Comparative effect of *Bacillus thuringiensis* delta endotoxin proteins on the fitness of F_1 hybrids obtained from *S. halepense X S. bicolor* and *S. sudanense X S. bicolor* crosses grown in competition with their parents

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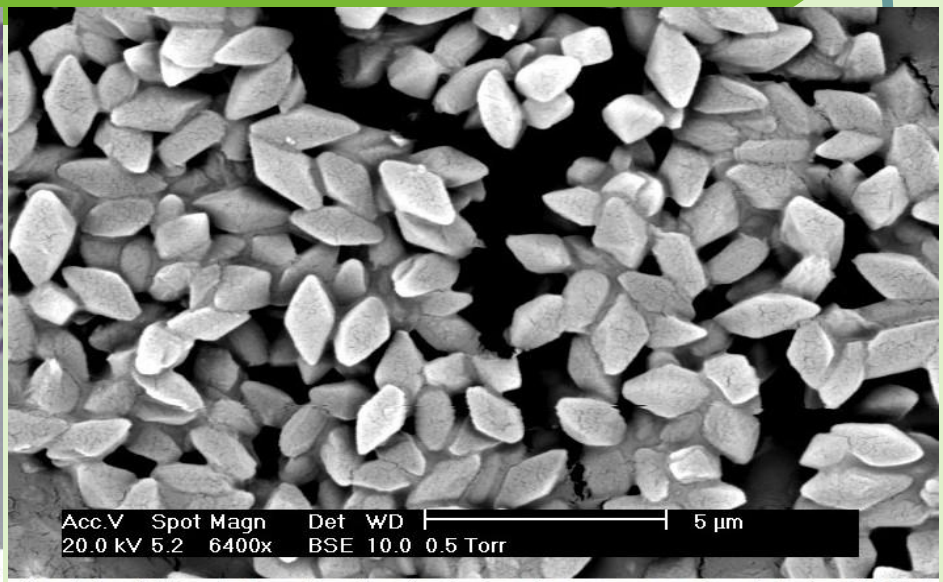
Introduction

- Disruptive selection has progressively maintained huge diversity among crop and weedy members of the sorghum genus.
- Crop improvement in the species has greater impact on alleles that enhance cultivation and productivity in traditional cropping systems.
- Similarly, natural selection seems to reward wild sorghums with greater adaptive advantage in given environments.
- However traits like disease and insect resistance maintained by breeders in crops may enhance fitness in progenies of crop and wild sorghums.
- Fitness advantage or penalty in hybrids may be due the transgenes' contribution to enhance or diminish vegetative and reproductive (fecundity) fitness.

Bt Endotoxins with insecticidal activity

Gram stain of *Bacillus thuringiensis* under 1000 × magnification



Crystals of Bt-toxin from *Bacillus thuringiensis* serovar morrisoni strain T08025.

•Several BT strains with insecticidal activity have been identified: (Bt. *tenebrionis*, Bt. *kurstaki*, Bt. *israelensis*, Bt. *aizawai*, Bt. *san diego*).

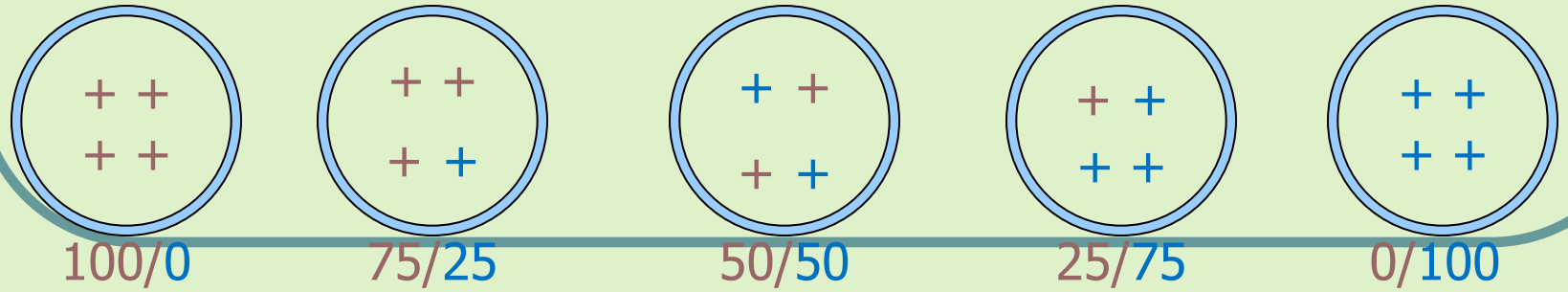
•Bt. products have been developed and are available as sprays in Kenya.
•These are sold under commercial names including: Dipell®, Javelinl®, Thuricidel®, and Xentaril®.

•Most Bt. strains endotoxins are used for control of caterpillars.
•Bt. *israelensis* is used for control of mosquitoes
•Bt. *tenebrionis* for control of beetles.

Research Approach

- This study evaluated the effect of *Bacillus thuringiensis* (Bt) endotoxin sprays on plant performance of two F_1 populations from *S. halepense* X *S. bicolor* and *S. sudanense X S. bicolor*.
- Replacement series assays were utilized to evaluate the competitiveness of the F_1 in the field and in the presence or absence of (Bt) endotoxin spray.
- An RCBD design with 4 replications used in the assay.

Bt larvicide sprayed	Bt larvicide not-sprayed
S. bicolor and (*S. halepense* X *S. bicolor*)	*S. bicolor* and (*S. halepense* X *S. bicolor*)
S. halepense and (*S. halepense* X *S. bicolor*)	*S. halepense* and (*S. halepense* X *S. bicolor*)
S. bicolor and (*S. sudanense* X *S. bicolor*)	*S. bicolor* and (*S. sudanense* X *S. bicolor*)
S. sudanense and (*S. sudanense* X *S. bicolor*)	*S. sudanense* and (*S. sudanense* X *S. bicolor*)



Results- Bt delta endotoxin proteins on panicle characteristics of *S. halepense, S. bicolor* and *S. halepense X S. bicolor* hybrids

- The presence of Bt larvicides increased seed production in the F_1 populations between *S. halepense* X *S. bicolor.*

Table 2. Panicle characteristics of *S. halepense (Sh), S. bicolor(Sb)* and *S. halepense X S. bicolor* hybrids grown in five plant ratio combinations of Bt sprayed and unsprayed plants.

Plant ratios	Spray	Total No. of seeds	Total Panicle Weight (g)	Percent Homopteran	Percent Homopteran /Lepidopteran
Parents (100%)	+ BT	559±60	35±3	22±4	-
Parents (100%)	- BT	618±70	40±4	-	26±5
F_1: Parents (75:25)	+ BT	679±49	42±3	26±3	-
F_1: Parents (75:25)	- BT	534±55	32±3	-	17±4
F_1: Parents (50:50)	+ BT	699±64	45±3	28±4	-
F_1: Parents (50:50)	- BT	580±68	41±4	-	28±5
F_1: Parents (25:75)	+ BT	510±56	37±3	10±4	-
F_1: Parents (25:75)	- BT	650±92	41±5	-	24±6
ShxSb (F_1) (100%)	+ BT	1025±54	57±3	21±4	-
ShxSb (F_1) (100%)	- BT	523±64	35±3	-	22±4

Panicle and foliage insects

Figure 8.4.7. Panicle and foliage insects on experimental plants showing (A) Sorghum aphid (*Melanaphis saccari*) on the abaxial surface of mature leaves, (B) African bollworm (*Helicoverpa armigera*) larvae on un-sprayed plant panicles and (C) Maize aphids (*Rhopalosiphum maidis*) on rachis in grain filling panicles.

Bt delta endotoxin proteins on panicle characteristics of *S. sudanense, S. bicolor* and *S. sudanense X S. bicolor* hybrids

- The presence of Bt larvicides increased seed production in the F_1 populations between *S. sudanense X S. bicolor*

Table 3. Panicle characteristics of *S. sudanense*(Ss), *S. bicolor* (Sb) and *S. sudanense X S. bicolor* hybrids grown in five plant ratio combinations of Bt sprayed and unsprayed plants.

Plant ratios	Spray	Total No. of seeds	Total Panicle Weight (g)	Percent Homopteran	Percent Homopteran /Lepidopteran
Parents (100%)	+ BT	576±42	21±2	6±2	-
Parents (100%)	- BT	578±41	27±1	-	12±2
Parents: F_1 (75:25)	+ BT	561±40	17±1	6±2	-
Parents: F_1 (75:25)	- BT	472±39	22±1	-	6±2
Parents: F_1 (50:50)	+ BT	681±41	28±1	5±2	-
Parents: F_1 (50:50)	- BT	410±49	21±2	-	8±2
Parents: F_1 (25:75)	+ BT	652±38	27±1	11±2	-
Parents: F_1 (25:75)	- BT	627±49	27±2	-	14±2
SsxSb (F_1) (100%)	+ BT	678±41	33±2	10±2	-
SsxSb (F_1) (100%)	- BT	569±50	23±2	-	8±2

Experimental plants

Figure 8.4.6. Morphological differences in experimental plants, showing variation in tillering, height, exertion among parents and F_1 progenies.

Bacillus thuringiensis delta endotoxin proteins on plant fitness traits of S. halepense, S. sudanense, S. bicolor, S. sudanense X S. bicolor and S. halepense X S. bicolor hybrids.

- Bt larvicide sprayed populations showed increased total plant weight the hybrid between *S. halepense* X *S. bicolor*.
- There was no significant difference in total plant weight in sprayed or non-sprayed *S. sudanense X S. bicolor* F_1 populations.

Species	Total Plant Weight	
	-Bt	+Bt
Sb	224±27	263±26
Sh	132±46	184±39
ShxSb:F_1	286±30	452±28
Ss	254±38	292±39
SsxSb:F_1	427±29	410±28

(Sh - *S. halepense;* Ss - *S. sudanense;* Sb - *S. bicolor).*

Bacillus thuringiensis delta endotoxin proteins on plant fitness traits of S. halepense, S. sudanense, S. bicolor, S. sudanense X S. bicolor and S. halepense X S. bicolor hybrids.

- Total seed weight and total number of seed increased in *S. halepense* X *S. bicolor* F_1 populations exposed to Bt endotoxins.
- This significant difference was not seen in *S. sudanense X S. bicolor* F_1 populations.

Species	Total No. of Seed	
	-Bt	+Bt
Sb	1730±247	2339±223
Sh	793±506	1234±379
ShxSb:F_1	1769±285	3006±248
Ss	2559±343	2835±336
SsxSb:F_1	3244±253	3756±240

(Sh - *S. halepense;* Ss - *S. sudanense;* Sb - *S. bicolor)*

Conclusions and Recommendations

- Results from the study indicate that the effect of Bt endotoxins varies with the genetic background of the parental groups of F_1 exposed to the Bt when grown in competition.
- Therefore generalizations of the effect of transgenes across all products of geneflow between crop and weedy sorghums may be insufficient.
- Assays of improved adaptive advantage in segregating populations from interspecific crosses need to involve several wild and weedy progenitors before the release of improved transgenic varieties in the sorghum genus.

Thank You

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