PROJECT NUMBER		M131/10
PROJECT TITLE		Chemical control of post-tasselling infestations of second-generation African stem borer, *Busseola fusca*
PROJECT MANAGER		JBJ van Rensburg
PROJECT STATUS		Complete
PROJECT DURATION		01/04/1999 - 31/03/2010
CO-WORKERS	(internal)	N de Klerk, LL Ramonyane
	(external)	None

ABSTRACT

Novel chemical compounds including insecticides, adjuvants and attractants were evaluated in 11 field trials conducted over a period of six years in an attempt to improve efficacy of control of stem borer infestations in the post tasselling period of plant development. No insecticide or adjuvant was identified that could provide significant improvement in the incidence of either stem or ear damage whereas the effect on borer numbers was only marginal. Variation in timing of applications did not provide significant improvement once the larvae were in advanced stages of development. It is concluded that improved efficacy of control can only be achieved by applications during the early tasselling stage or immediately thereafter.

KEYWORDS

Busseola fusca, chemical control, late infestations

INTRODUCTION

The maize stem borer is the most important insect pest of maize in South Africa and provides one of the most important insecticide markets including all field crops. Control measures are costly and epidemics pose a constant threat to food security. Recent research has shown that infestations occurring in the post-tasselling stages of plant development cause considerable losses as well as detrimental effects on grain quality. The only way that stem borer control could be improved is by increasing the penetration of the insecticide into the whorl of the plant and behind the leaves that cover maize ears. Surfactants or wetting agents can be used in pesticide formulations to improve physico-chemical characteristics of the spray solution and to increase the efficacy of foliage-applied agrochemicals. This technology has inflated in importance since the discovery of resistance to Bt maize in stem borers (Van Rensburg, 2007), particularly under irrigation. Only effective insecticides can be used to control ear damage in Bt maize, particularly in the post-tasselling stage when resistance to Bt becomes more evident. No literature relating to chemical control of *B. fusca* applies to the post tasseling period.

Improved efficacy of chemical control at late plant growth stages could reduce yield losses by up to 100 % during epidemic years, improve grain quality by 30 % and reduce levels of infection by Fusarium ear rot by at least 33 %. It may also have the additional advantage of reducing numbers of hibernating larvae that serve as sources of infestation of maize crops in the following season. It is not known to what extent stem borers contribute to the incidence of mycotoxins (Flett & Van Rensburg, 1992). It is, however, known that 100 % yield loss may result from direct ear damage caused by late infestations (Van Rensburg *et al*., 1987; 1988), whereas downgrading is a common occurrence during seasons with a late general planting date. Up to 33 % kernels affected by Fusarium ear rot due to larval feeding has been recorded.

Currently available insecticides were all registered based on testing during the vegetative plant growth stages and no insecticides are specifically intended for control of larvae other than those occurring in the whorls. The withdrawal of the systemic insecticide, monocrotophos, from the world market further reduced the options for effective chemical control of late stem borer infestation in maize. Control measures applied after tasselling is therefore not scientifically based and are often not effective. This shortcoming has become particularly important due to the increasing area planted under centre-pivot irrigation, in which insecticides are necessarily applied through chemigation without the necessary registration. In this study it was deemed possible that novel chemistry currently being tested (including adjuvants) and improved timing of application could provide the desired level of efficacy.

MATERIALS AND METHODS

During 2005/06 experimental insecticides were provided by DOW-Agrosciences and CLUB-M5. These were evaluated in three replicated field trials comprising 10 treatments, five replications and two times of application. Using a plot size of 80m row length the trials constituted a total area of 2 ha. During 2006/07 natural larval infestations were low and only one trial site (in the Ventersdorp area) could be found with sufficient larval numbers to warrant insecticide evaluation. Experimental insecticides were provided by DOW-Agrosciences. The trial comprised 10 treatments and five replications, using a plot size of 80m row length. The trial could not be sprayed at the optimal time and larvae were in advanced stages of development during application.

During 2007/08 the incidence of natural infestations was again low and no off-station trial sites were identified. A field at the Potchefstroom Experiment Station was artificially infested for evaluation of experimental insecticides and adjuvants (two trials). Artificial infestation of plants for the purpose of insecticide evaluation was followed by a delay of several weeks before application of insecticides to simulate severe testing conditions. Larvae were in the third to fourth instar and already established in the ears and stems. Another adjuvant was identified by North-West University to show promise. This compound as well as a new plant growth regulator provided by BASF was evaluated during the 2008/09 season.

During 2008/09 several moth attractants were evaluated including a novel product from Australia. Evaluation of experimental insecticides in combination with various adjuvants comprised two large trials. One trial was conducted at Potchefstroom (25 treatments, 5 replications) using artificial infestation of plants with neonate larvae and application of treatments at a relatively late stage. A similar trial was conducted at Ventersdorp (30 treatments, 4 replications) under conditions of natural infestation and more timely application of treatments. A new plant-growth regulator (Abacus) with potential positive effects on chemical control measures (provided by BASF) was evaluated in trials at Potchefstroom and Vaalharts.

In the end phase of this project (2009/10) emphasis was placed on the evaluation of a limited number of insecticides, applied at various times after infestation in an attempt to improve timing of application. This involved a field trial at Potchefstroom

RESULTS AND DISCUSSION

Despite using a late planting date in 2005 (mid-December) (Table 1), natural infestation levels were low and ear damage in the untreated controls amounted to only 5 %. Results were not conclusive and are not shown. Despite detrimental conditions prevailing during 2006/07 (Tables 2 and 3), three experimental insecticides provided better protection of ears than any registered insecticide. Results were again not conclusive. Similarly, the 2007/08 results were not promising (Tables 4 to 9). Of eleven insecticides tested (trial 1) only two biological products provided significant control when compared to an untreated control. These were an insect growth regulator and a preparation of the insect pathogen *Beauveria bassiana*. These compounds as well as the pyrethroid deltamethrin were the only treatments to result in significant yield increases whereas the same compounds and the combination Avalanche / Imidan were the only treatments to provide increased ear numbers. None of the treatments however, succeeded in preventing severe ear damage. In a second trial none of three adjuvants succeeded in improving the efficacy of any of four insecticides. Results on the evaluation of several novel moth attractants (2008/09) were not promising (data not shown). No moths of *Busseola* were captured whereas one formulation attracted only non-target species in significant numbers. During 2008/09 (Table 10) none of three adjuvants including the new product "Breakthru" provided significant improvement in efficacy of control over any parent insecticide on its own. The best treatments were conventional applications of Decis (Ventersdorp) and Karate (Potchefstroom), both pyrethroids with well known efficacy when applied during the whorl stages of plant development. The only experimental treatment that appeared to provide similar results to the standards was a combination of Dursban / Vantex. Timing of application seemed to be more important than the nature of the insecticide, including the biological products Bioneem and Bio-insect. The plant growth regulator Abacus provided some positive effects but these were only marginal (data not shown). Based on the incidence of damaged ears with early application during 2009/10 (Table 11), all insecticides showed improvement over the adjuvants applied on their own but no insecticide benefitted more from a given adjuvant. Based on the incidence of damaged internodes and on ear numbers all insecticides provided improvement over adjuvants on their own but the improvement was only marginal in terms of the untreated controls. Adjuvants had a significant effect on plant height, but independent from insecticide treatment. The result possibly relates to a positive effect by silicon, not related to any insecticidal effect. With late application (Table 12), results were even less pronounced.

Table 1 Insecticide trial, 2005.

No	Product	Active	Family	Rate / 100m	ml / 5L
1*	Avalanche	Alpha-Cypermethrin	Pir	1.5 ml	3.52
2*	Avalance +Azamax	AlphaCypermethrin + Azadiragtine	Pir + IGR	0.75ml + 18.7ml	1.76 43.8
3*	Imidan	Phosmet	OP	22.4g	52.5
4*	Avalanche + Imidan	AlphaCypermethrin + Phosmet	Pir + OP	0.75ml + 11.2g	1.76 26.2
5*	Imidan + Azamax	Phosmet + Azadiragtine	OP + IGR	11.2g + 18.7ml	26.2 43.8
5**	Oncol Super	Benfuracarb + Fenvalerate	Carb + OP	10ml	23.4
6**	Vantex	Gamma-Cyhalothrin	Pir	0.5ml	1.17
7**	Dursban	Chlorpyriphos	OP	3.5ml	8.20
8**	Dursban + Vantex	Chlorpyriphos + GammaCyhalothrin	OP + Pir	3.5ml + 0.5ml	8.20 1.17
9**	Upper check (Karate)	Lambda-Cyhalothrin	Pir	1.2ml	2.81
10	Check			-	-

* Added Upgrade 6.25ml / 5L

** Added Sanawett 0.90ml / 5L

Plot size 2 rows x 20m = 40m x 5 reps = 200m / treatment

Water delivery: 800ml / min / 37.5m = 2.1335 L/ 100m = 4.267 L/ treatment

Table 2 Chemical trial, Ventersdorp 2006.

Treatments:

No	Product	Active	Family	Rate / 100m	Rate / 160m (/3280 ml)	Rate / 4.0 L
1	Endoflo SC	Endosulfan	OP (Check 1)	5 ml	8	9.8
2	Karate EC	Lambda-Cyhalothrin	Pir (Check 2)	1.2 ml	1.92	2.4
3	Vantex EC	Gamma-Cyhalothrin	Pir	0.5 ml	2	2.5
4	Dursban EC	Chlorpyriphos	OP	3.5 ml	5.6	6.9
5	Oncol Super EC	Benfuracarb / Fenvalerate	Carb / OP	10 ml	16	19.7
6	Spinosad G			1 g / plant	do	do
7	Emperor*			6 ml	9.6	11.8
8	GF120 EC			10 ml	16	19.7
9	GF120 / Dursban			10 ml + 1.75 ml**	16 + 2.8	19.7 + 3.4
10	Check					

* Spinosad / Chlorpyriphos

** Half rate

Table 3 Surviving larvae and the incidence and degree of ear damage, Ventersdorp 2006.

No	Product	Damaged ears (%) (external)		R.I.A. (ears)		Surviving larvae / ear		Surviving larvae / stem		Damaged internodes / plant	
1	Endoflo SC	81.4 a		0.81 ab		3.50 ab		0.09 a		7.0 a	
2	Karate EC	87.9 a		0.82 ab		3.00 a		0.11 a		6.8 a	
3	Vantex EC	88.1 a		0.85 a		3.25 ab		0.08 a		7.0 a	
4	Dursban EC	85.6 a		0.82 ab		2.50 a		0.09 a		7.8 a	
5	Oncol Super EC	87.5 a		0.83 ab		3.50 ab		0.09 a		6.9 a	
6	Spinosad G	88.9 a		0.86 a		3.75 ab		0.03 a		6.8 a	
7	Emperor	87.0 a		0.84 a		2.25 a		0.09 a		7.6 a	
8	GF120 EC	87.6 a		0.79 b		3.25 ab		0.09 a		8.2 a	
9	GF120 / Dursban	85.1 a		0.82 ab		5.50 b		0.14 a		7.7 a	
10	Check	77.3 a		0.78 b		7.00 c		0.13 a		6.9 a	
Source		**F**	**P**	**F**	**P**	**F**	**P**	**F**	**P**	**F**	**P**
Treatments		1.81	0.1117	1.07	0.4125	1.54	0.1836	0.29	0.9712	0.65	0.7422
Reps		1.55	0.2249	1.82	0.1679	0.88	0.4659	0.85	0.4788	2.50	0.0811

Table 4 Insecticide Trials, 2007/08.

Trail 1

No	Product	Active	Family	Rate / 100m	ml / 5L
1	Imidan	Phosmet	OP	22.4g	52.5
2	Larvin	Thiodicarb	Carb	6.5ml	15.2
3	Bioneem	Azadirachtin	Plant extract	4.27ml	10.0
4	Bio-insek	*Beauveria bassiana*	Microbial	4.27ml	10.0
5	Avalanche + Imidan	Alpha Cypermethrin + Phosmet	Pir + OP	0.75ml + 11.2g	1.76 26.2
6	Imidan + Azamax	Phosmet + Azadiragtine	OP + IGR	11.2g + 18.7ml	26.2 43.8
7	Vantex	Gamma-Cyhalothrin	Pir	0.5ml	1.17
8	Dursban	Chlorpyriphos	OP	3.5ml	8.20
9	Dursban + Vantex	Chlorpyriphos + GammaCyhalothrin	OP + Pir	3.5ml + 0.5ml	8.20 1.17
10	Upper check (Karate)	Lambda-Cyhalothrin	Pir	1.2ml	2.81
11	Upper check (Decis)	Deltamethrin	Pir	0.6ml	1.40
12	Check 1	----	----	----	----

Plot size 2 rows x 20m = 40m x 5 reps = 200m / treatment

Water delivery: 800ml / min / 37.5m = 2.1335 L/ 100m = 4.267 L/ treatment

Table 5 Evaluations 3 days after application, 2007/08.

No	Product	SL*	Damint	Damear (%)	DL*	P	%Control**
1	Imidan	2.71	2.71	17.9	0.06	0.04	11.0a
2	Larvin	2.65	2.65	14.3	0.12	0.06	25.7a
3	Bioneem	2.78	2.78	12.4	0.09	0.06	48.3b
4	Bio-insek	2.61	2.61	12.5	0.10	0.05	46.3b
5	Avalanche + Imidan	2.81	2.81	12.4	0.13	0.07	27.2a
6	Imidan + Azamax	2.43	2.43	13.2	0.09	0.06	22.4a
7	Vantex	2.12	2.12	13.7	0.05	0.06	12.1a
8	Dursban	2.23	2.23	12.2	0.07	0.05	16.1a
9	Dursban +Vantex	3.25	3.25	18.0	0.12	0.07	23.2a
10	Upper check (Karate)	2.81	2.81	12.6	0.07	0.09	13.2a
11	Upper check (Decis)	2.68	2.68	12.3	0.07	0.07	18.7a
12	Check 1	2.27	2.27	14.5	0.10	0.05	23.1a
F		*0.61*	*0.61*	*0.64*	*0.74*	*0.26*	*2.46*
P		*0.8231*	*0.8231*	*0.7956*	*0.7056*	*0.9922*	*0.0136*

* SL = surviving larvae / plant; DL = dead larvae; P = pupae / plant;

** Only variable where some treatments differed significantly from the control

Note: The 2 biological agents were the only treatments to provide significant control

Table 6 Evaluations at harvest, 2007/08.

No	Product	SL*	Damint	Damear (%)	R.I.A. ears*	Earno	Gyield
1	Imidan	0.04b	2.59b	9.57a	0.98a	1.44ab	3.355ab
2	Larvin	0.03b	3.01a	10.27a	0.97a	1.53a	3.908a
3	Bioneem	0.04b	3.17a	14.50a	0.96a	1.57a	3.414a
4	Bio-insek	0.05b	2.75ab	11.26a	0.97a	1.42ab	2.914b
5	Avalanche + Imidan	0.05b	3.16a	9.75a	0.97a	1.50a	3.298ab
6	Imidan + Azamax	0.06b	2.62b	13.24a	0.97a	1.33ab	3.340ab
7	Vantex	0.06b	2.20b	14.04a	0.97a	1.36ab	2.946b
8	Dursban	0.09a	2.82ab	10.52a	0.97a	1.19b	2.825b
9	Dursban +Vantex	0.01b	3.03a	15.72a	0.96a	1.25b	2.869b
10	Upper check (Karate)	0.07a	2.95a	10.67a	0.97a	1.31ab	3.029b
11	Upper check (Decis)	0.02b	3.33a	11.84a	0.97a	1.47ab	3.665a
12	Check 1	0.11a	3.65a	12.18a	0.97	1.20b	2.603b
F		*1.22*	*1.12*	*0.33*	*0.28*	*0.75*	*0.79*
P		*0.2973*	*0.3657*	*0.9798*	*0.9899*	*0.6998*	*0.6592*

Note: The 2 biological agents and Decis were the only treatments to result in significant yield increases. The 2 biological agents and Avalanche / Imidan were the only treatments to provide significant increases in ear numbers

Table 7 Trial 2, 2007/08.

No	Product	ml / 5L
1	Karate	2.81
2	+ Upgrade	+6.25
3	+Sanawett	+0.90
4	+Marine 3	+0.75
5	Vantex	1.17
6	+ Upgrade	+6.25
7	+Sanawett	+0.90
8	+Marine 3	+0.75
9	Larvin	15.2
10	+ Upgrade	+6.25
11	+Sanawett	+0.90
12	+Marine 3	+0.75
13	Dursban	8.20
14	+ Upgrade	+6.25
15	+Sanawett	+0.90
16	+Marine 3	+0.75
17	Check	----

Table 8 Evaluations 3 days after application, trial 2, 2007/08.

Variable	Treatment	Adjuvant					Analyses		
		None	Upgrade	Sanawett	Marine3	Mean			
Surviving larvae / plant	Karate	0.09	0.18	0.20	0.15	0.16a	Source	F	P
	Vantex	0.21	0.21	0.29	0.26	0.24a	Treatments	6.16	0.0006
	Larvin	0.07	0.05	0.09	0.15	0.09a	Adjuvents	1.82	0.1608
	Dursban	0.04	0.17	0.13	0.15	0.12a	Interaction	0.59	0.8339
	Check	0.13	-	-	-	0.13a			
	Mean	0.11a	0.15a	0.17a	0.17a				
Damaged internodes / plant	Karate	1.91	2.13	1.99	1.30	1.83a	Source	F	P
	Vantex	1.68	1.87	2.17	1.71	1.86a	Treatments	0.68	0.6104
	Larvin	2.47	1.68	1.96	1.99	2.02a	Adjuvents	0.42	0.7392
	Dursban	1.50	1.71	1.77	1.74	1.68a	Interaction	0.58	0.8435
	Check	1.71	-	-	-	1.71a			
	Mean	1.85a	1.82a	1.92a	1.69a				
Damaged ears (%)	Karate	4.17	7.10	10.11	5.50	6.75a	Source	F	P
	Vantex	6.40	7.67	10.46	8.16	8.17a	Treatments	0.87	0.4903
	Larvin	7.21	3.41	6.44	5.49	5.64b	Adjuvents	0.71	0.5496
	Dursban	6.94	5.71	7.99	9.81	7.46a	Interaction	0.32	0.9815
	Check	8.84	-	-	-	8.83a			
	Mean	6.73a	6.55a	8.77a	7.43a				

Note: No significant differences observed

Table 9 Evaluations at harvest, trial 2, 2007/08

Variable	Treatment	Adjuvant					Analyses		
		None	Upgrade	Sanawett	Marine3	Mean			
Surviving larvae / plant	Karate	0.01	0.07	0.04	0.02	0.03b	Source	F	P
	Vantex	0.01	0.02	0.02	0.02	0.02b	Treatments	3.59	0.0140
	Larvin	0.03	0.05	0.03	0.02	0.03b	Adjuvents	1.07	0.3748
	Dursban	0.01	0.01	0.01	0.04	0.01b	Interaction	0.93	0.5248
	Check	0.06	-	-	-	0.06a			
	Mean	0.02a	0.04a	0.03a	0.03a				
Damaged internodes / plant	Karate	1.37	2.36	2.49	1.31	1.88a	Source	F	P
	Vantex	1.83	2.16	2.05	1.83	1.97a	Treatments	1.67	0.1764
	Larvin	2.40	1.63	1.92	1.71	1.92a	Adjuvents	0.68	0.5680
	Dursban	1.47	1.54	1.86	1.76	1.66a	Interaction	0.72	0.7252
	Check	1.34	-	-	-	1.34a			
	Mean	1.68a	1.81a	1.93a	1.59a				
Damaged ears (%)	Karate	2.05	3.53	5.35	6.04	4.24b	Source	F	P
	Vantex	5.94	8.33	8.72	5.47	7.11b	Treatments	7.59	0.0001
	Larvin	7.75	8.23	4.17	9.47	7.41b	Adjuvents	0.32	0.8126
	Dursban	3.00	4.10	3.13	10.39	5.16b	Interaction	0.24	0.9944
	Check	18.87	-	-	-	18.87a			
	Mean	7.52a	8.61a	8.05a	10.05a				
R.I.A. (ears)	Karate	0.99	0.99	0.99	0.98	0.99b	Source	F	P
	Vantex	0.99	0.98	0.99	0.98	0.98b	Treatments	19.59	<0.0001
	Larvin	0.98	0.97	0.99	0.98	0.98b	Adjuvents	0.59	0.6231
	Dursban	0.99	0.99	0.99	0.97	0.99b	Interaction	0.34	0.9758
	Check	0.94	-	-	-	0.94a			
	Mean	0.98a	0.97a	0.98a	0.97a				
Ears / plant	Karate	1.48	1.29	1.29	1.42	1.37b	Source	F	P
	Vantex	1.08	1.16	1.08	1.02	1.09a	Treatments	5.99	0.0008
	Larvin	0.94	1.18	1.04	1.00	1.04a	Adjuvents	0.51	0.6798
	Dursban	0.76	1.09*	0.87	1.11*	0.95a	Interaction	0.59	0.8360
	Check	0.97	-	-	-	0.97a			
	Mean	1.05a	1.14a	1.05a	1.11a				
Grain yield (t/ha)	Karate	3.370	2.694	2.537	2.785	2.846b	Source	F	P
	Vantex	2.667	3.451*	2.053	2.013	2.546a	Treatments	2.70	0.0449
	Larvin	2.054	2.428	1.975	2.120	2.144a	Adjuvents	1.35	0.2731
	Dursban	1.700	2.349	2.094	2.099	2.061a	Interaction	0.83	0.6162
	Check	2.419	-	-	-	2.419a			
	Mean	2.442a	2.668a	2.215a	2.287a				

Table 10 Ventersdorp 2008/09, 30 treatments, 4 replications, applied immediately after tasselling.

Treatment	**Sub-treatment**	**Damaged internodes / plant**	**Damaged ears (%)**	**R.I.A. (ears)**	**Ears /plant**	**Plant height (cm)**	**Grain yield (t/ha)**
Karate	Only	0.04*	0.03*	0.99*	1.25	226.5	5.789
	Upgrade	0.11*	0.03*	0.99*	1.29	220.9	5.335
	Sanawett	0.03*	0.04	0.99*	1.14	219.5	4.992
	Breakthru	0.17*	0.24#	0.95#	1.27	215.1	4.741
	Untreated	0.38#	0.22#	0.95#	1.07	225.0	4.956
Vantex	Only	0.20*#	0.09*	0.98*	1.37	225.4	5.699
	Upgrade	0.03*	0.09*	0.98*	1.03	227.5	4.701
	Sanawett	0.06*	0.08*	0.98*	1.13	241.2	5.765
	Breakthru	0.09*	0.07*	0.98*	1.10	205.7#	4.687
	Untreated	0.53#	0.25#	0.95#	1.15	235.7	5.148
Larvin	Only	0.07	0.12	0.97	1.13	215.3	4.876
	Upgrade	0.02*	0.21#	0.96	1.20	209.6	5.281
	Sanawett	0.09*	0.08*	0.98	1.12	222.2	5.040
	Breakthru	0.16*	0.13	0.97	1.05	226.1	5.077
	Untreated	0.37*#	0.22#	0.97	1.15	224.4	5.760
Dursban	Only	0.36#	0.22#	0.96#	1.05	232.6	4.447
	Upgrade	0.23#	0.14	0.97	1.23	234.1	5.722
	Sanawett	0.37#	0.14	0.97	1.21	231.8	4.152
	Breakthru	0.14	0.10	0.98	0.80	206.2#	3.305
	Untreated	0.26#	0.21#	0.95#	1.15	233.8	5.398
Check	Upgrade	0.19*	0.18	0.96#	1.02	231.6	4.807
	Sanawett	0.37#	0.23#	0.95#	1.01	211.8	4.508
	Breakthru	0.28*#	0.20	0.95#	1.08	214.6	4.907
	Untreated	0.49#	0.26#	0.94#	0.94	230.9	4.571
Bioneem	Only	0.42#	0.19	0.96#	1.06	222.5	4.633
Bio-insek	Only	0.28#	0.13	0.97	1.05	232.1	4.767
Dursban	Vantex	0.21#	0.07	0.98	1.04	225.1	4.868
Decis	Only	0.001	0.08	0.98	0.94	232.1	4.421
Anova	**F**	*3.52*	*1.45*	*1.38*	*0.98*	*0.67*	*0.63*
	P	*<0.0001*	*0.1150*	*0.1492*	*0.5118*	*0.8817*	*0.9127*

* Significantly different from untreated within treatment grouping

\# Significantly different from Decis as standard

Notes: Absence of any positive effect on ear numbers, plant height and grain yield were to be expected since application was done after tasselling. Based on F-values the incidence of damaged internodes was the only variable that provided significant differences.

Table 11 Field trial, Potchefstroom 2009/10, early application.

Treatment	**Sub-treatment**	**Damaged internodes / plant**		**Damaged ears (%)**		**R.I.A. (ears)**		**Ears /plant**		**Plant height (cm)**	
Dursban	None	7.4		0.9		0.99		0.77		142.7	
Vantex		11.3		1.2		0.99		0.71		142.4	
Larvin		12.4		1.2		0.99		0.55		140.3	
Karate		8.0		1.6		0.99		0.70		145.6	
Control		8.7		2.4		0.99		0.80		154.2	
Dursban	Upgrade	5.2		0.0		1.0		0.78		148.8	
Vantex		7.8		0.7		0.99		0.69		137.9	
Larvin		5.1		2.4		0.99		0.72		140.5	
Karate		2.5		0.0		1.0		0.69		139.6	
Control		3.8		0.0		1.0		0.65		140.1	
Dursban	Sanawett	5.1		0.0		1.0		0.80		139.9	
Vantex		5.3		0.0		1.0		0.64		130.6	
Larvin		4.6		0.0		1.0		1.03		156.7	
Karate		6.8		0.0		1.0		0.60		138.7	
Control		4.5		0.9		0.99		0.72		148.4	
Dursban	Breakthru	5.7		0.0		1.0		0.79		148.4	
Vantex		4.4		1.7		0.99		0.77		138.3	
Larvin		7.1		0.0		1.0		0.85		152.6	
Karate		4.7		0.0		1.0		0.98		132.3	
Control		12.8		0.0		1.0		0.91		153.2	
Dursban	Silicon	5.3		1.5		0.99		0.70		146.9	
Vantex		12.2		2.1		0.99		0.84		139.3	
Larvin		3.4		0.9		0.99		0.88		148.8	
Karate		4.2		0.0		1.0		0.81		126.5	
Control		6.3		0.0		1.0		0.87		159.3	
Source		**F**	**P**	**F**	**P**	**F**	**P**	**F**	**P**	**F**	**P**
Treatments		1.28	0.2855	1.28	0.2873	2.01	0.1018	1.68	0.1646	0.34	0.8493
Adjuvants		0.52	0.7245	0.56	0.6959	0.58	0.6781	0.2	0.8623	5.67	0.0005
Interaction		0.49	0.9424	0.64	0.8414	0.42	0.9731	0.86	0.6105	1.28	0.2319

Table 12 Field trial, Potchefstroom 2009/10, late application.

Treatment	**Sub-treatment**	**Damaged internodes / plant**		**Damaged ears (%)**		**R.I.A. (ears)**		**Ears /plant**		**Plant height (cm)**	
Dursban	None	0.6		3.1		0.98		0.67		128.2	
Vantex		0.4		5.7		0.98		0.57		122.9	
Larvin		0.4		1.9		0.98		0.61		125.6	
Karate		0.3		0.0		1.0		0.47		119.9	
Control		0.3		0.0		1.0		0.46		130.7	
Dursban	Upgrade	0.6		2.1		0.99		0.64		132.7	
Vantex		0.3		0.0		1.0		0.62		131.6	
Larvin		0.3		0.0		1.0		0.50		126.3	
Karate		0.6		1.5		0.99		0.64		134.4	
Control		0.8		0.0		1.0		0.56		138.8	
Dursban	Sanawett	0.4		0.0		1.0		0.65		121.5	
Vantex		0.4		0.0		1.0		0.65		135.6	
Larvin		0.6		0.0		1.0		0.69		135.7	
Karate		0.5		0.0		1.0		0.64		137.6	
Control		0.9		1.5		0.99		0.60		136.4	
Dursban	Breakthru	0.5		0.0		1.0		0.56		130.8	
Vantex		0.3		0.0		1.0		0.71		133.2	
Larvin		0.4		1.4		0.99		0.56		129.3	
Karate		0.6		1.4		0.99		0.50		126.2	
Control		0.6		3.6		0.98		0.59		129.3	
Dursban	Silicon	0.3		0.0		1.0		0.70		123.8	
Vantex		0.6		0.0		1.0		0.79		137.5	
Larvin		0.4		1.2		0.99		0.54		124.1	
Karate		0.2		0.0		1.0		0.32		122.6	
Control		0.3		2.2		0.99		0.56		120.4	
Source		**F**	**P**	**F**	**P**	**F**	**P**	**F**	**P**	**F**	**P**
Treatments		1.64	0.1727	1.16	0.3371	2.17	0.0807	0.58	0.6803	1.10	0.3614
Adjuvants		0.93	0.4509	0.24	0.9155	0.36	0.8330	1.97	0.1090	0.35	0.8440
Interaction		1.25	0.25550	1.10	0.3710	1.02	0.4427	0.73	0.7565	0.44	0.9646

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