FORAGE ENTOMOLOGY

Activity 1. Screening *Brachiaria* genotypes for spittlebug resistance.

Continuous mass rearing of spittlebug species in Palmira and Macagual

A permanent supply of insects is essential in the process of evaluating genotypes for resistance to spittlebug. At present, the progress made in mass rearing of nymphs and in obtaining eggs from adults collected in the field allows us to conduct simultaneous screening of large number of *Brachiaria* genotypes for resistance to all major spittlebug species present in Colombia. Insects produced in our mass rearing facilities are used for greenhouse evaluations in Palmira and field evaluations in Caquetá.

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Identify *Brachiaria* genotypes resistant to spittlebug

Greenhouse screening of *Brachiaria* accessions and hybrids for resistance to four spittlebug species

Rationale: Assessment of resistance to spittlebugs is an essential step in the process of breeding superior *Brachiaria* cultivars at CIAT. In 2004, intensive screening of selected hybrids was conducted under greenhouse and field conditions.

Materials and Methods: Screenings for resistance were conducted with *Aeneolamia varia, A. reducta, Zulia carbonaria,* and *Prosapia simulans*. Test materials were usually compared with five checks fully characterized for resistance or susceptibility to *A. varia*. Plants were infested with six eggs per plant of the respective spittlebug species and the infestation was allowed to proceed without interference until all nymphs were mature (fifth instar stage) or adult emergence occurred. Plants (usually 5-10 per genotype) were scored for symptoms using a damage score scale (1, no visible damage; 5, plant dead) developed in previous years. Percentage nymph survival was calculated. Materials were selected on the basis of low damage scores (<2.0 in a 1-5 scale) and reduced percentage nymph survival (<30%). All those rated as resistant or intermediate were reconfirmed. All susceptible hybrids were discarded.

Results and Discussion: A set of 731 pre-selected sexual (SX03) hybrids were simultaneously screened for resistance to *A. varia*, *A. reducta*, and *Z. carbonaria*. We used one rep per hybrid per insect species. For comparison, we used 16 well-known checks replicated 10 times per insect species. In terms of damage scores, 78.3%, 84.3%, and 74.9% of the hybrids were rated as resistant to *A. varia*, *A. reducta*, and *Z. carbonaria*, respectively **(Table 1)**. After percentage survival was recorded, 120 hybrids combining low damage levels and high levels of antibiosis resistance were selected for reconfirmation tests. These were conducted using five replications per genotype per insect species. Results **(Table 2)** clearly indicated that a very significant progress has been made in incorporating antibiosis resistance to all of the three test species in a relatively short period of time. The rapid progress made in incorporating resistance to spittlebug is also illustrated in **Figure 1**. There has been a steady increase in the frequency of resistant genotypes as a result of recurrent selection through cycles.

Table 1. Frequency distribution (percentages) of resistance reactions in a set of 731 sexual *Brachiaria* hybrids screened for resistance to three spittlebug species.

Category	*Aeneolamia varia*	*Aeneolamia reducta*	*Zulia carbonaria*	All Three Species
Resistant	64.2	75.2	59.1	39.5
Intermediate	14.1	9.1	15.8	33.9
Susceptible	21.7	15.7	25.1	26.6

Table 2. Levels of resistance to three spittlebug species in selected sexual *Brachiaria* hybrids.

Genotype	Damage Scores			Percentage Nymph Survival		
	Aeneolamia varia	*Aeneolamia reducta*	*Zulia carbonaria*	*Aeneolamia varia*	*Aeneolamia reducta*	*Zulia carbonaria*
Elite hybrids						
SX03/2483	1.0	1.0	2.4	8.0	0.0	26.7
SX03/2226	1.0	1.0	1.7	3.3	6.7	16.7
SX03/2061	1.3	1.0	1.3	16.7	0.0	16.7
SX03/4043	1.3	1.0	1.2	10.0	10.0	6.7
SX03/3744	1.0	1.4	1.6	13.3	6.7	3.3
SX03/4351	1.1	1.4	1.4	20.0	13.3	10.0
SX03/3882	1.0	1.3	1.2	13.3	20.0	10.0
SX03/2053	1.0	1.0	2.4	20.0	20.0	33.3
SX03/1100	1.0	1.5	2.7	25.0	21.7	13.3
SX03/4224	1.4	1.2	1.2	20.0	23.2	4.2
SX03/0282	1.0	1.0	1.5	30.0	6.7	6.7
SX03/0770	1.3	1.3	1.2	30.0	10.0	3.3
SX03/1090	1.3	1.7	1.7	30.0	17.3	13.3
SX03/1408	1.0	1.2	1.2	26.7	23.3	13.3
SX03/2784	1.5	1.1	2.0	26.7	16.7	0.0
Checks						
CIAT 36062[a]	1.0	1.4	2.2	25.0	21.7	60.0
SX01NO/0102[a]	1.6	1.0	2.2	26.7	10.0	20.0
CIAT 0606[b]	4.6	3.8	4.0	91.7	75.0	53.3
BRX-44-02[b]	4.8	4.6	3.8	83.3	80.0	68.3

[a] Resistant check.
[b] Susceptible check.

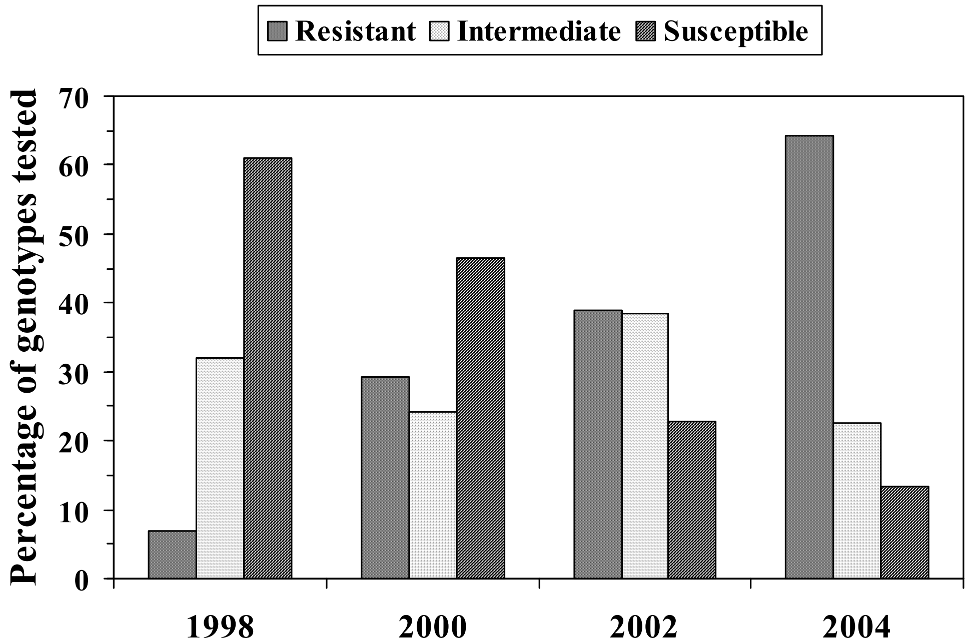

Figure 1. Progress in the incorporation of resistance to *Aeneolamia varia* in *Brachiaria*; note the steady increase in the frequency distribution of resistance genotypes and the decline in the frequency of susceptible genotypes as a result of continuous cycles of selection.

As part of on-going studies on mechanisms of resistance to spittlebug species of economic importance in Mexico, we screened 34 hybrids for resistance to *Prosapia simulans*. These hybrids had been pre-selected in Mexico for good adaptation and desirable agronomic characteristics. Using a level of infestation of six nymphs per plant and 10 replications, the hybrids were compared with four accessions, and two susceptible and two resistant checks. Results **(Table 3)** showed that 11 hybrids have antibiosis resistance to *P. simulans*. This information will be crossed with that obtained in Mexico with the species *Aeneolamia albofasciata* and *A. postica* (part of Ulises Castro's M. Sc. thesis on mechanisms of resistance to Mexican species).

In progress is the evaluation for resistance to *A. varia*, *A. reducta* and *Z. carbonaria* of 422 apomictic hybrids derived from crosses between the highly resistant sexual hybrid SX01NO/0102 and *B. decumbens* 'Basilisk' and other susceptible genotypes. The main purpose of this study is to identify patterns of segregation of resistance for each of the spittlebug species involved. Results will be reported in 2005.

Table 3. Levels of resistance to *Prosapia simulans* in *Brachiaria* hybrids pre-selected for Mexican conditions.

Genotype	Damage Scores	Percentage Nymph Survival	Rating
Hybrids			
MX 1905	1.1	3.3	Resistant
MX 1561	1.3	5.6	Resistant
MX 3056	1.6	1.7	Resistant
MX 1423	1.8	1.7	Resistant
MX 1880	1.8	29.6	Intermediate
MX 3641	2.0	25.0	Intermediate
MX 2295	2.2	10.0	Resistant
MX 1809	2.2	16.7	Resistant
MX 1388	2.2	16.7	Resistant
MX 3567	2.2	26.7	Intermediate
MX 2552	2.2	33.3	Intermediate
MX 1788	2.3	31.5	Susceptible
MX 3426	2.3	26.7	Intermediate
MX 1263	2.4	42.6	Susceptible
MX 3731	2.4	18.5	Resistant
MX 2135	2.5	48.3	Susceptible
MX 2531	2.6	50.0	Susceptible
MX 1942	2.6	41.7	Susceptible
MX 3850	2.7	50.0	Susceptible
MX 2783	2.7	60.0	Susceptible
MX 3213	2.8	9.2	Resistant
MX 1660	2.9	47.9	Susceptible
MX 1769	3.0	3.3	Resistant
MX 1548	3.1	50.0	Susceptible
MX 1565	3.1	31.7	Susceptible
MX 2775	3.1	40.7	Susceptible
MX 1638	3.2	56.7	Susceptible
MX 3861	3.2	66.7	Susceptible
MX 2273	3.2	6.2	Resistant
MX 2090	3.2	23.3	Susceptible
MX 1614	3.3	46.7	Susceptible
MX 3626	3.4	71.7	Susceptible
MX 3582	3.7	75.9	Susceptible
Checks			
CIAT 16827	1.2	5.0	Resistant
CIAT 26110	1.8	21.7	Resistant
CIAT 36087	1.8	1.7	Resistant
CIAT 36061	3.1	27.1	Intermediate
CIAT 36062	1.8	0.0	Resistant check
CIAT 06294	1.6	6.7	Resistant check
CIAT 0606	3.6	50.0	Susceptible check
BRX-44-02	4.0	68.3	Susceptible check
LSD 5%	1.97	12.5	

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Activity 2. Field screening of *Brachiaria* accessions and hybrids for resistance to four spittlebug species.

Rationale: Assessment of spittlebug resistance under natural levels of infestation in the field is very difficult due to the focal, unpredictable occurrence of the insect. This problem has been overcome since 1998 when we developed an artificial infestation technique that allows us to properly identify resistance under field conditions. The purpose of field evaluations is to reconfirm levels of resistance identified under greenhouse conditions.

Materials and Methods: Using the experimental unit described in our 1998 Annual Report, the genotypes (usually 10 replicates) are initially infested in the greenhouse with an average of 10 eggs per stem. Once the infestation is well established, with all nymphs feeding on the roots, the units are transferred to the field and transplanted 10-15 days after infestation. The infestation is then allowed to proceed without interference until all nymphs have developed and adults emerge some 30-35 days thereafter. The plants are then scored for damage by means of the 1-5 visual scale utilized in greenhouse screenings. The number of stems per clump is counted before and after infestation and a tiller ratio (tillers per plant at the end of the infestation process/tillers per plant at the beginning of the infestation process) is then calculated. Using this methodology, 12 major screening trials (four with *A. varia*, four with *Zulia carbonaria,* two with *Z. pubescens*, and one with *Mahanarva trifissa*) were conducted in Caquetá in 2004. The main purpose of these trials was to reconfirm resistance in 22 sexual hybrids (SX01) previously selected in Palmira under greenhouse conditions.

Results and Discussion: As shown in **Table 1**, virtually all of the sexual hybrids showed adequate levels of field resistance to all four species tested. Consistently, average damage scores were significantly lower than those obtained with the susceptible checks, CIAT 0606 and BRX-44-02. Tiller ratios for the sexual hybrids were significantly higher than those of susceptible checks, suggesting that antibiosis resistance present in the hybrids protects the plants from intense insect damage, allowing the plant to grow and produce new tillers. On the contrary, susceptible plants lose tillers As in previous occasions there were significant ($P < 0.01$) negative correlations between damage scores and tiller ratios (r = -0.844 for *A. varia*, -0.887 for *Z. carbonaria*, -0.785 for *Z. pubescens*, and -0.697 for *M. trifissa*). This means that damage scores are useful in predicting tiller losses resulting from intense insect damage. One of the commercial checks (CIAT 36087, 'Mulato 2') was resistant. Surprisingly, the commercial check CIAT 36061 ('Mulato'), which is not antibiotic to any spittlebug species, showed a very interesting level of field tolerance both in terms of damage scores and tiller ratios **(Figure 1)**.

Table 1. Damage scores and tiller ratios obtained with 22 selected sexual *Brachiaria* hybrids and checks tested for resistance to *Aeneolamia varia* (Av), *Zulia carbonaria* (Zc), *Z. pubescens* (Zp), and *Mahanarva trifissa* (Mt) under field conditions.

Genotype	Damage Scores				Tiller Ratiosa			
	Av	Zc	Zp	Mt	Av	Zc	Zp	Mt
SX01/NO/0067	1.8	2.1	1.6	1.3	1.09	1.21	1.29	1.62
SX01/NO/0102	2.0	1.7	1.6	1.4	1.29	1.76	1.92	1.60
SX01/NO/0159	1.6	1.8	1.5	1.3	1.37	1.66	1.53	1.82
SX01/NO/0233	2.7	1.9	1.8	1.9	0.94	1.29	1.43	1.33
SX01NO/0263	2.0	1.9	1.6	1.2	1.34	1.48	1.55	1.76
SX01/NO/0446	1.8	1.8	1.6	1.1	1.09	1.26	1.38	1.47
SX01/NO/0878	1.9	1.8	1.8	1.7	1.38	1.44	1.65	1.71
SX01/NO/1090	1.9	1.9	1.8	1.2	1.06	1.61	1.26	1.24
SX01/NO/1175	1.8	2.0	1.8	1.3	1.12	1.26	1.35	1.43
SX01NO/1186	2.1	2.1	1.9	1.4	1.22	1.46	1.34	1.18
SX01NO/1710	1.7	2.0	1.6	1.5	1.33	1.52	1.46	2.72
SX01/NO/2017	1.9	2.0	1.6	1.3	1.48	1.39	1.72	1.83
SX01/NO/2420	1.9	1.8	1.6	1.7	1.35	1.57	1.46	1.18
SX01/NO/2619	1.7	1.7	1.7	1.2	1.11	1.46	1.69	1.49
SX01/NO/3168	1.8	1.8	1.8	1.4	1.10	1.33	1.52	1.38
SX01/NO/3178	1.9	1.8	1.8	1.3	1.12	1.41	1.34	1.47
SX01/NO/3390	2.1	2.3	1.8	1.9	0.92	1.14	1.30	1.14
SX01/NO/3439	1.9	1.9	1.6	1.0	1.25	1.61	1.58	2.22
SX01/NO/3615	1.7	1.8	1.7	1.4	1.22	1.54	1.32	1.47
SX01/NO/4506	2.1	2.1	1.7	1.6	0.92	1.17	1.29	1.44
SX01/NO/4785	1.9	2.0	1.6	1.1	1.22	1.27	1.57	1.83
SX01/NO/4861	1.7	1.7	1.7	1.6	1.28	1.64	1.62	1.74
Mean 22 hybrids	1.9b	1.9b	1.7b	1.4b	1.19b	1.43b	1.48a	1.59a
CIAT 36087	2.0	1.6	1.6	1.4	1.31	1.60	1.50	1.50
CIAT 36061	1.7	1.5	1.3	1.3	1.44	2.00	1.59	1.71
Mean commercial checks	1.8b	1.6bc	1.4c	1.3b	1.37a	1.80a	1.54	1.60a
CIAT 36062	1.6	1.3	1.4	1.1	1.64	1.92	1.69a	1.89
CIAT 6294	1.1	1.4	1.2	1.1	1.22	1.58	1.33	1.46
Mean resistant checks	1.3c	1.3c	1.3c	1.1b	1.43a	1.75a	1.51a	1.67a
CIAT 0606	4.0	3.1	2.9	3.7	0.37	0.62	0.59	0.46
BRX-44-02	4.5	3.5	3.4	4.0	0.30	0.64	0.70	0.54
Mean susceptible checks	4.2a	3.3a	3.1a	3.8a	0.33c	0.63c	0.64b	0.50b

a Tillers per plant at the end of the infestation process/Tillers per plant at the beginning of the infestation process. Means of 10 reps per genotype per species, 4 trials in the case of A. varia and Z. carbonaria, two trials with Z. pubescens and one trail with M. trifissa. Means within a column followed by the same letter are not significantly different at the 5% level according to Scheffe's multiple range test for arbitrary comparisons. Each species analyzed separately.

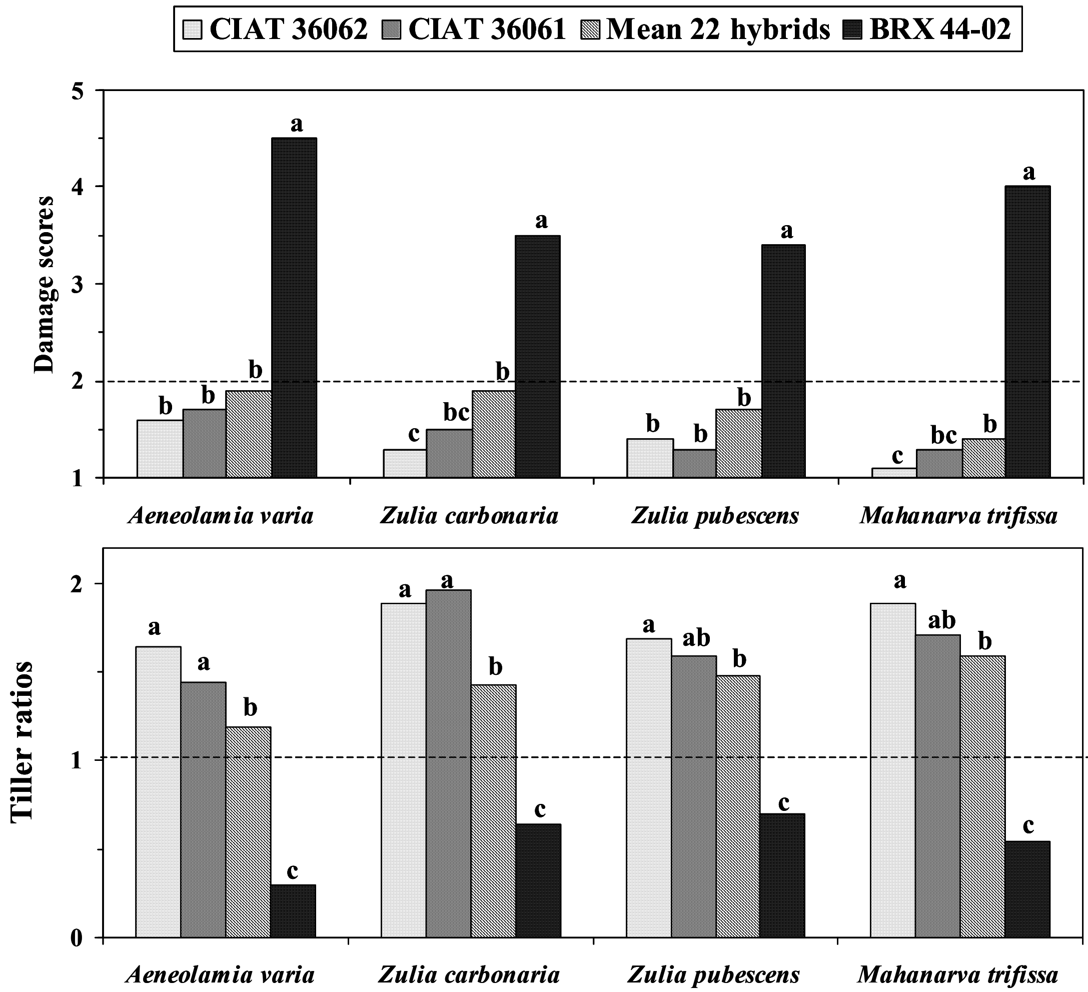

Figure 1. Resistance to four spittlebug species in selected *Brachiaria* genotypes tested under field conditions. Dotted lines represent cut-off points for resistance rating and selection. Within a given spittlebug species, bars with the same letter are not significantly different at the 5% by LSD. Each species analyzed separately.

Damage scores obtained with the 22 sexual hybrids and assorted *Brachiaria* accessions in the greenhouse correlated very well ($r = 0.76$; $P < 0.01$) with damage scores recorded in the field **(Figure 2)**. This is further proof that the technique we are using to screen for resistance in the field is a reliable one to reconfirm resistance detected under greenhouse conditions.

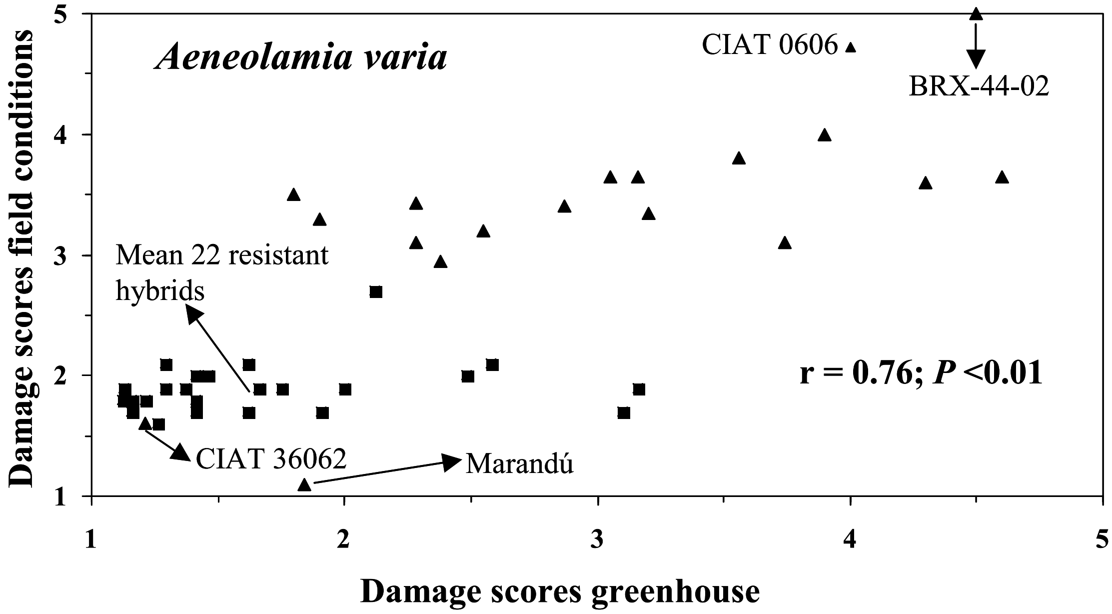

Figure 2. Damage scores obtained with selected sexual *Brachiaria* hybrids (■) and accessions (▲) tested for resistance to *Aeneolamia varia* under greenhouse and field conditions.

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Activity 3. Identify host mechanisms for spittlebug resistance in *Brachiaria.*

Effect of host plant resistance on the demography of *Aeneolamia varia*

Rationale: Varying levels of antibiosis resistance to nymphs of several spittlebug species have been well characterized in a number of resistant *Brachiaria* genotypes. The effects of antibiosis on the biology of nymphs have also been studied. Not much was known about possible direct effects of antibiotic genotypes on the biology of adults. Even less was known about sub-lethal effects (i. e., reduced oviposition rates, reduced longevity, prolonged generation times, reduced rates of growth, etc.) on adults resulting from nymphs feeding on antibiotic genotypes. We initiated a series of studies aimed at measuring how antibiotic genotypes may directly or indirectly (through sub-lethal effects) affect the biology of adults of *A. varia*. We used the life-table technique, which is widely recognized as one of the most effective means of teasing apart the subtle, interrelated aspects of changes in population density. Longevity, age-specific fecundity, sex ratio and generation time can be examined and compared among treatments as they relate to the most important demographic parameter, the intrinsic rate of natural increase.

Materials and Methods: A comprehensive series of experiments aimed at determining whether antibiosis to nymphs has an adverse effect on the demography of *A. varia* were conducted. For this, 18 life tables (nine fecundity, nine complete) were constructed. Treatment combinations are shown in **Table 1**. For each of these treatments we established cohorts of 105 pairs of spittlebug and the fate and reproductive rate of individuals were recorded until death occurred. From these data the following life-table statistics were derived: net reproductive rate (R_o) [net contribution per female to the next generation]; mean generation time (T) [mean time span between the birth of individuals of a generation and that of the next generation]; doubling time (D) [time span necessary to double the initial population]; finite rate of population increase (λ) [multiplication factor of the original population at each time period]; and intrinsic rate of natural increase (r_m) [innate capacity of the population to increase in numbers]. Life-table statistics were analyzed using the SAS program based on jackknife estimates of demographic parameters. Other variables recorded were sex ratios, percentage egg fertility and adult dry weights. These data were submitted to analysis of variance and when the *F* test was significant, we performed mean separation by LSD.

Table 1. Treatment combinations to study possible sub-lethal effects of intermediate and high levels of nymphal antibiosis on adults of *Aeneolamia varia*.

Nymphs Reared on:	Resulting Adults Feeding on:	Null hypothesis
BRX 44-02[a]	BRX 44-02	Absolute check
BRX 44-02	CIAT 06294	A genotype that is moderately antibiotic to nymphs does not affect adults
BRX 44-02	CIAT 36062	A genotype that is highly antibiotic to nymphs does not affect adults
CIAT 06294	BRX 44-02	Intermediate antibiosis to nymphs does not affect resulting adults
CIAT 06294	CIAT 06294	Intermediate antibiosis to nymphs does not affect resulting adults even when these are feeding on a moderately antibiotic genotype
CIAT 06294	CIAT 36062	Intermediate antibiosis to nymphs does not affect resulting adults even when these are feeding on a highly antibiotic genotype

Nymphs Reared on:	Resulting Adults Feeding on:	Null hypothesis
CIAT 36062	BRX 44-02	High antibiosis to nymphs does not affect resulting adults
CIAT 36062	CIAT 06294	High antibiosis to nymphs does not affect resulting adults even when these are feeding on a moderately antibiotic genotype
CIAT 36062	CIAT 36062	High antibiosis to nymphs does not affect resulting adults even when these are feeding on a highly antibiotic genotype

[a] BRX44-02 is a highly susceptible accession; CIAT 6294 (an accession) and CIAT 36062 (a resistant hybrid) possess intermediate and high levels of antibiosis resistance to nymphs of A. varia, respectively.

Results and Discussion:

A. Sub-lethal effects of resistance on adults of *Aeneolamia varia*: The impact of antibiosis to nymphs on the reproductive biology of resulting adults

Both resistant genotypes caused significant effects on the demography of *A. varia*. For simplicity, we will limit the discussion to the results obtained with the most resistant genotype, CIAT 36062. In general, rearing of nymphs of *A. varia* on the resistant genotype had a deleterious effect on the weight of resulting males and on the number and fertility of eggs laid per female **(Table 2)**. Females feeding on the susceptible genotype BRX-44-02 weighted significantly more than those feeding on the resistant genotype.

Table 2. Life history parameters of *Aeneolamia varia* as affected by all possible combinations of rearing immature stages and feeding resulting adults on susceptible (BRX 44-02) or resistant (CIAT 36062) *Brachiaria* genotypes.

Treatment[a]		Adult Dry Weight (g x 10^{-3})			
Nymphs Reared on:	Resulting Adults Feeding on:	Females	Males	Eggs Per Female	Percentage Egg Fertility
BRX 44-02 (S)	BRX 44-02 (S)	5.73a	3.79a	130.4ab	93.0a
BRX 44-02 (S)	CIAT 36062 (R)	4.90b	3.66ab	147.8a	92.6a
CIAT 36062 (R)	BRX 44-02 (S)	5.46ab	3.28b	108.0bc	80.6b
CIAT 36062 (R)	CIAT 36062 (R)	4.37c	3.10c	86.1c	80.4b

[a] S, susceptible; R, resistant.
Within a column, means followed by the same letter are not significantly different at the 5% level by LSD.

Age-specific survival and age-specific fecundity curves for *A. varia* adults are presented in **Figure 1**. Mean survival times for the four treatment combinations did not differ at the 5% level, meaning that there was not a major impact of nymphal antibiosis on the survival of resulting males or females. On the contrary, rearing of the insect on the resistant genotype CIAT 36062 did have a pronounced effect on the ability of resulting females to lay eggs. Independently of the food substrate used to feed the adults, females obtained from rearing the nymphs on the resistant genotype laid less eggs for a slightly shorter period of time, than those obtained from rearing the insect on the susceptible genotype. This can be interpreted as a sub-lethal effect of nymphal antibiosis on the reproductive capacity of the insect.

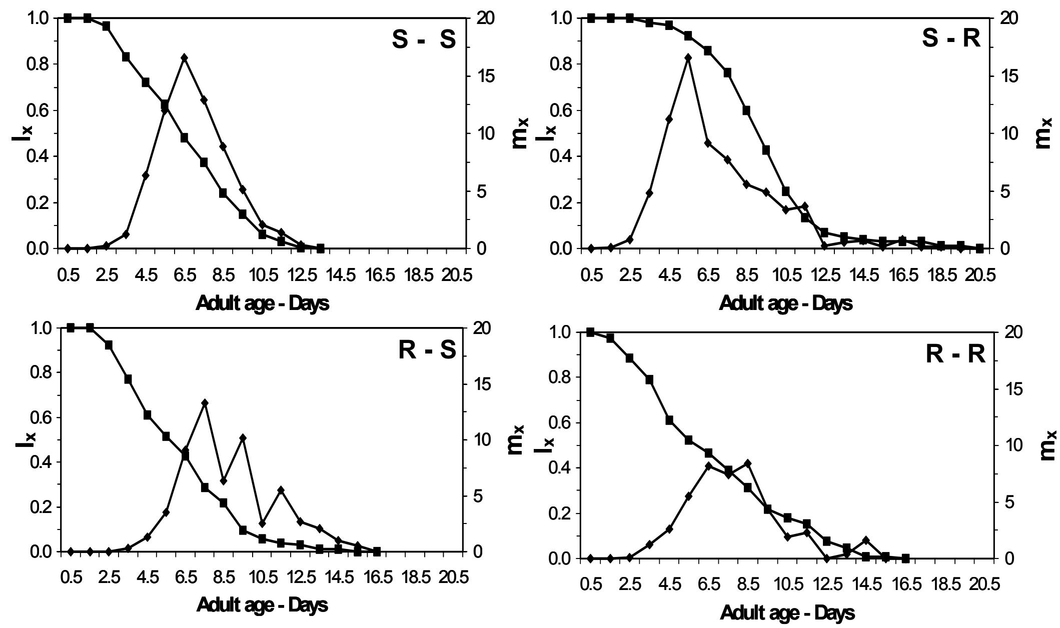

Figure 1. **Age-specific survival (l_x) (■) and age-specific fecundity (m_x) (♦) curves for adults of *Aeneolamia varia* as affected by all possible combinations of food substrate for adults and nymphs. First initial in letter combinations indicates the food substrate for nymphs followed by the initial for the food substrate for resulting adults. S, susceptible genotype (BRX 44-02); R, resistant genotype (CIAT 36062).**

All demographic parameters of *A. varia* adults were significantly affected by the antibiotic effect of CIAT 36062 on the nymphs **(Table 3)**. Females originating from nymphs reared on the resistant genotype had lower net reproductive rates, lower intrinsic rates of natural increase, lower finite rates of increase and longer generation times than those reared on the susceptible genotype. We conclude that antibiosis to nymphs in the resistant *Brachiaria* hybrid CIAT 36062 causes significant sub-lethal effects on the reproductive biology of resulting adults.

Table 3. **Fecundity life-table statistics for *Aeneolamia varia* adults as affected by all possible combinations of rearing immature stages and feeding resulting adults on susceptible (BRX 44-02) or resistant (CIAT 36062) *Brachiaria* genotypes.**

Treatment[a]		Demographic Parameters			
Nymphs Reared on:	Resulting Adults Feeding on:	Net Reproductive Rate (R_o)	Intrinsic Rate of Natural Increase (r_m)	Mean Generation Time (T)	Finite Rate of Increase (λ)
BRX 44-02 (S)	BRX 44-02 (S)	65.8a	0.724a	5.8b	2.06a
BRX 44-02 (S)	CIAT 36062 (R)	69.5a	0.747a	5.7b	2.11a
CIAT 36062 (R)	BRX 44-02 (S)	52.5b	0.576b	6.9a	1.77b
CIAT 36062 (R)	CIAT 36062 (R)	42.2b	0.574b	6.3a	1.80b

[a] S, susceptible; R, resistant.

Within a column, means followed by the same letter are not significantly different at the 5% level by LSD Jackknife estimates of the intrinsic rate of increase (per capita rate of population growth).

B. Total effects of resistance on the demography of *Aeneolamia varia*

To measure the total impact of antibiosis resistance on the demography of *A. varia*, we took into account the rates of immature mortality caused by both the resistant and the susceptible genotypes. Age-specific survival curves for nymphs and adults, as well as age-specific fecundity curves for *A. varia* adults are presented in **Figure 2**. The antibiosis to nymphs present in the resistant genotype CIAT 36062 had a significant deleterious effect on the biology of the insect, which reflected in very high levels of immature mortality. As a result, survival curves were very low as compared to those obtained with the susceptible genotype. Rearing of the insect on the resistant genotype caused a delay of about 15 days in the emergence of adults. Antibiosis also had a significant effect on the ability of resulting females to lay eggs. Independently of the food substrate used to feed the adults, females obtained from rearing the nymphs on the resistant genotype laid less eggs than those obtained from rearing the insect on the susceptible genotype.

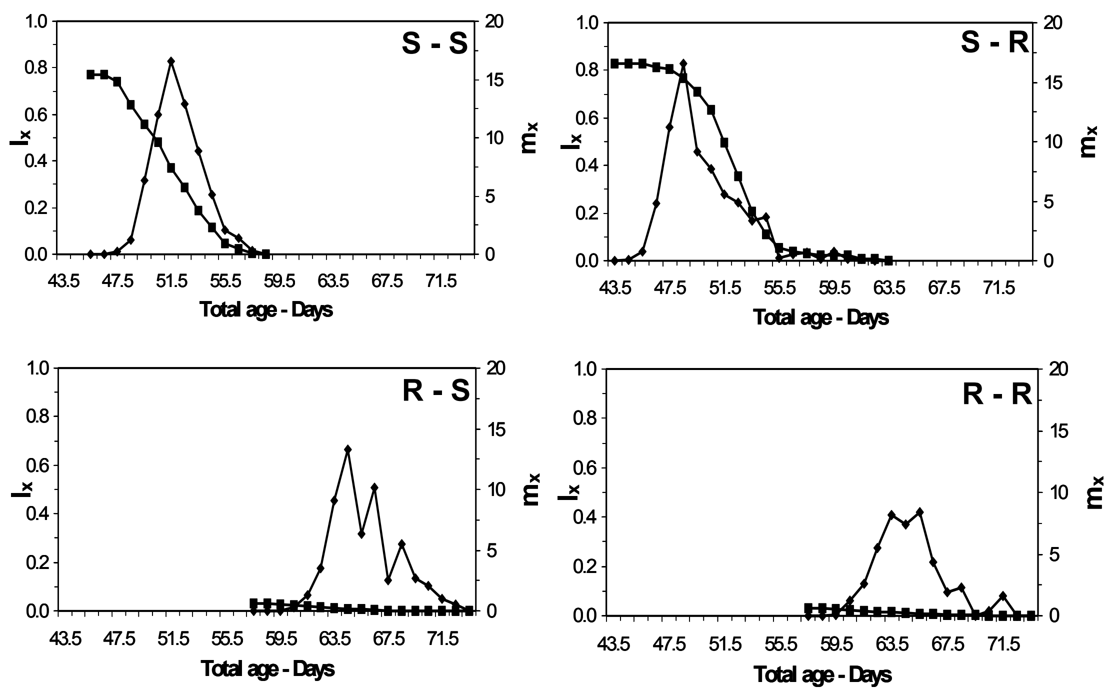

Figure 2. Age-specific survival (l_x) (■) and age-specific fecundity (m_x) (♦) curves for *Aeneolamia varia* as affected by all possible combinations of food substrate for adults and nymphs. First initial in letter combinations indicates the food substrate for nymphs followed by the initial for the food substrate for resulting adults. S, susceptible genotype (BRX 44-02); R, resistant genotype (CIAT 36062).

As a result of high immature mortality and sub-lethal effects on resulting adults, all demographic statistics of the *A. varia* population tested were significantly affected by the antibiosis present in CIAT 36062 **(Table 4)**. Populations derived from the resistant genotype had lower net reproductive rates, lower intrinsic rates of natural increase, lower finite rates of increase and longer generation times than those obtained from rearing the insect on the susceptible genotype.

The finite rate of increase is a parameter that describes deleterious effects on a given population. It is defined as a multiplication factor of the original population at each time period. The decimal part of the finite rate of increase corresponds to the daily rate of increase expressed as a percentage. This means that populations reared on the susceptible genotype would grow by 9.5 to 10.3% whereas those on the resistant genotype would grow by 0.4-0.8% **(Table 4)**. We conclude that high immature mortality and sub-lethal effects of antibiosis on resulting adults caused by the resistant *Brachiaria* hybrid CIAT 36062 have a major impact on the demography of *A. varia*.

Table 4. Life-table statistics for *Aeneolamia varia* as affected by all possible combinations of rearing immature stages and feeding resulting adults on susceptible (BRX 44-02) or resistant (CIAT 36062) *Brachiaria* genotypes.

Treatment[a]		Demographic parameters			
Nymphs Reared on:	Resulting Adults Feeding on:	Net Reproductive Rate (R_o)	Intrinsic Rate of Natural Increase (r_m)	Mean Generation time (T)	Finite Rate of Increase (λ)
BRX 44-02 (S)	BRX 44-02 (S)	50.7a	0.090b	43.3b	1.095b
BRX 44-02 (S)	CIAT 36062 (R)	57.7a	0.098a	41.5c	1.103a
CIAT 36062 (R)	BRX 44-02 (S)	1.6b	0.008c	54.4a	1.008c
CIAT 36062 (R)	CIAT 36062 (R)	1.3b	0.004c	53.8a	1.004c

[a] S, susceptible; R, resistant.
Within a column, means followed by the same letter are not significantly different at the 5% level by LSD Jackknife estimates of the intrinsic rate of increase (per capita rate of population growth).

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Activity 4. Publications, Workshop and Conferences, Awards.

Journal papers

Cardona, C., P. Fory, G. Sotelo, A. Pabon, G. Díaz, and J. W. Miles. 2003. Antibiosis and tolerance to five species of spittlebug (Homoptera: Cercopidae) in *Brachiaria* spp.: Implications for breeding for resistance. J. Econ. Entomol. 97(2): 635-645.

Kelemu, S., C. Cardona, and G. Segura. 2004. Antimicrobial and insecticidal protein isolated from seeds of *Clitoria ternatea* (L.), a tropical forage legume. Plant Physiology and Biochemistry (accepted for publication August, 2004; in press).

Sotelo, G., C. Cardona y J. Miles. 2003. Desarrollo de híbridos de *Brachiaria* resistentes a cuatro especies de salivazo (Homoptera: Cercopidae). Rev. Colombiana de Entomología 29(2): 157-163.

Workshop and Conference Papers

Cardona, C., J. Miles, and G. Sotelo. 2004. Allopatric resistance to several species of spittlebug (Homoptera: Cercopidae) in *Brachiaria* spp.: Sources, mechanisms, and progress in plant breeding. p.756 *In*: Proceedings, XV International Congress of Plant Protection, 10-15 May, 2004. Beijing, China.

Kelemu, S., C. Cardona, and G. Segura. 2004. Antimicrobial and insecticidal properties of a protein isolated from seeds of the tropical forage legume *Clitoria ternatea* (L). (Abstract) Phytopathology 94: S50. .

Sotelo, P., C. Cardona, G. Sotelo y J. Montoya. 2004. Resistencia de *Brachiaria* spp. al salivazo: Posibles efectos subletales de cultivares resistentes sobre los adultos de *Aeneolamia varia* (F.) (Homoptera: Cercopidae). p. 64 *In*: Resúmenes XXXI Congreso Sociedad Colombiana de Entomología, Socolen, Bogotá, Julio 28-30, 2004.

Pabón , A., G. Sotelo y C. Cardona. Resistência de dois genótipos híbridos de *Brachiaria* spp. ao ataque combinado de quarto espécies de cigarrinha das pastagens (Homoptera: Cercopidae). XX Congreso Brasileiro de Entomología, Gramado, Brasil, 5-10 Setembro, 2004. (Poster).

Awards

"Francisco Luis Gallego Award" to the best paper presented by an undergraduate student. XXX Congress of the Colombian Entomological Society. Awarded to: A. Pabón, G. Sotelo, and C. Cardona

Personnel

César Cardona, Guillermo Sotelo, Gilberto Córdoba, Reinaldo Pareja, William Mera.

Students

Alejandro Pabón, M. Sc. candidate, Universidad de Viçosa, Brazil. Thesis title: Mechanisms of resistance to *Deois incompleta* and *Notozulia entreriana* en *Brachiaria* spp.

Ulises Castro, M. Sc. candidate. Colegio de Postgraduados de Chapingo, Chapingo, Mexico. Thesis title: Mechanisms of resistance to *Aeneolamia albofasciata* and *Prosapia simulans* en *Brachiaria* spp.

Paola Sotelo. B. Sc. Thesis (finalized): Resistencia de *Brachiaria* spp. al salivazo*:* Efectos subletales de cultivares resistentes sobre los adultos de *Aeneolamia varia* (F.) (Homoptera: Cercopidae).

María Fernanda Miller. B. Sc. Thesis: Resistencia de *Brachiaria* spp. al salivazo*:* Efectos subletales de cultivares resistentes sobre los adultos de *Zulia carbonaria* (Lallemand) (Homoptera: Cercopidae).

Collaborators: J. W. Miles, Personnel in the Breeding Section, CORPOICA – Macagual.