control TS-10	-0.641	-8.638	7.355
Control Molinera	- Control TS-10	-2.170	-11.964	7.624
Control Achirana-INTA	- Control TS-10	-5.418	-13.414	2.579
Control Cruza-148	- Control TS-10	-5.859	-13.855	2.138

d) Variable: Average weight for each tuber

Line comparison		Difference between means	Simultaneous 95% confidence interval	
Control LT-9	- Control TS-10	31.84	-9.03	72.70
Control Achirana-INTA	- Control TS-10	13.44	-27.43	54.30
Control Molinera	- Control TS-10	10.24	-39.81	60.29
Control Désirée	- Control TS-10	-1.14	-42.01	39.72
Control Cruza-148	- Control TS-10	-22.87	-63.74	17.99

Table A-6.- Harvest data for **control potato genotypes** analysed after growth in a *Ralstonia solanacearum*-infested field. Dunnett's t test for **Cruza-148** compared to other genotypes. N = number of sowed rows (5 sowed plants per row). Comparisons significant at the 0.05 level are indicated by ***. Critical value of Dunnett's t: 2.63519).

a) Variable: Surviving percentage of plants

Line comparison			Difference between means	Simultaneous 95% confidence interval	
Control TS-10	- Control	Cruza-148	40.00	0.47	79.53 ***
Control LT-9	- Control	Cruza-148	37.50	-2.03	77.03
Control Achirana-INTA	- Control	Cruza-148	32.50	-7.03	72.03
Control Molinera	- Control	Cruza-148	32.50	-15.91	80.91
Control Désirée	- Control	Cruza-148	22.50	-17.03	62.03

b) Variable: Number of surviving plants per row

Line comparison			Difference between means	Simultaneous 95% confidence interval	
Control TS-10	- Control	Cruza-148	2.0000	0.0236	3.9764 ***
Control LT-9	- Control	Cruza-148	1.8750	-0.1014	3.8514
Control Achirana-INTA	- Control	Cruza-148	1.6250	-0.3514	3.6014
Control Molinera	- Control	Cruza-148	1.6250	-0.7956	4.0456
Control Désirée	- Control	Cruza-148	1.1250	-0.8514	3.1014

c) Variable: Average number of tubers per surviving plant

Line comparison			Difference between means	Simultaneous 95% confidence interval	
Control Désirée	- Control	Cruza-148	6.709	-1.288	14.705
Control TS-10	- Control	Cruza-148	5.859	-2.138	13.855
Control LT-9	- Control	Cruza-148	5.218	-2.779	13.214
Control Molinera	- Control	Cruza-148	3.689	-6.105	13.483
Control Achirana-INTA	- Control	Cruza-148	0.441	-7.555	8.438

d) Variable: Average weight for each tuber

Line comparison			Difference between means	Simultaneous 95% confidence interval	
Control LT-9	- Control	Cruza-148	54.71	13.84	95.57 ***
Control Achirana-INTA	- Control	Cruza-148	36.31	-4.56	77.17
Control Molinera	- Control	Cruza-148	33.11	-16.94	83.16
Control TS-10	- Control	Cruza-148	22.87	-17.99	63.74
Control Désirée	- Control	Cruza-148	21.73	-19.13	62.60

Table A-7.- Harvest data for **control potato genotypes** analysed after growth in a *Ralstonia solanacearum*-infested field. N = number of sowed rows (5 sowed plants per row). **Mean and standard deviation** are shown for the following variables: surv_p = surviving percentage, surv_n = number of surviving plants per row, tubpl = average number of tubers per surviving plant in each row, tubw = average weight for each tuber.

Control Achirana-INTA

Variable	N	Mean	Std Dev
surv_p	8	55.0000000	29.7609524
surv_n	8	2.7500000	1.4880476
tubpl	8	4.4200000	4.0784801
tubw	8	49.2087500	38.7167835

Control Désirée

Variable	N	Mean	Std Dev
surv_p	8	45.0000000	23.2992949
surv_n	8	2.2500000	1.1649647
tubpl	8	10.6875000	7.6388925
tubw	8	34.6312500	10.3286390

Control LT-9

Variable	N	Mean	Std Dev
surv_p	8	60.0000000	30.2371578
surv_n	8	3.0000000	1.5118579
tubpl	8	9.1962500	3.8885507
tubw	8	67.6087500	54.7497164

Control TS-10

Variable	N	Mean	Std Dev
surv_p	8	62.5000000	42.0034012
surv_n	8	3.1250000	2.1001701
tubpl	8	9.8375000	9.0683023
tubw	8	35.7725000	17.7656143

Control Molinera

Variable	N	Mean	Std Dev
surv_p	4	55.0000000	10.0000000
surv_n	4	2.7500000	0.5000000
tubpl	4	7.6675000	2.9454301
tubw	4	46.0100000	11.5307097

Control Cruza-148

Variable	N	Mean	Std Dev
surv_p	8	22.5000000	27.1240536
surv_n	8	1.1250000	1.3562027
tubpl	8	3.9787500	4.8886938
tubw	8	12.9000000	15.6776492

Table B-1.- Harvest data for **Achirana-INTA-transgenic potato lines** analysed after growth in a *Ralstonia solanacearum*-infested field. Waller-Duncan test. N = number of sowed rows (5 sowed plants per row). Means with the same letter are not significantly different.

a) variable: Surviving percentage of plants
(Pr > F 0.3525 ; minimum significant difference: 58.778)

Grouping	Mean	N	Line
A	57.50	8	PS-1
A	55.00	8	Control Achirana-INTA
A	50.00	4	PS-10
A	47.50	8	PS-13
A	45.00	4	PS-12
A	42.50	8	TS-9
A	40.00	4	PS-7
A	30.00	4	PS-11
A	22.50	8	TS-12
A	22.50	8	TS-22

b) variable: Number of surviving plants per row
(Pr > F 0.3525; minimum significant difference: 2.9389)

Grouping	Mean	N	Line
A	2.8750	8	PS-1
A	2.7500	8	Control Achirana-INTA
A	2.5000	4	PS-10
A	2.3750	8	PS-13
A	2.2500	4	PS-12
A	2.1250	8	TS-9
A	2.0000	4	PS-7
A	1.5000	4	PS-11
A	1.1250	8	TS-12
A	1.1250	8	TS-22

c) variable: Average number of tubers per surviving plant
(Pr > F 0.0005; minimum significant difference: 7.1828)

Grouping	Mean	N	Line
B	19.105	4	PS-12
A	14.175	4	PS-10
B	10.125	4	PS-7
D	6.004	8	PS-1
D	5.763	8	PS-13
D	5.426	8	TS-9
D	5.125	4	PS-11
D	4.420	8	Control Achirana-INTA
D	3.531	8	TS-22
D	1.441	8	TS-12

d) variable: Average weight for each tuber
(Pr > F 0.4938; minimum significant difference: 99.736)

Grouping	Mean	N	Line
A	90.01	8	PS-13
A	66.67	4	PS-11
A	60.38	4	PS-7
A	54.88	8	TS-9
A	49.21	8	Control Achirana-INTA
A	46.12	8	PS-1
A	40.81	8	TS-22
A	37.29	8	TS-12
A	27.94	4	PS-12
A	18.90	4	PS-10

Table B-2.- Harvest data for Achirana-INTA-transgenic potato lines analysed after growth in a *Ralstonia solanacearum*-infested field. Dunnett's t test for surviving percentage variable. N = number of sowed rows (5 sowed plants per row). Comparisons significant at the 0.05 level are indicated by ***. Critical value of Dunnett's t 2.80626).

a) variable: Surviving percentage of plants

Line comparison		Difference between means	Simultaneous 95% confidence interval	
PS-1 - Control	Achirana-INTA	2.50	-42.30	47.30
PS-10 - Control	Achirana-INTA	-5.00	-59.87	49.87
PS-13 - Control	Achirana-INTA	-7.50	-52.30	37.30
PS-12 - Control	Achirana-INTA	-10.00	-64.87	44.87
TS-9 - Control	Achirana-INTA	-12.50	-57.30	32.30
PS-7 - Control	Achirana-INTA	-15.00	-69.87	39.87
PS-11 - Control	Achirana-INTA	-25.00	-79.87	29.87
TS-12 - Control	Achirana-INTA	-32.50	-77.30	12.30
TS-22 - Control	Achirana-INTA	-32.50	-77.30	12.30

b) variable: Number of surviving plants per row

Line comparison		Difference between means	Simultaneous 95% confidence interval	
PS-1 - Control	Achirana-INTA	0.1250	-2.1150	2.3650
PS-10 - Control	Achirana-INTA	-0.2500	-2.9934	2.4934
PS-13 - Control	Achirana-INTA	-0.3750	-2.6150	1.8650
PS-12 - Control	Achirana-INTA	-0.5000	-3.2434	2.2434
TS-9 - Control	Achirana-INTA	-0.6250	-2.8650	1.6150
PS-7 - Control	Achirana-INTA	-0.7500	-3.4934	1.9934
PS-11 - Control	Achirana-INTA	-1.2500	-3.9934	1.4934
TS-12 - Control	Achirana-INTA	-1.6250	-3.8650	0.6150
TS-22 - Control	Achirana-INTA	-1.6250	-3.8650	0.6150

c) variable: Average number of tubers per surviving plant

Line comparison		Difference between means	Simultaneous 95% confidence interval	
PS-12 - Control	Achirana-INTA	14.685	4.642	24.728 ***
PS-10 - Control	Achirana-INTA	9.755	-0.288	19.798
PS-7 - Control	Achirana-INTA	5.705	-4.338	15.748
PS-1 - Control	Achirana-INTA	1.584	-6.616	9.784
PS-13 - Control	Achirana-INTA	1.343	-6.857	9.542
TS-9 - Control	Achirana-INTA	1.006	-7.194	9.206
PS-11 - Control	Achirana-INTA	0.705	-9.338	10.748
TS-22 - Control	Achirana-INTA	-0.889	-9.089	7.311
TS-12 - Control	Achirana-INTA	-2.979	-11.179	5.221

d) variable: Average weight for each tuber

Line comparison		Difference between means	Simultaneous 95% confidence interval	
PS-13 - Control	Achirana-INTA	40.80	-31.20	112.79
PS-11 - Control	Achirana-INTA	17.46	-70.72	105.63
PS-7 - Control	Achirana-INTA	11.17	-77.00	99.35
TS-9 - Control	Achirana-INTA	5.67	-66.32	77.67
PS-1 - Control	Achirana-INTA	-3.09	-75.08	68.90
TS-22 - Control	Achirana-INTA	-8.40	-80.39	63.60
TS-12 - Control	Achirana-INTA	-11.92	-83.91	60.08
PS-12 - Control	Achirana-INTA	-21.27	-109.45	66.90
PS-10 - Control	Achirana-INTA	-30.31	-118.49	57.86

Table B-3.- Harvest data for Achirana-INTA-transgenic potato lines analysed after growth in a *Ralstonia solanacearum*-infested field. N = number of sowed rows (5 sowed plants per row). Mean and standard deviation are shown for the following variables: surv_p = surviving percentage, surv_n = number of surviving plants per row, tubpl = average number of tubers per surviving plant in each row, tubw = average weight for each tuber.

Control Achirana-INTA			
Variable	N	Mean	Std Dev
surv_p	8	55.0000000	29.7609524
surv_n	8	2.7500000	1.4880476
tubpl	8	4.4200000	4.0784801
tubw	8	49.2087500	38.7167835

Line PS-1			
Variable	N	Mean	Std Dev
surv_p	8	57.5000000	39.1881906
surv_n	8	2.8750000	1.9594095
tubpl	8	6.0037500	3.4499231
tubw	8	46.1187500	33.6613366

Line PS-7			
Variable	N	Mean	Std Dev
surv_p	4	40.0000000	16.3299316
surv_n	4	2.0000000	0.8164966
tubpl	4	10.1250000	2.7801379
tubw	4	60.3800000	32.1098967

Line PS-10			
Variable	N	Mean	Std Dev
surv_p	4	50.0000000	47.6095229
surv_n	4	2.5000000	2.3804761
tubpl	4	14.1750000	12.7641098
tubw	4	18.8975000	13.8739958

Line PS-11			
Variable	N	Mean	Std Dev
surv_p	4	30.0000000	25.8198890
surv_n	4	1.5000000	1.2909944
tubpl	4	5.1250000	4.5893899
tubw	4	66.6675000	49.7556921

Line PS-12			
Variable	N	Mean	Std Dev
surv_p	4	45.0000000	30.0000000
surv_n	4	2.2500000	1.5000000
tubpl	4	19.1050000	13.9569254
tubw	4	27.9350000	6.3586503

Table B-3.- (Cont.)

Line PS-13

Variable	N	Mean	Std Dev
surv_p	8	47.5000000	28.1577191
surv_n	8	2.3750000	1.4078860
tubpl	8	5.7625000	3.0132742
tubw	8	90.0075000	97.7790772

Line TS-9

Variable	N	Mean	Std Dev
surv_p	8	42.5000000	24.9284691
surv_n	8	2.1250000	1.2464235
tubpl	8	5.4262500	4.3996232
tubw	8	54.8800000	30.6880261

Line TS-12

Variable	N	Mean	Std Dev
surv_p	8	22.5000000	37.7018378
surv_n	8	1.1250000	1.8850919
tubpl	8	1.4412500	2.5997606
tubw	8	37.2912500	55.9046258

Line TS-22

Variable	N	Mean	Std Dev
surv_p	8	22.5000000	29.1547595
surv_n	8	1.1250000	1.4577380
tubpl	8	3.5312500	5.8377428
tubw	8	40.8112500	49.4636806

Table C-1.- Harvest data for **Désirée transgenic potato lines** analysed after growth in a *Ralstonia solanacearum*-infested field. Waller-Duncan test. N = number of sowed rows (5 sowed plants per row). Means with the same letter are not significantly different.

a) variable: Surviving percentage of plants
(Pr > F 0.1114; minimum significant difference: 45.78)

Grouping	Mean	N	Line
A	70.00	4	TS-16
A	70.00	4	TS-14
B	65.00	4	TS-10
B	62.50	8	TS-21
B	60.00	4	TS-15
B	57.50	8	TS-23
B	57.50	8	TS-24
B	55.00	8	TS-4
B	45.00	8	TS-3
B	45.00	8	Control Désirée
B	42.50	8	TS-5
B	35.00	4	TS-2
B	22.50	8	TS-6

b) variable: Number of surviving plants per row
(Pr > F 0.1114; minimum significant difference: 2.289)

Grouping	Mean	N	Line
A	3.5000	4	TS-16
A	3.5000	4	TS-14
B	3.2500	4	TS-10
B	3.1250	8	TS-21
B	3.0000	4	TS-15
B	2.8750	8	TS-23
B	2.8750	8	TS-24
B	2.7500	8	TS-4
B	2.2500	8	TS-3
B	2.2500	8	Control Désirée
B	2.1250	8	TS-5
B	1.7500	4	TS-2
B	1.1250	8	TS-6

c) variable: Average number of tubers per surviving plant
(Pr > F 0.3913; minimum significant difference: 13.505)

Grouping	Mean	N	Line
A	10.688	8	Control Désirée
A	10.575	8	TS-21
A	8.109	8	TS-5
A	8.030	8	TS-23
A	7.405	8	TS-3
A	6.230	8	TS-24
A	6.000	8	TS-6
A	4.441	8	TS-4
A	3.895	4	TS-10
A	3.255	4	TS-14
A	3.043	4	TS-2
A	2.500	4	TS-15
A	2.193	4	TS-16

d) variable: Average weight for each tuber
(Pr > F 0.0395; minimum significant difference: 44.082)

Grouping	Mean	N	Line
A	72.22	8	DTS-24
A	72.06	4	TS-15
B	60.58	8	TS-23
B	58.53	8	TS-6
B	56.20	4	TS-10
B	47.21	4	TS-14
B	45.36	4	TS-16
B	44.88	8	TS-21
B	34.63	8	Control Désirée
B	33.31	8	TS-5
B	31.31	8	TS-3
B	27.31	8	TS-4
B	25.93	4	TS-2

Table C-2.- Harvest data for **Désirée transgenic potato lines** analysed after growth in a *Ralstonia solanacearum*-infested field. Dunnett's t test for surviving percentage variable. N = number of sowed rows (5 sowed plants per row). Comparisons significant at the 0.05 level are indicated by ***. Critical value of Dunnett's t 2.87100).

a) Variable: surviving percentage of plants

Line comparison			Difference between means	Simultaneous 95% confidence interval	
TS-16	- Contro	Désirée	25.00	-23.37	73.37
TS-14	- Contro	Désirée	25.00	-23.37	73.37
TS-10	- Contro	Désirée	20.00	-28.37	68.37
TS-21	- Contro	Désirée	17.50	-22.00	57.00
TS-15	- Contro	Désirée	15.00	-33.37	63.37
TS-23	- Contro	Désirée	12.50	-27.00	52.00
TS-24	- Contro	Désirée	12.50	-27.00	52.00
TS-4	- Contro	Désirée	10.00	-29.50	49.50
TS-3	- Contro	Désirée	0.00	-39.50	39.50
TS-5	- Contro	Désirée	-2.50	-42.00	37.00
TS-2	- Contro	Désirée	-10.00	-58.37	38.37
TS-6	- Contro	Désirée	-22.50	-62.00	17.00

b) Variable: Number of surviving plants per row

Line comparison			Difference between means	Simultaneous 95% confidence interval	
TS-16	- Contro	Désirée	1.2500	-1.1687	3.6687
TS-14	- Contro	Désirée	1.2500	-1.1687	3.6687
TS-10	- Contro	Désirée	1.0000	-1.4187	3.4187
TS-21	- Contro	Désirée	0.8750	-1.0998	2.8498
TS-15	- Contro	Désirée	0.7500	-1.6687	3.1687
TS-23	- Contro	Désirée	0.6250	-1.3498	2.5998
TS-24	- Contro	Désirée	0.6250	-1.3498	2.5998
TS-4	- Contro	Désirée	0.5000	-1.4748	2.4748
TS-3	- Contro	Désirée	0.0000	-1.9748	1.9748
TS-5	- Contro	Désirée	-0.1250	-2.0998	1.8498
TS-2	- Contro	Désirée	-0.5000	-2.9187	1.9187
TS-6	- Contro	Désirée	-1.1250	-3.0998	0.8498

c) Variable: Average number of tubers per surviving plant

Line comparison			Difference between means	Simultaneous 95% confidence interval	
TS-21	- Contro	Désirée	-0.113	-9.974	9.749
TS-5	- Contro	Désirée	-2.579	-12.440	7.282
TS-23	- Contro	Désirée	-2.657	-12.519	7.204
TS-3	- Contro	Désirée	-3.283	-13.144	6.579
TS-24	- Contro	Désirée	-4.458	-14.319	5.404
TS-6	- Contro	Désirée	-4.688	-14.549	5.174
TS-4	- Contro	Désirée	-6.246	-16.107	3.615
TS-10	- Contro	Désirée	-6.793	-18.870	5.285
TS-14	- Contro	Désirée	-7.433	-19.510	4.645
TS-2	- Contro	Désirée	-7.645	-19.722	4.432
TS-15	- Contro	Désirée	-8.188	-20.265	3.890
TS-16	- Contro	Désirée	-8.495	-20.572	3.582

d) Variable: Average weight for each tuber

Line comparison			Difference between means	Simultaneous 95% confidence interval	
TS-24	- Contro	Désirée	37.59	-4.17	79.35
TS-15	- Contro	Désirée	37.43	-13.72	88.58
TS-23	- Contro	Désirée	25.95	-15.81	67.71
TS-6	- Contro	Désirée	23.90	-17.86	65.66
TS-10	- Contro	Désirée	21.57	-29.58	72.72
TS-14	- Contro	Désirée	12.58	-38.57	63.72
TS-16	- Contro	Désirée	10.73	-40.42	61.87
TS-21	- Contro	Désirée	10.24	-31.52	52.01
TS-5	- Contro	Désirée	-1.32	-43.08	40.44
TS-3	- Contro	Désirée	-3.31	-45.07	38.45
TS-4	- Contro	Désirée	-7.33	-49.09	34.44
TS-2	- Contro	Désirée	-8.70	-59.85	42.44

Table C-3.- Harvest data for **Désirée** transgenic potato lines analysed after growth in a *Ralstonia solanacearum*-infested field. N = number of sowed rows (5 sowed plants per row). Mean and standard deviation are shown for the following variables: surv_p = surviving percentage, surv_n = number of surviving plants per row, tubpl = average number of tubers per surviving plant in each row, tubw = average weight for each tuber.

Control Désirée

Variable	N	Mean	Std Dev
surv_p	8	45.0000000	23.2992949
surv_n	8	2.2500000	1.1649647
tubpl	8	10.6875000	7.6388925
tubw	8	34.6312500	10.3286390

Line TS-10

Variable	N	Mean	Std Dev
surv_p	4	65.0000000	10.0000000
surv_n	4	3.2500000	0.5000000
tubpl	4	3.8950000	3.2784702
tubw	4	56.2025000	20.4942795

Line TS-14

Variable	N	Mean	Std Dev
surv_p	4	70.0000000	25.8198890
surv_n	4	3.5000000	1.2909944
tubpl	4	3.2550000	2.9000747
tubw	4	47.2075000	16.1319587

Line TS-15

Variable	N	Mean	Std Dev
surv_p	4	60.0000000	23.0940108
surv_n	4	3.0000000	1.1547005
tubpl	4	2.5000000	2.0716338
tubw	4	72.0625000	72.6557400

Line TS-16

Variable	N	Mean	Std Dev
surv_p	4	70.0000000	25.8198890
surv_n	4	3.5000000	1.2909944
tubpl	4	2.1925000	1.0909743
tubw	4	45.3575000	9.2850000

Line TS-2

Variable	N	Mean	Std Dev
surv_p	4	35.0000000	25.1661148
surv_n	4	1.7500000	1.2583057
tubpl	4	3.0425000	2.3116859
tubw	4	25.9275000	22.0745938

Table C-3.- (Cont.)

Line TS-21

Variable	N	Mean	Std Dev
surv_p	8	62.5000000	31.0529502
surv_n	8	3.1250000	1.5526475
tubpl	8	10.5750000	10.4943182
tubw	8	44.8750000	14.0558193

Line TS-23

Variable	N	Mean	Std Dev
surv_p	8	57.5000000	24.9284691
surv_n	8	2.8750000	1.2464235
tubpl	8	8.0300000	7.1590163
tubw	8	60.5825000	41.6543267

Line TS-24

Variable	N	Mean	Std Dev
surv_p	8	57.5000000	19.8206242
surv_n	8	2.8750000	0.9910312
tubpl	8	6.2300000	4.3045590
tubw	8	72.2200000	30.0491588

Line TS-3

Variable	N	Mean	Std Dev
surv_p	8	45.0000000	25.6347978
surv_n	8	2.2500000	1.2817399
tubpl	8	7.4050000	7.3419246
tubw	8	31.3237500	15.7159418

Line TS-4

Variable	N	Mean	Std Dev
surv_p	8	55.0000000	43.7525509
surv_n	8	2.7500000	2.1876275
tubpl	8	4.4412500	5.0566969
tubw	8	27.3050000	19.2437834

Line TS-5

Variable	N	Mean	Std Dev
surv_p	8	42.5000000	34.5377640
surv_n	8	2.1250000	1.7268882
tubpl	8	8.1087500	11.1884780
tubw	8	33.3087500	27.7614246

Line TS-6

Variable	N	Mean	Std Dev
surv_p	8	22.5000000	16.6904592
surv_n	8	1.1250000	0.8345230
tubpl	8	6.0000000	4.7809144
tubw	8	58.5300000	38.1382601

Table D-1.- Harvest data for **LT-9** transgenic potato line analysed after growth in a *Ralstonia solanacearum*-infested field. Dunnett's t test for surviving percentage variable. N = number of sowed rows (5 sowed plants per row). Means with the same letter are not significantly different. Comparisons significant at the 0.05 level are indicated by ***. Critical value of Dunnett's t (2.14485).

a) Variable: surviving percentage of plants
(Pr > F 0.3734; minimum significant difference: 29.159)

Line comparison	Difference between means	Simultaneous 95% confidence interval	
TS-29 - Control LT-9	12.50	-16.66	41.66

b) Variable: Number of surviving plants per row
(Pr > F 0.3734; minimum significant difference: 1.4579)

Line comparison	Difference between means	Simultaneous 95% confidence interval	
TS-29 - Control LT-9	0.6250	-0.8329	2.0829

c) Variable: Average number of tubers per surviving plant
(Pr > F 0.3320; minimum significant difference: 4.9256)

Line comparison	Difference between means	Simultaneous 95% confidence interval	
TS-29 - Control LT-9	2.308	-2.618	7.233

d) Variable: Average weight for each tuber
(Pr > F 0.1244; minimum significant difference: 42.77)

Line comparison	Difference between means	Simultaneous 95% confidence interval	
TS-29 - Control LT-9	-32.60	-75.37	10.17

Table D-2.- Harvest data for **LT-9** transgenic potato line analysed after growth in a *Ralstonia solanacearum*-infested field. N = number of sowed rows (5 sowed plants per row). Mean and standard deviation are shown for the following variables: surv_p = surviving percentage, surv_n = number of surviving plants per row, tubpl = average number of tubers per surviving plant in each row, tubw = average weight for each tuber.

Control LT-9

variable	N	Mean	Std Dev
surv_p	8	60.0000000	30.2371578
surv_n	8	3.0000000	1.5118579
tubpl	8	9.1962500	3.8885507
tubw	8	67.6087500	54.7497164

Line TS-29

variable	N	Mean	Std Dev
surv_p	8	72.5000000	23.7546988
surv_n	8	3.6250000	1.1877349
tubpl	8	11.5037500	5.2028672
tubw	8	35.0112500	13.5510447

Table E-1.- Harvest data for **TS-10** transgenic potato lines analysed after growth in a *Ralstonia solanacearum*-infested field. Waller-Duncan test. N = number of sowed rows (5 sowed plants per row). Means with the same letter are not significantly different.

a) variable: Surviving percentage of plants
(Pr > F 0.1486; minimum significant difference: 55.851)

Grouping	Mean	N	Line
A	65.00	4	TS-2
A	62.50	8	Control TS-10
B	55.00	8	PS-4
B	50.00	8	TS-26
B	45.00	8	PS-8
B	42.50	8	PS-2
B	40.00	8	PS-3
B	37.50	8	PS-6
B	35.00	8	PS-9
B	25.00	4	TS-11
B	22.50	8	TS-27
B	20.00	8	TS-28
B	5.00	4	TS-20

b) variable: Number of surviving plants per row
(Pr > F 0.1486; minimum significant difference: 2.7926)

Grouping	Mean	N	Line
A	3.2500	4	TS-2
A	3.1250	8	Control TS-10
B	2.7500	8	PS-4
B	2.5000	8	TS-26
B	2.2500	8	PS-8
B	2.1250	8	PS-2
B	2.0000	8	PS-3
B	1.8750	8	PS-6
B	1.7500	8	PS-9
B	1.2500	4	TS-11
B	1.1250	8	TS-27
B	1.0000	8	TS-28
B	0.2500	4	TS-20

Table E-1.- (Cont.)

c) Variable: Average number of tubers per surviving plant
(Pr > F 0.9238; minimum significant difference: 19.096)

Grouping	Mean	N	Line
A	9.838	8	Control TS-10
A	9.291	8	PS-3
A	9.094	8	PS-2
A	9.063	8	PS-6
A	8.219	8	PS-4
A	8.019	8	TS-26
A	7.625	8	PS-8
A	7.525	4	TS-2
A	7.354	8	TS-27
A	6.269	8	PS-9
A	5.500	8	TS-28
A	4.750	4	TS-11
A	0.500	4	TS-20

d) Variable: Average weight for each tuber
(Pr > F 0.8557; minimum significant difference: 60.213)

Grouping	Mean	N	Line
A	50.31	4	TS-2
A	40.95	8	PS-2
A	38.41	8	PS-3
A	37.61	8	PS-9
A	37.52	8	PS-4
A	35.77	8	Control TS-10
A	35.71	8	TS-26
A	33.37	8	PS-8
A	27.92	4	TS-11
A	27.43	8	PS-6
A	25.74	8	TS-28
A	23.45	8	TS-27
A	16.25	4	TS-20

Table E-2.- Harvest data for **TS-10** transgenic potato lines analysed after growth in a *Ralstonia solanacearum*-infested field. Dunnett's t test for surviving percentage variable. N = number of sowed rows (5 sowed plants per row). Comparisons significant at the 0.05 level are indicated by ***. Critical value of Dunnett's t: 2.85213).

a) Variable: Surviving percentage of plants

Line comparison	Difference between means	Simultaneous 95% confidence interval
TS-2 - Control TS-10	2.50	-57.65 62.65
PS-4 - Control TS-10	-7.50	-56.61 41.61
TS-26 - Control TS-10	-12.50	-61.61 36.61
PS-8 - Control TS-10	-17.50	-66.61 31.61
PS-2 - Control TS-10	-20.00	-69.11 29.11
PS-3 - Control TS-10	-22.50	-71.61 26.61
PS-6 - Control TS-10	-25.00	-74.11 24.11
PS-9 - Control TS-10	-27.50	-76.61 21.61
TS-11 - Control TS-10	-37.50	-97.65 22.65
TS-27 - Control TS-10	-40.00	-89.11 9.11
TS-28 - Control TS-10	-42.50	-91.61 6.61
TS-20 - Control TS-10	-57.50	-117.65 2.65

b) variable: Number of surviving plants per row

Line comparison	Difference between means	Simultaneous 95% confidence interval
TS-2 - Control TS-10	0.1250	-2.8825 3.1325
PS-4 - Control TS-10	-0.3750	-2.8306 2.0806
TS-26 - Control TS-10	-0.6250	-3.0806 1.8306
PS-8 - Control TS-10	-0.8750	-3.3306 1.5806
PS-2 - Control TS-10	-1.0000	-3.4556 1.4556
PS-3 - Control TS-10	-1.1250	-3.5806 1.3306
PS-6 - Control TS-10	-1.2500	-3.7056 1.2056
PS-9 - Control TS-10	-1.3750	-3.8306 1.0806
TS-11 - Control TS-10	-1.8750	-4.8825 1.1325
TS-27 - Control TS-10	-2.0000	-4.4556 0.4556
TS-28 - Control TS-10	-2.1250	-4.5806 0.3306
TS-20 - Control TS-10	-2.8750	-5.8825 0.1325

Table E-2.- (Cont.)

c) Variable: Average number of tubers per surviving plant

Line comparison	Difference between means	Simultaneous 95% confidence interval	
PS-3 - Control TS-10	-0.546	-12.285	11.193
PS-2 - Control TS-10	-0.744	-12.483	10.995
PS-6 - Control TS-10	-0.775	-12.514	10.964
PS-4 - Control TS-10	-1.619	-13.358	10.120
TS-26 - Control TS-10	-1.819	-13.558	9.920
PS-8 - Control TS-10	-2.213	-13.951	9.526
TS-2 - Control TS-10	-2.313	-16.690	12.065
TS-27 - Control TS-10	-2.484	-14.223	9.255
PS-9 - Control TS-10	-3.569	-15.308	8.170
TS-28 - Control TS-10	-4.338	-16.076	7.401
TS-11 - Control TS-10	-5.088	-19.465	9.290
TS-20 - Control TS-10	-9.338	-23.715	5.040

d) Variable: Average weight for each tuber

Line comparison	Difference between means	Simultaneous 95% confidence interval	
TS-2 - Control TS-10	14.54	-32.51	61.59
PS-2 - Control TS-10	5.18	-33.23	43.59
PS-3 - Control TS-10	2.63	-35.78	41.05
PS-9 - Control TS-10	1.84	-36.58	40.25
PS-4 - Control TS-10	1.74	-36.67	40.16
TS-26 - Control TS-10	-0.06	-38.48	38.35
PS-8 - Control TS-10	-2.41	-40.82	36.01
TS-11 - Control TS-10	-7.86	-54.90	39.19
PS-6 - Control TS-10	-8.34	-46.75	30.07
TS-28 - Control TS-10	-10.04	-48.45	28.38
TS-27 - Control TS-10	-12.32	-50.73	26.09
TS-20 - Control TS-10	-19.52	-66.57	27.52

Table E-3.- Harvest data for **TS-10** transgenic potato lines analysed after growth in a *Ralstonia solanacearum*-infested field. N = number of sowed rows (5 sowed plants per row). Mean and standard deviation are shown for the following variables: surv_p = surviving percentage, surv_n = number of surviving plants per row, tubpl = average number of tubers per surviving plant in each row, tubw = average weight for each tuber.

Control TS-10

Variable	N	Mean	Std Dev
surv_p	8	62.5000000	42.0034012
surv_n	8	3.1250000	2.1001701
tubpl	8	9.8375000	9.0683023
tubw	8	35.7725000	17.7656143

Line PS-2

Variable	N	Mean	Std Dev
surv_p	8	42.5000000	32.8416112
surv_n	8	2.1250000	1.6420806
tubpl	8	9.0937500	8.9061952
tubw	8	40.9537500	28.6558121

Line PS-3

Variable	N	Mean	Std Dev
surv_p	8	40.0000000	32.0713490
surv_n	8	2.0000000	1.6035675
tubpl	8	9.2912500	10.1204904
tubw	8	38.4062500	33.4776706

Line PS-4

Variable	N	Mean	Std Dev
surv_p	8	55.0000000	41.0574510
surv_n	8	2.7500000	2.0528726
tubpl	8	8.2187500	8.1365989
tubw	8	37.5175000	24.3585308

Line PS-6

Variable	N	Mean	Std Dev
surv_p	8	37.5000000	37.7018378
surv_n	8	1.8750000	1.8850919
tubpl	8	9.0625000	9.0373728
tubw	8	27.4325000	25.0366946

Line PS-8

Variable	N	Mean	Std Dev
surv_p	8	45.0000000	38.1725406
surv_n	8	2.2500000	1.9086270
tubpl	8	7.6250000	10.7885521
tubw	8	33.3675000	28.7753400

Table E-3.- (Cont.)

Line PS-9

Variable	N	Mean	Std Dev
surv_p	8	35.0000000	36.6450153
surv_n	8	1.7500000	1.8322508
tubpl	8	6.2687500	6.4944447
tubw	8	37.6100000	28.7914481

Line TS-11

Variable	N	Mean	Std Dev
surv_p	4	25.0000000	10.0000000
surv_n	4	1.2500000	0.5000000
tubpl	4	4.7500000	1.8929694
tubw	4	27.9175000	15.1144707

Line TS-2

Variable	N	Mean	Std Dev
surv_p	4	65.0000000	25.1661148
surv_n	4	3.2500000	1.2583057
tubpl	4	7.5250000	2.7206188
tubw	4	50.3125000	13.1771352

Line TS-20

Variable	N	Mean	Std Dev
surv_p	4	5.0000000	10.0000000
surv_n	4	0.2500000	0.5000000
tubpl	4	0.5000000	1.0000000
tubw	4	16.2500000	32.5000000

Line TS-26

Variable	N	Mean	Std Dev
surv_p	8	50.0000000	45.3557368
surv_n	8	2.5000000	2.2677868
tubpl	8	8.0187500	7.6006549
tubw	8	35.7087500	31.2788744

Line TS-27

Variable	N	Mean	Std Dev
surv_p	8	22.5000000	19.8206242
surv_n	8	1.1250000	0.9910312
tubpl	8	7.3537500	9.3321088
tubw	8	23.4525000	23.5672659

Line TS-28

Variable	N	Mean	Std Dev
surv_p	8	20.0000000	28.2842712
surv_n	8	1.0000000	1.4142136
tubpl	8	5.5000000	6.6547513
tubw	8	25.7350000	29.9178466