MECHANISMS OF RESISTANCE TO STINK BUG COMPLEX IN THE SOYBEAN CULTIVAR IAC-100

Carlos J. Rossetto[1], Paulo B. Gallo[1], Luiz F. Razera[1], Nelson Bortoletto[1], Toshio Igue[1], Priscila F. Medina[1], Otávio Tisselli F°[1], Vanderlei Aquilera[2], Renato F.A. Veiga[1] e José B. Pinheiro[1]

ABSTRACT

The soybean cultivar IAC-100, with multiple resistance to insect defoliators and the stink bug complex, was distributed to farmers of the State of São Paulo, Brazil, in 1989. The mechanisms of resistance of this cultivar to the stink bug complex is discussed. At least five resistance mechanisms are involved: shorter pod filling period; higher number of seeds; rejection of young damaged pods and replacement of new pods; normal leaf senescence under stress; and resistance to the yeast spot desease caused by *Nematospora coryli* Peglion.

KEY WORDS: Insecta, varietal resistance, Pentatomidae, *Nezara viridula, Euschistus heros, Piezodorus guildinii*.

RESUMO

Mecanismos da Resistência ao Complexo de Percevejos na Cultivar de Soja IAC-100

A cultivar de soja IAC-100, com resistência múltipla a insetos mastigadores de folhas (coleópteros e lagartas) e a percevejos sugadores de vagem, foi distribuída para os agricultores do Estado de São Paulo em 1989. Os mecanismos de resistência desta cultivar ao complexo de percevejos sugadores são discutidos neste trabalho. Pelo menos cinco mecanismos de resistência estão envolvidos: menor período de enchimento de vagens; maior número de sementes; rejeição de vagens novas danificadas e substituição por novas vagens; senescência normal com queda das folhas na maturação; e resistência à levedura *Nematospora coryli* Peglion transmitida pelos percevejos.

PALAVRAS-CHAVE: Insecta, resistência varietal, Pentatomidae, *Nezara viridula, Euschistus heros, Piezodorus guildinii*.

Received on 08/22/94. Accepted on 09/29/95.
[1]Instituto Agronômico, Caixa postal 28, 13001-970, Campinas, SP.
[2]COOPERMOTA, Palmital, SP.

INTRODUCTION

The stink bug complex *Piezodorus guildinii* (West.), *Euschistus heros* (Fabr.), and *Nezara viridula* (L.) is the key pest of the soybean crop in the State of São Paulo, Brazil. The cultivar IAC-100 with resistance to this complex and to insect defoliators was released to growers in 1989 (Rossetto 1989). This paper discusses the mechanisms of resistance of this cultivar to stink bugs.

MATERIAL AND METHODS

All the experiments were conducted in different counties of the State of São Paulo, Brazil. The pod filling period, R5 to R7 according to the classification of Fehr & Caviness (1977), was determined in two seasons, November (rainy season without irrigation) and March-April (dry season with irrigation), in two locals, Campinas and Votuporanga, with three cultivars IAC-100 (resistant to stink bugs), BR-4 and IAS-5 (susceptible to stink bugs), using a complete randomized block design for each local and season, with three treatments and six replications. These trials were intensively sprayed in order to keep the stink bug level near zero, to allow the precise determination of R8 (time of harvest).

The number of pods per plant was determined in Mococa and Campinas. In the Mococa Experiment Station one trial was conducted with two cultivars, IAC-100 and IAS-5, using a complete randomized block design with two treatments and six replications, with two sprays to control stink bugs. Pods were counted in five plants per plot. Number of pods was also determined in Campinas, in the presence of high stink bug infestation, without any control, in two paired fields of one hectare each, in two rainy seasons, October 1st and November 20, 1988. Pods were counted in ten paired plants taken at random from the two fields of cultivars IAC-100 and IAS-5. The count was stratified in intervals of 10cm from the ground to the plant top, allowing to make a vertical frequency distribution of pods and stink bug damage.

Pods eliminated by the resistant IAC-100 and susceptible IAS-5 were counted on the ground in one linear meter per plot, in a complete randomized block design experiment with two treatments and four replications, in Palmital, after intensive stink bug infestation.

Foliar retention at harvest was evaluated in an intensively sprayed trial in order to keep the stink bug level near zero, planted on March 26, 1990, in Campinas, with the resistant cultivar IAC-100 and the susceptible 'Foscarin', using a complete randomized block design with five replications. The percentage of foliar retention (PFR) was visually determined by grading the amount of green foliage in the plot at harvest.

The stink bug damage was evaluated by the Index of Percent Pod Damage (IPPD) (Rossetto 1989). This index is obtained by classifying one hundred pods per plot at harvest in empty, intermediate and full (or normal), and applying the equation: IPPD = % of empty pods + 1/2 (% of intermediate pods). Insecticide sprays to control stink bugs were made with Endosulfan 350, using one liter of the commercial product/ha (350g a.i./ha).

RESULTS AND DISCUSSION

The variation of duration of pod filling and plant cycle was nule among plots, and analysis of variance was not necessary. The data shows that the pod filling period is smaller in the

Table 1. Pod filling period in days (R5-R7), total plant cycle and yield of three soybean cultivars in two locals and two seasons. The March planting was irrigated. The yield data followed by the same letter do not differ by the Tukey test at 5%.

Local and date of planting	Cultivar	R5-R7	Total plant cycle	kg/ha	F	CV
Campinas	IAS-5	38	111	2521		
29/11/89	IAC-100	36	119	2940	1.5ns	18.8
	BR-4	39	116	2439		
Campinas	IAS-5	38	99	1984c		
26/03/90	IAC-100	38	101	2132b	29.2*	3.6
	BR-4	44	101	2353a		
Votuporanga	IAS-5	39	107	2060		
20/11/89	IAC-100	33	111	2218	2.5ns	18.1
	BR-4	40	110	2635		
Votuporanga	IAS-5	28	86	1398b		
03/04/90	IAC-100	30	91	1100b	7.8*	16.4
	BR-4	33	93	1671a		

*Asterisk indicates significance (P<0.05).

resistant IAC-100 than in the susceptible BR-4 despite the fact that the total plant cycle is smaller in IAS-5 and BR-4 (Table 1). The pod filling is the most susceptible period to stink bug damage and when this period is smaller there is host evasion (Painter 1951) and the damage done by stink bug is smaller. The reduction of the pod filling period reduces the stink bug damage but also reduces yield. This feature presents an opposition between reduction of damage and yield. For this reason the pod filling cannot be reduced substantially without affecting the yield capacity.

Table 2. Number of pods per plant, index of percent pod damage (IPPD), percentage of foliar retention (PFR) and yield (kg/ha), with two insecticide sprays to control stink bug, Mococa, SP.

	Planting Date Nov. 22/1988			
Cultivar	Pods/plant	IPPD	PFR	kg/ha
IAC-100	145.2	10.2	2.7	6,333
IAS-5	67.5	26.5	100.0	4,467
F test	10.9*	48.0*	21.3*	10.7*
CV%	38.2	21.1	2.2	18.4

*Asterisk indicates significance (P<0.05).

The number of pods is much higher in the resistant cultivar IAC-100 than in the susceptible IAS-5. This is a mechanism of pseudoresistance denominated damage dilution (Rossetto & Lara 1991). Tables 2 and 3 shows that the susceptible cultivar IAS-5 has strong foliar retention

Table 3. Number of pods per plant, index of percent pod damage (IPPD), percentage of foliar retention (PFR) and yield of two soybean cultivars without stink bug control, Campinas, SP.

Cultivar	Pods/plant	IPPD	PFR	kg/ha
		Planting Date Oct 1st 1988		
IAC-100	82.7	29.5	9.5	3,584
IAS-5	40.8	61.6	100.0	1,884
t test	4.9*	10.3*	65.4*	6.0*
CV%	88.3	43.3	4.8	53.0
		Planting Date Nov 20 1988		
IAC-100	104.9	22.0	5.1	3,656
IAS-5	66.7	45.1	60.0	3,040
t test	5.0*	7.3*	14.4*	3.1*
CV%	89.3	61.4	22.0	100.0

*Asterisk indicates significance (P<0.05).

at harvest when damaged by stink bug. This response is called crazzy or duddy soybean. The resistant cultivar IAC-100 presents normal leaf senescence at harvest under stink bug attack.

Tables 4 and 5 shows freqquency distribution of pods and stink bug damage per intervals of 10cm from the botton to the top of the plant. In the October 1st planting average height of IAC-100 was 62.8 ± 2.0 (2.0 = standard deviation) with minimum of 51 and maximum of 81, and IAS-5 was 37.5 ± 1.0 with minimum of 28 and maximum of 44cm. In the November 20 planting the average of IAC-100 was 63.7 ± 0.6, with minimum of 48 and maximum of 77, and IAS-5 was 49.6 ± 1.7 with minimum of 38 and maximum of 63cm. This shows that the cultivar IAC-100 had a stable height and is insensitive to photoperiod whereas IAS-5 is

Table 4. Vertical frequency distribution of pods in percentage of the total by intervals of 10cm, in two rainy planting season without stink bug control, Campinas, SP.

Cultivar	0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80
			Planting Date Oct 1st 1988					
IAC-100	1.8	13.0	19.3	20.2	23.3	15.8	5.0	1.4
IAS-5	38.3	42.8	14.9	3.9	0	-	-	-
			Planting Date Nov 20 1988					
IAC-100	2.3	9.0	17.3	24.1	26.1	12.3	7.1	1.7
IAS-5	8.7	19.6	33.9	25.5	8.8	3.3	0.1	-

sensitive. Soybean cultivars sensitive to photoperiod, when planted October the first, in the State of São Paulo, present reduced height in comparison with November 20 planting.

Table 4 shows that 'IAC-100' has only 1.8% of pods (October planting) or 2.3% (November planting) in the botton 10cm of the plant. This is a positive feature since the botton pods are lost in the mechanical harvest. The IAC-100 cultivar is taller and has a better distribution of pods.

Table 5. Actual damage caused by stink bug expressed by the index of percentage pod damage, in intervals of 10cm from the botton to the top of the plant, in two rainy planting seasons, without stink bug control, Campinas, SP.

Cultivar	0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80
			Planting Date Oct 1st 1988					
IAC-100	13.3	18.7	25.0	30.4	34.3	38.7	34.9	27.0
IAS-5	37.5	73.8	90.2	92.2	-	-	-	-
			Planting Date Nov 20 1988					
IAC-100	12.7	10.2	17.4	18.4	23.5	22.9	33.7	40.3
IAS-5	15.9	20.4	48.2	64.9	70.9	67.0	100.0	-

Table 5 shows that the stink bug damage increases from the botton to the top of the plant. Pods eliminated by the cultivars under severe infestation of stink bugs are presented in Table 6.

The resistant cultivar IAC-100 eliminates more damaged pods than susceptible 'IAS-5'. Kogan & Turnipseed (1980) show that depodding up to R3 is totally compensated and up to R4 are substantially compensated. The resistant cultivar IAC-100 eliminates more damaged pods and compensates more the damage done by stink bugs than the susceptible cultivar. This is a tolerance mechanism of resistance.

Table 6. Number of pods damaged by stink bugs, eliminated by two soybean cultivars, counted in one linear meter on the ground, Palmital, SP.

Cultivar	Pods/meter
IAC-100	262.7
IAS-5	56.2
F test	143.4*
CV%	15.3

*Asterisk indicates significance ($P<0.05$).

Foliar retention of two cultivars IAC-100 (resistant to stink bugs) and Foscarin (susceptible), under intensive spraying to keep the stink bug level near zero is presented in Table 7.

Table 7 shows that the resistant cultivar IAC-100 has normal senescence when planted in March whereas the susceptible 'Foscarin' presents foliar retention. The March planting induced foliar retention even in the absence of stink bugs. This shows that the normal senescence caracter is not a response only to stink bug damage. It seems to be a genetic trait that confers normal leaf senescence under different types of stresses: stink bug infestation or planting in the dry season (March).

Table 7. Index of percent pod damage (IPPD) and percentage of foliar retention (PFR) of two cultivars in the absence of stink bug damage, under irrigation, in dry season planting (March 26, 1990), Campinas, SP.

Cultivar	IPPD	PFR
IAC-100	4.3	0
Foscarin	8.0	62
F test	6.3*	113.1*
CV%	37.8	29.7

*Asterisk indicates significance ($P<0.05$)

The data presented demostrate four mechanisms of resistance to stink bug damage: smaller pod filling period, higher number of pods, damaged pod rejection by the resistant cultivar, normal leaf senescence under stress. Besides these four mechanisms, during the selection process of 'IAC-100', differences in yeast spot disease caused by *Nematospora coryli* Peglion were observed. 'IAC-100' was selected because it presents less damage by *N. coryli* transmitted by stink bugs, being this resistance a fifth mechanism of resistance of the cultivar IAC-100 to the stink bug complex. The resistance of IAC 100 to stink bug is not a simple trait, being a complex resistance with several components.

REFERENCES CITED

Fehr, W.R. & C.E. Caviness. 1977. Stages of soybean development. Iowa Coop. Ext. Serv. Spec. Rep. 80. 12p.

Kogan, M. & S.G. Turnipseed. 1980. Soybean growth and assessment of damage by arthropods, p.3-29. In M. Kogan & D.C. Herzog (eds.), Sampling methods in soybean entomology. New York, Spring-Verlag, 587p.

Painter, R.H. 1951. Insect resistance in crop plants. New York. The Macmillan Company, 520p.

Rossetto, C.J. 1989. Breeding for resistance to stink bugs. p. 2046-2060. In A.J. Pascale (ed.), World Soybean Research Conference IV, Vol. IV, Buenos Aires, Orientacion Gráfica Editora S.R.L.

Rossetto, C.J. & F.M. Lara. 1991. Diluição do dano, mecanismo de pseudoresistência, p.535. In Resumos Congresso Brasileiro de Entomologia, 13, Recife, vol. II, 672p.