



Development of molecular markers associated with tomato fruitworm (*Helicoverpa armigera* Hübner) resistance components in wild tomato (*Solanum pimpinellifolium* L.)

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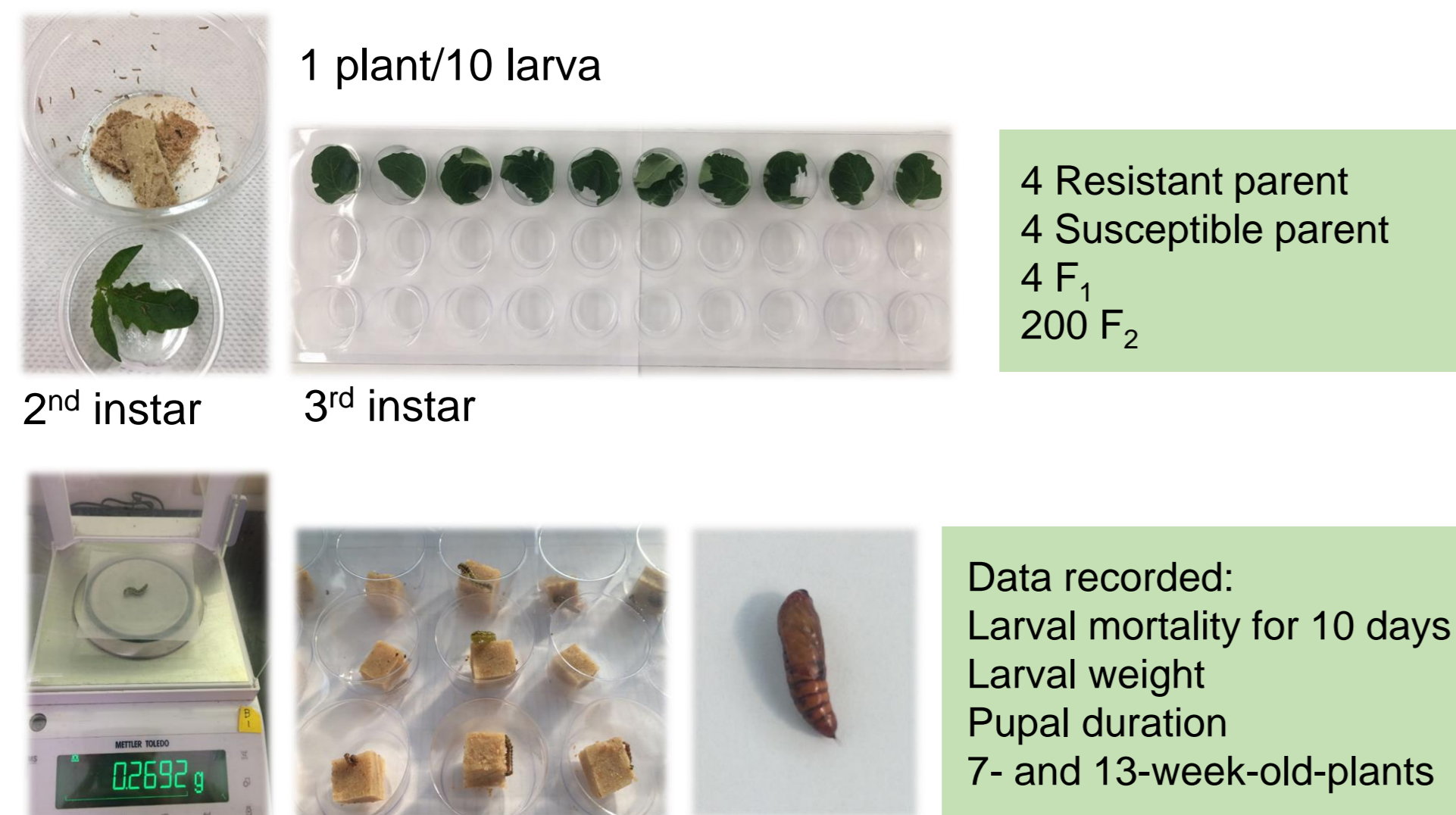
Abstract

Tomato fruitworm (*Helicoverpa armigera* Hübner) is a major production constraint to cultivated tomato (*Solanum lycopersicum* L.) in the tropics and subtropics. Developing pest-resistant cultivars would be an alternative control approach, and contribute to a reduction in the misuse of chemical pesticides in tomato production. Here, molecular markers, glandular trichomes and acylsugars associated with tomato fruitworm resistance were investigated. A total of 200 F₂ plants derived from the interspecific hybridization between WorldVeg breeding lines *S. lycopersicum* CLN3682C and *S. pimpinellifolium* VI030462 were genotyped using 8 putative resistance loci previously identified for whitefly resistance on chromosomes 3, 5, 6, 7, 9 and 11. The same plants, along with resistant and susceptible parents, their F₁, and susceptible check tomato line, were bioassayed for larval mortality, larval weight, pupal duration, and egg number using a no-choice test at 7 and 13 weeks after sowing. The results show that the mortality rate of larvae feeding on F₂ populations for 10 days positively correlated with density of type IV trichomes in 7-week-old plants. Type IV trichomes and acylsugar production showed recessive gene action, because the F₁ was skewed strongly toward the susceptible parent. A total of 12, 2, 3, 1 and 9 CAPS markers in 4 regions were significantly associated with the density of type IV trichomes, larval mortality, pupal duration, larval weight and acylsugars, respectively. More studies are underway to confirm these markers in F₃ and BC₁F₂ populations, which would be very useful for marker-assisted selection in our breeding program for insect resistance.

Keywords: Cleaved amplified polymorphic sequence, insect resistance, *Solanum lycopersicum* L., marker-assisted selection

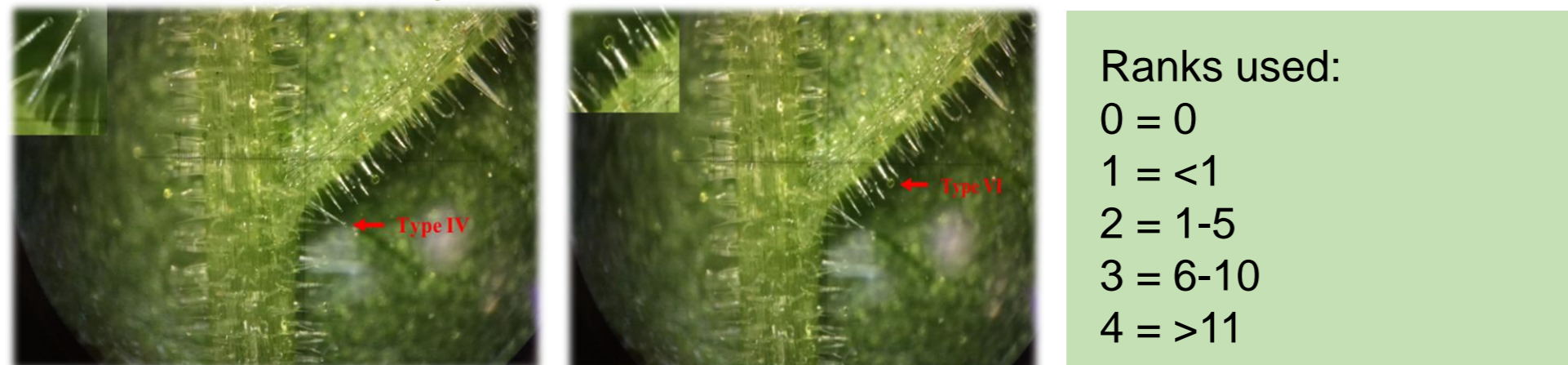
Materials & Methods

No-choice assay test



After 10 days, larval weight was recorded and larvae moved to an artificial diet.

Trichome analysis

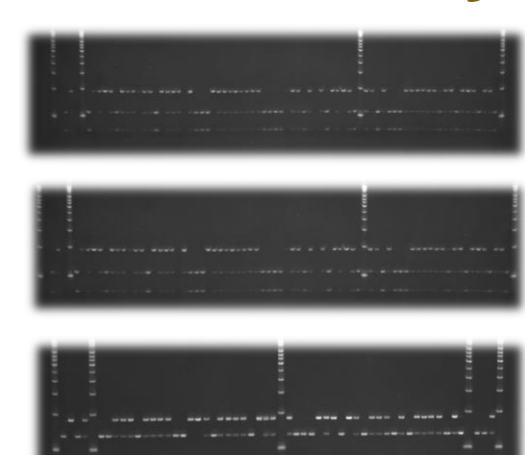


Acylsugar analysis



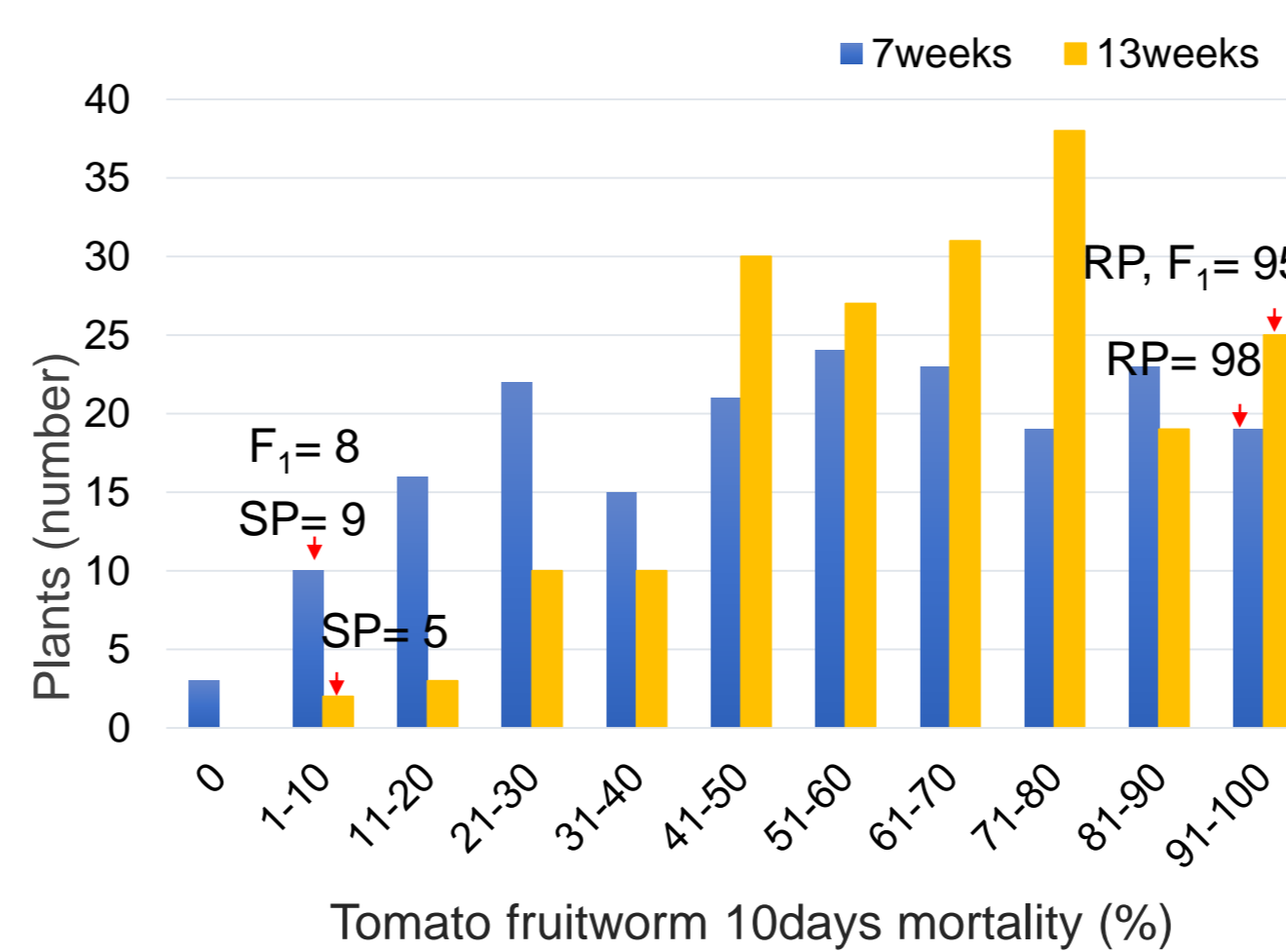
Sixteen CAPS markers associated with whitefly resistance parameters were used to genotype 200 F₂, resistant parent, susceptible parent, and F₁ plants.

Marker analysis

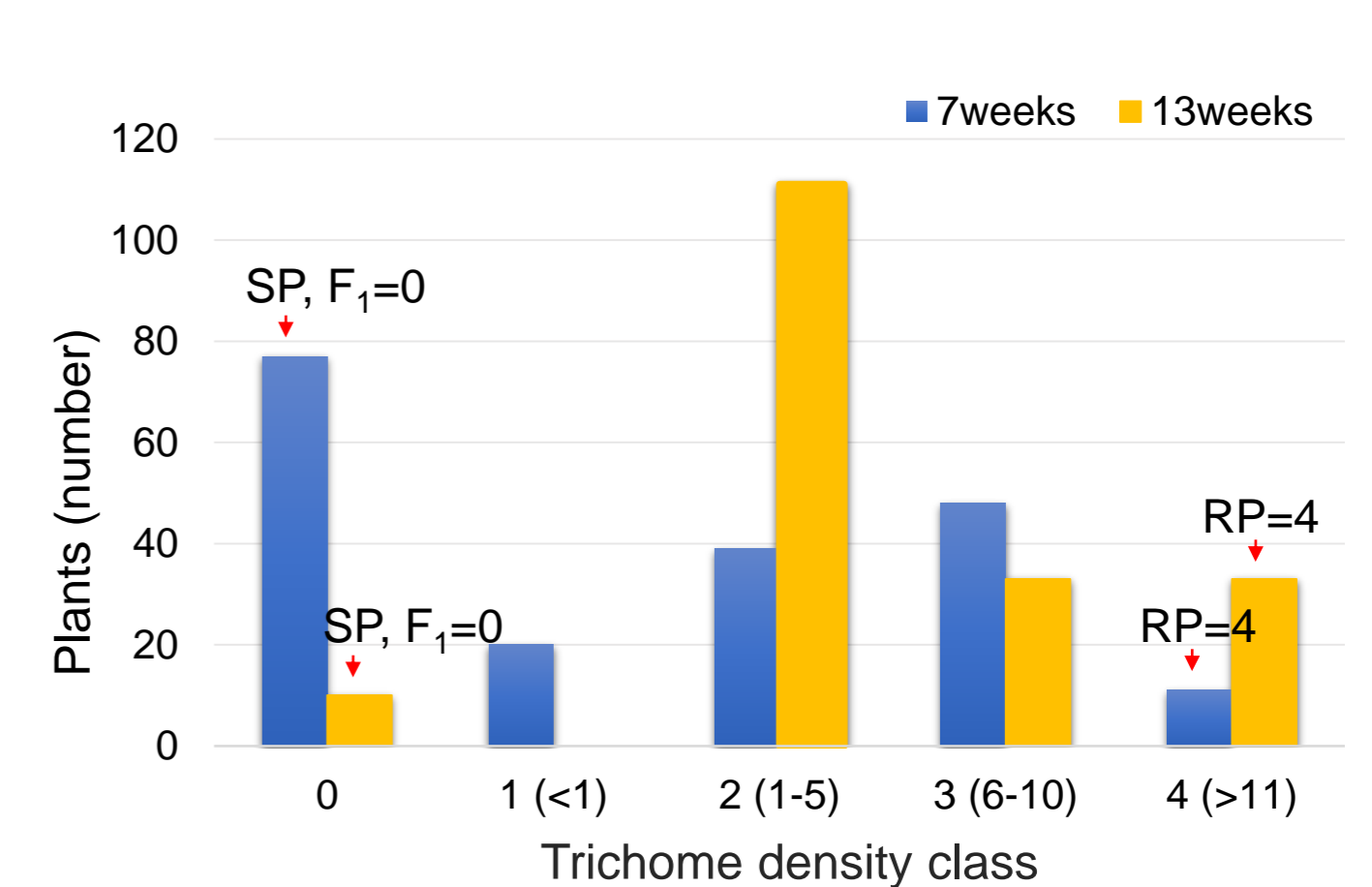


Results

Frequency distribution of 10 days mortality in a 195 plant F₂ population



Frequency distribution of type IV trichome density in a 195 plant F₂ population



Linear correlations between tomato fruitworm resistance parameters, trichome types, and acylsugars of F₂ population evaluated in no-choice bioassays

Parameters	Trichome type				Acylsugars
	IV	Spherical VI	Intermediate VI	Lobe VI	
7 weeks					
10 days mortality	0.30**	0.02 ^{ns}	0.08 ^{ns}	-0.23**	0.22**
Larval weight	-0.10 ^{ns}	0.07 ^{ns}	0.23 ^{ns}	-0.16 ^{ns}	-0.12 ^{ns}
Pupal duration	-0.02 ^{ns}	0.29*	-	-0.05 ^{ns}	-0.16 ^{ns}
10 weeks					
Acylsugars	0.45**	0.6 ^{ns}	-0.08 ^{ns}	0.12 ^{ns}	
13 weeks					
10 days mortality	0.20*	0.07 ^{ns}	-0.04 ^{ns}	-0.07 ^{ns}	0.14*
Larval weight	-0.25**	-0.11 ^{ns}	-0.09 ^{ns}	0.05 ^{ns}	-0.20*
Pupal duration	0.23 ^{ns}	0.17 ^{ns}	0.02 ^{ns}	0.22 ^{ns}	0.11 ^{ns}

* and ** indicate significance at P < 0.05 and P < 0.001, respectively; ns indicates not significant

Stepwise multiple regression analysis of putative QTL linked to tomato fruitworm resistance in an F₂ population

Model	IV trichome Model R ²	Mortality Model R ²	pupal duration Model R ²	Acylsugars Model R ²
Single marker analysis- Locus R² (single QTL)				
Marker 2 (58.87/3)	0.07**	-	-	0.05**
Marker 4 (58.42/3)	0.07**	-	-	0.05**
Marker 6 (63.24/5)	0.11**	-	-	0.07**
Marker 9 (64.17/5)	0.09**	-	0.11*	0.05*
Marker 10 (43.07/6)	-	0.09**	-	-
Marker 11 (45.13/6)	0.03*	0.03*	-	-
Marker 14 (5.17/9)	-	-	0.13*	-
Significant marker model- Model R² (QTLxQTL effects)				
2+6	-	-	-	0.10*
6+4	0.17**	-	-	-
6+4+11	0.20*	-	-	-

* and ** indicate significance at P < 0.05 and P < 0.001, respectively; ns indicates not significant

Major findings

- Type IV trichomes and acylsugars were significantly associated with tomato fruitworm resistance parameters based on no-choice assay in 7- and 13-week-old plants.
- Overall, 13-week-old plants were more resistant to tomato fruitworm than 7-week-old plants.
- Type IV trichome and acylsugars production showed recessive gene action because the F₁ was skewed strongly toward the susceptible parent in 7-week-old plants.
- A total of 12, 2, 3, 1 and 9 CAPS markers in 4 regions were significantly associated with density of type IV trichomes, larval mortality, pupal duration, larval weight and acylsugars, respectively.

References

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Acknowledgments

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