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The Performance of Ingard® Cotton in Australia during the 1998-99 Season:

A final report on research conducted by Cotton Consultants Australia Inc. and Michael Boyce & Co. on behalf of the Cotton Research and Development Corporation

CRDC
AUSTRALIA

Executive Summary

This report is based on data gathered with the assistance of the membership of Cotton Consultants Australia Inc. (CCA) and covers all major cotton growing regions in Australia. The data analysed are drawn from a sample of 110 paired comparisons of Ingard and conventional cotton crops. The sample draws on data from 7,634 ha of Ingard cotton, which represents approximately 9% of the 85,000 ha of transgenic cotton grown in 1998/99.

Section 1 of this document was prepared by David Clark on behalf of the CCA and discusses the impact of Ingard cotton on pesticide use by product and by pest. Section 2 is a separate report on the economic performance of Ingard cotton by Tony Long of Michael Boyce and Company. Both Sections are based on the same data set but were analysed independently of each other. The following summary draws on conclusions taken from both Sections of this report and where appropriate compares these results with the previous two seasons.

The 1998/99 season was one of the worst for insects for many years. In most districts, the 1998 winter was extremely wet and it remained cool well into spring. These conditions favoured the development of weed hosts of many pests. The wet conditions also discouraged cotton farmers from effectively controlling overwintering heliothis pupae in the soil through tillage. The high pest numbers are reflected in the high number of sprays applied to both conventional and Ingard cotton crops in 1998/99.

In 1998/99 Ingard cotton reduced average pesticide use by 5.4 sprays (37%) compared 4.4 sprays or 44% in 1997/98 and 5.3 sprays or 52% in 1996/97. For specific pesticide groups, the impact of Ingard cotton varied according to which stage of the season they were predominantly used. For example, endosulfan (used early in the season) was reduced by 71% (81% in 1997/98 and 84% in 1996/97), synthetic pyrethroids (used mainly mid season) were reduced by 33% (30% in 1997/98 and 49% in 1996/97) and major organophosphates (used mainly late season) were reduced by approximately 30% (18% in 1997/98 and 15% in 1996/97).

In comparison to conventional crops, Ingard cotton reduced the number of sprays required for the key pests *Helicoverpa* spp., by approximately 43 % (44% in 1997/98 and 57% in 1996/97). Although there was some variability in the relative importance of the minor pests between regions, overall there was a small increase in sprays on Ingard for mirids; aphids and thrips; and a similar numbers for mites. Cotton tipworm was a significant pest in 1998/99 following a wet cool finish to winter that favoured carry-over of weed hosts into the cotton season. Ingard cotton provided very effective control of tipworm, reducing the number of sprays applied by 85%.

On average, the cost of each spray applied to Ingard cotton was $3.97 per ha higher than for conventional comparison crops ($4.17/ha in 1997/98 and $7.34/ha higher in 1996/97). The average combined cost of applied pesticides and license fee for Ingard cotton was $ 90.74 lower per ha than the average cost of applied pesticides for conventional crops ($35.31/ha higher in 197/98 and $42.78/ha higher in 1996/97).

The overall average yield of comparative crops of conventional crops was 7.5% higher than for Ingard cotton crops. This differs from the 1997/98 survey result which suggested that the Ingard and conventional cotton yields were very similar. However, it should be noted that in 1998/99 yields for conventional and Ingard crops in most regions did not differ greatly with the exception of the Gwydir valley where on average Ingard crops yielded 12% less than conventional. The survey was unable to establish any reasons for this result.

When all individual economic performance results are grouped, the average Ingard cotton crop returned a small economic benefit of $5.66 more per ha than conventional cotton. ($22.13 more per ha in 1997/98) However, there was considerable variability between regions (ranging from a benefit of $421.90 per ha in central Queensland to a $325.05 per ha loss in the Gwydir Valley). As occurred in 1997/98, the variability between individual farms was even more extreme than between regions (ranging from two farms benefiting by over $1,000/ha to six having a loss in excess of $1,000/ha).

The economic performance of Ingard Cotton presented in Section 2 has not included any extra monitoring or scouting costs associated with the technology. However, a majority of survey respondents indicated that Ingard Cotton required more time to check and required more frequent checking than conventional cotton. This may need to be considered as an additional cost for managing Ingard Cotton crops.

The current public debate over genetically modified organisms (GMOs) in the human food chain, in Australia appears to have ignored any potential benefits to the environment that might be achieved through the application of some GM crops. In the case of Ingard cotton there is a clear benefit to the environment through the 40-50% reduction in pesticide use measured. While this has not translated into any significant economic benefit to cotton farmers, they, along with the whole community are benefitting from the positive environmental impact of this technology.

THE IMPACT OF INGARD COTTON ON PESTICIDE USE, 1998/99

INTRODUCTION

For the third season, the CRDC have commissioned a survey to examine the impact of Ingard® Cotton, by Monsanto, on pesticide use in the Australian cotton industry. This section of the survey examines the differences in use patterns by examining details of paired comparisons of Ingard and conventional cotton.

This years survey is similar in most aspects to surveys done in the previous two seasons, with greater emphasis placed on balanced representation between valleys and respondents. In comparison with previous seasons, it must be kept in mind that the 1998/9 season had particularly high pest pressure in all valleys. Tipworm numbers were quite high in all valleys, except Emerald, Central Queensland, St George and Bourke. Aphid, mirid and *Helicoverpa* numbers were quite high in all valleys. Mites were unusually high. The exception was thrip numbers which were low in all areas, consequently no data was collected for thrip in this years survey.

METHODS

The survey was conducted during July, 1999 and asked active field agronomists to supply data relating to the performance of Ingard compared to a conventional area which had the same or similar characteristics. These characteristics included: variety, soil type, field history, planting date and management of other factors apart from insects. The data was screened to ensure that the comparisons were valid and then analysed.

A copy of the questionnaire appears in the Appendix. The questionnaire asked for: field history; spray data including dates, products, rates, application method and the pests that the sprays were targeting; yield; differences in quality, if any; relative pest pressure; differences in checking; differences in diseases; pupae control levels; reasons for growing Ingard; and comments.

There are references in this report to the previous season. This refers to information in the CRDC Occasional Paper titled "The Performance of Ingard Cotton in Australia in the 1998/7 season".

RESULTS

A total of 117 paired samples were considered to be valid comparisons. The source of these is given below in Table 1. The data for these comparisons was supplied by 42 agronomists who, collectively, were responsible for approximately 31 000 hectares of Ingard cotton. The area of Ingard in the survey data, is a just under 3 000 hectares of Ingard cotton.

TABLE 1: Source of Paired Comparisons – Number per Valley.

Valley	Emerald, Central Q'land	St George	Darling Downs	MacIntyre	Gwydir	Namoi	Macquarie, Lachlan	Bourke, Tandou	TOTAL
Irrigated	8	8	13	18	20	18	18	7	110
Dryland	0	0	4	0	3	0	0	0	7

For the purpose of the analysis, only the irrigated valleys had enough data to make comparisons for individual valleys. There is no analysis for individual dryland valleys as the sample size is small. From these samples, various analyses were done as follows.

REDUCTION IN NUMBER OF SPRAYS

General

The average number of sprays for all samples for all valleys was 8.7 for Ingard, compared to 14 for conventional cotton as presented in Figure 1. This represents an average reduction of the number of sprays of 5.3, or a 38% fewer sprays in the Ingard, compared to the number of sprays applied to conventional cotton. The reduction in the number of sprays varied between valleys, with up to a 53 percent reduction in St George, to a 30 percent reduction in the Darling Downs.

There was a reduction of just over one extra spray for Ingard in the 1998/9 season (5.3 sprays less), compared to the reduction in 1997/8 (4.2 sprays less). Note, however, that the percent reduction in 1998/9 is similar to 1997/8 as there were more sprays applied in 1998/9 (14 sprays) to conventional cotton compared to 1997/8 (10.2 sprays).

Figure 5 is the Frequency Distribution for the number of sprays. This graph compares the distribution of the number of sprays that were applied to Ingard and conventional cotton. The number of responses is given for each sprays group, as indicated on the X axis. The distribution clearly shows there is a general reduction in the level of sprays in Ingard cotton. Note that the shapes of the distribution curves are similar, albeit with the Ingard lower and the conventional higher.

Pests

Industry sources, as well as data collected in the survey, indicate that the number of sprays on conventional cotton for 1998/9 was higher than the previous season. Figure 2 presents data for the average number of sprays for the key pests.

For the main target pest, *Helicoverpa* spp (*Heliothis*), there was a reduction in the number of sprays with the Ingard by an average of 43 percent. This is very similar to the reduction in the previous season (44 percent). One of the features of the 1998/9 season was the unusually high number of Tipworm, *Crocidosema plebejana*, which were present. Ingard proved to be quite effective in the control of this pest with a reduction of 85 percent in the number of sprays.

There was a slight increase in the number of sprays for aphid (4 percent) and mirids (10 percent) on Ingard cotton. While these percentages are different, these results are in line with last season's results. Mite sprays were similar (a reduction of one percent) for the Ingard and conventional, whereas last season there was a 17 percent reduction in Ingard cotton in sprays that were targeting mites.

Details for individual valleys can be found in Figure 6

Growth Stage

Figure 3 gives results for the reduction in the number of sprays for the growth stages of Squaring, Boll Fill and Opening. These were defined as:

- Squaring – from emergence to first squares
- Boll Fill – from first squares to first open bolls
- Opening – from first open bolls to the end of the season.

The greatest reduction in the number of sprays was during the squaring period (61 percent reduction), which is similar to last year. This is consistent with research data which suggests that the efficacy of Ingard declines as the season progresses. The reduction for the Boll Fill period (27 percent) and Opening (25 percent) were also similar to last years results.

Details for individual valleys are in Figure 7.

Products

There was a large variation in the reduction of sprays for individual products as presented in Figures 4a and 4b. Trade names have been used in some cases for simplicity. Parathion and Rescue have been combined.

Endosulfan (4.4 sprays) was the most commonly used product for conventional cotton, followed closely by pyrethroids (4.2), noting that Talstar® is listed separately. The reduction in the use of Endosulfan was 71 percent. Endosulfan is primarily used at the start of the season when Ingard efficacy is good so the reduction is to be expected. The reduction in pyrethroids (33 percent) is similar to last season (30 percent). Pyrethroids are mostly used during the boll fill stage.

Ingard significantly reduced the use of products that are primarily (but not always) used to target *Helicoverpa* eggs, e.g. Amitraz (63 percent) and methomyl (77 percent). All other products that are used primarily to target *Helicoverpa* were used less in the Ingard than in the conventional cotton, noting that the reduction for Tracer was a lot smaller than other *Helicoverpa* products. Tracer is a product suited for IPM management and the smaller change in its use in Ingard may indicate that IPM guidelines are being used more widely with Ingard.

In cotton, Monocrotophos is mainly used for tipworm control. There was no Monocrotophos used in the Ingard for the samples collected with a 100 percent reduction in its use, supporting the belief that Ingard was giving good control of tipworm.

For the products primarily targeting mites, Agrimec ®, Comite ®, Pegasus ® and Intrepid ®, there was an increase in their use in Ingard. Although the percent increase for some of these products may be high, the number of sprays for both conventional and Ingard was relatively low.

Products that primarily target sucking pests, Folimat ® and Dimethoate, were also used more in the Ingard. Again the number of sprays was relatively low.

In summary, there were substantial reductions in Endosulfan and products that primarily target *Helicoverpa* eggs. There were reductions in all products that primarily target *Helicoverpa* , but increases in products that primarily target sucking pests and mites.

Details for individual valleys are in Figure 8.

Differences in Maturity

Differences in the maturity of Ingard compared to conventional cotton were measured by comparing the difference in planting date to first defoliation date and to the picking date. While there were some substantial differences in individual comparisons, there was less than half a day difference when all samples were averaged. The data would suggest, however, that there were more occasions where the conventional was later to mature. Table 2 gives a summary of the comparisons.

Table 2: Difference in the Number of Days Between Planting and First Defoliation or Picking for Ingard and Conventional Cotton Paired Samples.

Event	First Defoliation	Picking
Average number of days difference between Ingard and Conventional. (Ingard being quicker)	0.3	0.4
Maximum delay in days where Ingard was later	19	34
Maximum delay in days where Conventional was later	22	23
Number of samples where Ingard was longer	44 (39%)	45 (39%)
Number of samples where Ingard was shorter	70 (61%)	69 (61%)

Relative Pest Pressure

Table 3 summarises the differences that respondents gave for relative pest pressure of the key insect pests. These were subjective assessments. Aphid were perceived to be a problem season long but more so during squaring and boll fill, with slightly more in Ingard. *Helicoverpa* were a season long problem at high levels, being slightly less in the Ingard. Tipworm were only a problem at the start of the season with fewer problems in the Ingard. Mirids were a problem at the start of the season being slightly more of a problem in the Ingard. Mites were perceived to be a problem in the early part of the

season, but even more so during boll fill and opening, with little difference between Ingard and conventional cotton.

Table 3: Relative Pest Pressure: Subjective Assessment; All Areas;
0 = nil, 5 = very high.

	Aphid			*Helicoverpa*			Tipworm		
	Squares	Boll Fill	Open	Squares	Boll Fill	Open	Squares	Boll Fill	Open
Ingard	2.4	2.4	1.7	2.6	3.7	3.7	2.2	0.5	0.1
Conventional	2.0	2.2	1.8	3.1	4.0	3.9	3.3	0.6	0.1

	Mirid			Mites		
	Squares	Boll Fill	Open	Squares	Boll Fill	Open
Ingard	3.0	0.9	0.1	1.9	3.2	3.3
Conventional	2.7	0.9	0.1	1.8	3.4	3.1

Relative Control of Pests

Table 4 presents a summary of results reflecting the control of two pests, with the Ingard perceived to be slightly better at the start of the season for *Helicoverpa*, but slightly poorer control during boll fill and opening. Control of Tipworm was perceived to be substantially better in the Ingard at the start of the season, noting that tipworm numbers decreased as the season progressed, so control was not relevant.

Table 4: Relative Control of Pests: All Valleys; Subjective Assessment
0 = not relevant, 1 = very poor, 5 = very good

	Helicoverpa			Tipworm		
	Squares	Boll Fill	Opening	Squares	Boll Fill	Opening
Ingard	3.8	2.9	2.3	3.5	0.9	0.1
Conventional	3.5	3.1	2.8	2.1	0.6	0.1

Ingard Performance

Table 5 gives the responses for the checking of Ingard. The majority of respondents felt that Ingard needed slightly more time to check than conventional cotton with about one fifth feeling it required the same or less time. About one third felt that the frequency of checking was the same as conventional cotton, with about half feeling that it required slightly more checking. 15 percent felt that considerably more checks were needed.

Table 5: Ingard Checking Compared to Conventional Cotton.

	Considerably Less	Slightly Less	The Same	Slightly More	Considerably More
Time Needed to Check	0%	4%	17%	68%	11%
Frequency of Checking	0%	0%	34%	51%	15%

Table 6 gives the responses for performance of Ingard. About two thirds felt that Ingard rarely or never performed as originally promoted, but most felt that it was performing to their expectations. Nearly all respondents followed industry threshold all or most of the time with slightly fewer allowing two consecutive checks before spraying.

Table 6: Ingard Performance.

	Always	Mostly	Rarely	No
Perform as Originally Promoted	0%	35%	33%	32%
Perform to Expectations	2%	82%	6%	10%
Follow Industry Thresholds	32%	62%	6%	0%
Allow two Consecutive Checks	25%	55%	18%	2%

Value for Money

Table 7 gives respondent's perceptions of the value that the Ingard gave them. About one fifth felt that Ingard was good value for the money invested, with a little over a quarter feeling that Ingard was Poor or very poor value. Approximately half felt that Ingard was even value.

Table 7: Value for Money for Ingard

	Very Good	Good	Even	Poor	Very Poor
Ingard	4%	17%	53%	18%	9%

Disease and Disorder Levels

A subjective assessment of disease levels was asked with the results presented in Table 8. For all diseases, the levels in the Ingard were the same, slightly more or considerably more, but never less than the conventional. While many diseases were not considered to be present in many crops, bacterial blight and the disorder, Bonsai Bunchy Top, were perceived to be at a slightly more or considerably more level in some of the Ingard crops.

Table 8: Level of Disease and Disorders in the Ingard Compared to the Conventional

	Considerably Less	Slightly Less	The Same	Slightly More	Considerably More	Not Present	Don't Know
Bacterial Blight	0%	0%	37%	4%	10%	47%	3%
Verticillium Wilt	0%	0%	70%	1%	0%	26%	3%
Fusarium	0%	0%	42%	0%	0%	56%	2%
Black Root Rot	0%	0%	65%	5%	0%	29%	1%
Bonsai Bunchy Top	0%	0%	42%	13%	3%	40%	2%

Pupae Control

An interesting question related to the percent of Ingard and conventional cotton that received good pupae control. Given that conditions were quite wet during the preparation period leading up to the 1998 planting, pupae control was difficult. Table 9 gives the percent of respondents that felt their areas had good pupae control. Almost two thirds of the Ingard achieved good control compared to just under half of the conventional cotton. Respondents were asked to give a reason if there was a difference, with most replying that emphasis was placed on good control in the Ingard because of Ingard Audit requirements.

Table 9: Percent of Respondents with Differing Levels of Good Pupae Control.

Level of Good Pupae Control	0	25	50	75	100
Ingard	0%	1%	2%	34%	63%
Conventional	0%	0%	29%	25%	46%

Reason and Fit for Ingard

An open ended question was asked relating to the reason for growing Ingard and the fit that respondent felt that Ingard had in their insect management program. The results are presented in Table 10. Note that not all respondents answered this question and some gave multiple reasons. A large majority felt that the reason for growing Ingard was for environmental reasons. The other main reasons, IPM (Integrated Pest Management) and reducing sprays, would also supplement environmental aims. There were no replies giving value of Ingard or yield benefits as a reason for growing Ingard.

A little over a third of replies indicated that the fit for Ingard in their insect management program was for environmental reasons. IPM and reducing sprays were also important. Better *Helicoverpa* control and maximising the available Ingard area were given in several replies. Some respondents were unsure of the fit that Ingard had.

Table 10: Reason for Growing Ingard and Fit that Ingard has in Insect Program

		Enviro-nmental	IPM	Reduce Sprays	Better Heli Control	Look & See	Value	Yield Benefit	Maximize Ingard Area	Not Sure
Reason for Growing Ingard	number	98	11	12	2	2	0	0	0	0
	percent	78%	9%	10%	2%	2%	0%	0%	0%	0%
Fit that Ingard has in Insect Program	number	41	24	13	9	0	1	1	8	16
	percent	36%	21%	12%	8%	0%	1%	1%	7%	14%

Comments

Provision was made available for any additional comments. These are listed below with the valley that the reply came from.

Darling Downs	Some variations with varieties as to control. At times a little difficult to measure in dryland
Emerald, Central Qld	Very happy with its performance
Emerald, Central Qld	The Ingard on these farms performed very well. The 189i received more sprays than the Nucottn, however blight is still a real threat to the Nucottn 37. More regular and timely checks is the key to Ingard checking, hence less spraying
Emerald, Central Qld	Mostly a good tool. However too much variation between fields - some gave good control, some poor.
Gwydir	More experience is generating better management. Will become more valuable in light of Endosulfan issues.
Gwydir	Not real BBT symptoms in the Nucottn 37 but smaller bolls none the less.
Gwydir	Too dear
Gwydir	Knowledge increased with Ingard experience. People now know how to manage around its limitations for better production
Gwydir	Good control on Heli for no more than 60 days! Excellent control on tipworm
Gwydir	It won't be used again on dryland cotton in the immediate future
Gwydir	Good product once we learn about insect threshold within. Lack of predators hurt this year's Ingard crop. More support by Monsanto in field & reduce price to even financial load.
Gwydir	Performed as usual - either ok or not at all
MacIntyre	This was the season that Ingard proved its worth.
MacIntyre	There was 100 to 120 days in-reduction in Heli control with adequate control of high tipworm numbers. N37 better than 189i.
MacIntyre	Strive for more efficacious Ingard varieties. Greater portion of Ingard area for industry to remain viable under insect resistance & environmental

	problems
MacIntyre	Good tipworm control. Average Heli control. BBT an issue on late blocks & aphid areas
Macquarie, Lachlan	Need to be able to predict when control mechanisms not effective as damage occurs rapidly
Macquarie, Lachlan	Performing at similar levels over the past few years. Expression drop off in Jan still disappointing
Macquarie, Lachlan	Field kits should be available for growers and consultants to test expression of Bt gene. High amount of variability in performance seen between plants side by side & same row
Macquarie, Lachlan	Would like >20% allocation. Even >30% (99/00 allocation?) would be beneficial.
Macquarie, Lachlan	Worked well on tipworm. Good early Heli control. Needs longer period of Bt expression
Macquarie, Lachlan	More data for mirid & apple dimpling bugs thresholds would be helpful
Namoi	Am concerned with the unreliability of Ingard: few seasons experience on different farms not happy with yield variability & expression of Ingard gene
Namoi	L23i best, V15i next, then V2i. Nucottn ok except BBT (small bolls)
Namoi	About 1.8 to 2 sprays saving. Saving only on stage 1 chemicals $15 to 20 per Ha spray. Mostly ground rigged
St George	Ingard charges need some reduction ie. to $100/Ha
St George	Would like to see both seed companies with the one gene constraint. Field people agree. Should not be charged the same licensing fee
St George	Not overly thrilled with the current varieties available in 189i, should be good but seems very different in growth to Sicot 189.
St George	Early performance was generally good & Nucottn stood out in this regard

SUMMARY

Ingard gave good reductions in the number of sprays, 38 percent less than conventional, and this was similar to reductions in the results from the 1997/8 survey. Most of the reduction in spray numbers were during the early part of the season, with smaller reductions later in the season. Consequently, reduction in products used early in the season, such as Endosulfan, were among the highest. There was also a high reduction in the number of products primarily used to target *Helicoverpa* eggs, such as methomyl and Amitraz.

There were reductions in sprays for all *Helicoverpa* products used, whereas there were slight increases in products where the primary target was mites or sucking pests. Ingard gave very good control of tipworm.

A subjective assessment of relative pest pressure indicated that mirid and aphid numbers were slightly higher in the Ingard, however tipworm was considerably lower in the Ingard. Mite pressure was generally similar and *Helicoverpa* pressure was slightly less in the Ingard.

On average, there was little difference in the maturity of the Ingard compared to the conventional cotton.

Most respondents felt that more time was needed for Ingard checking and that it needed to be checked more often than conventional cotton, but was performing to their expectations, even though this may not have been as Ingard was originally promoted.

For most diseases or disorders, there were no major differences in the levels seen in Ingard and conventional cotton, though bacterial blight and Bonsai Bunchy Top were higher in the Ingard in some cases. Pupae control for Ingard during 1998 was perceived to be better than conventional cotton, but was less than ideal due to a wet winter.

Environmental considerations are by far the main reason why most feel that Ingard is being grown, with IPM and reducing the number of sprays being common reasons. There is more emphasis on the later two reasons for the fit that Ingard has in insect management programs.

Figure 1: AVERAGE NUMBER OF SPRAYS BY VALLEY AND FOR ALL VALLEYS, 1998/9

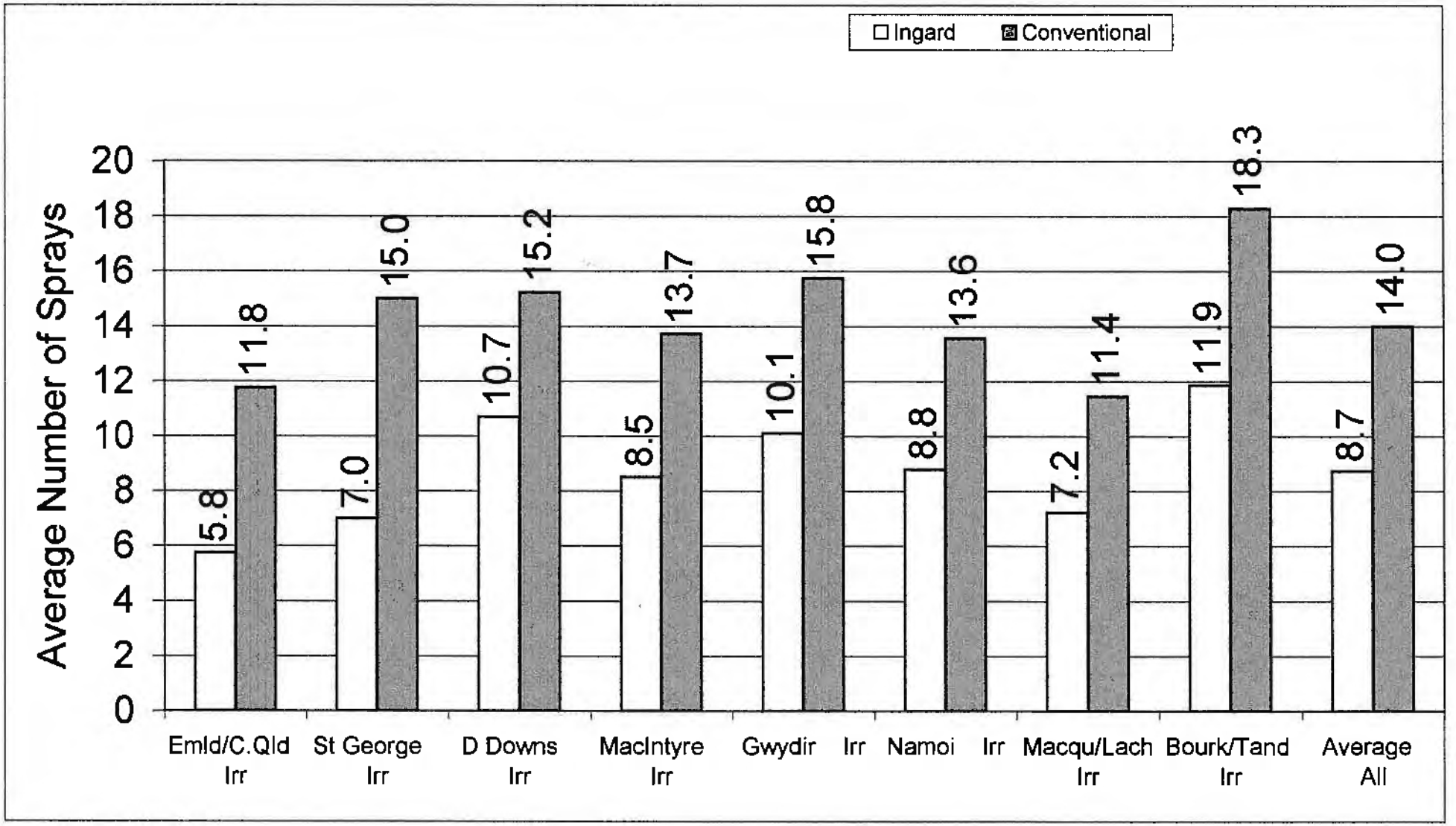


Figure 2: AVERAGE NUMBER OF SPRAYS BY PEST
All Valleys, 1998/9

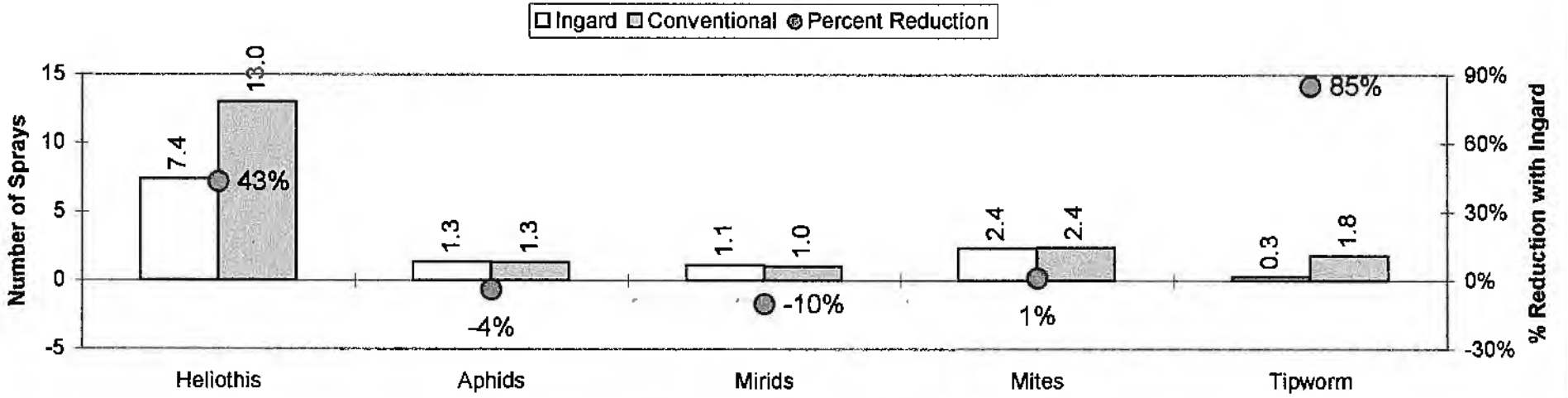


Figure 3: AVERAGE NUMBER OF SPRAYS BY CROP STAGE, All Valleys, 1998/9

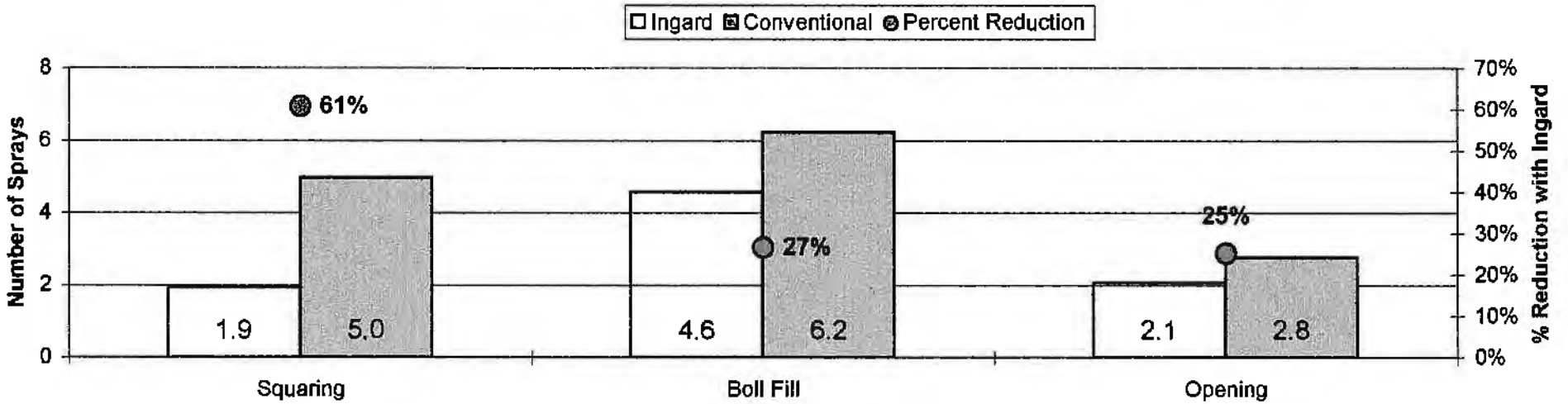


Figure 4a: AVERAGE NUMBER OF SPRAYS BY PRODUCT
All Valleys, 1998/9

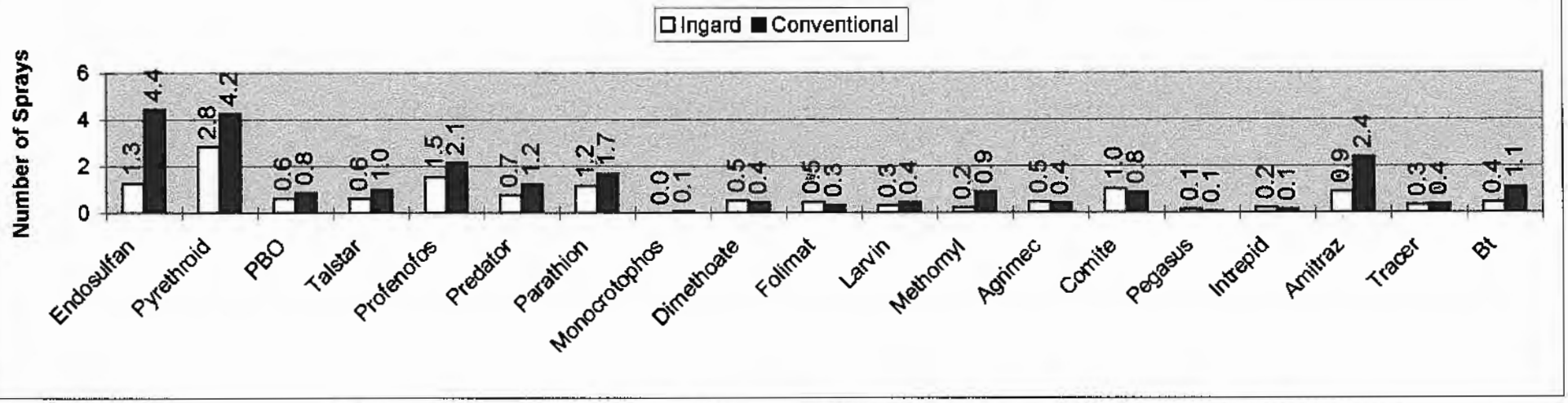


Figure 4b: AVERAGE REDUCTION IN NUMBER OF SPRAYS BY PRODUCT
All Valleys, 1998/9

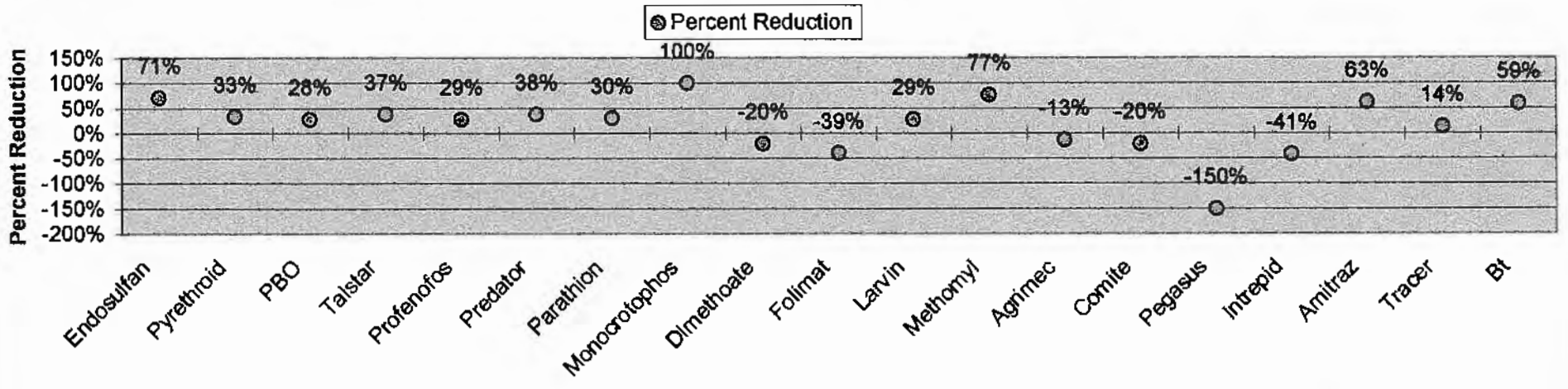


Figure 5: SPRAY FREQUENCY DISTRIBUTION, All Valleys, Irrigated, 1998/9

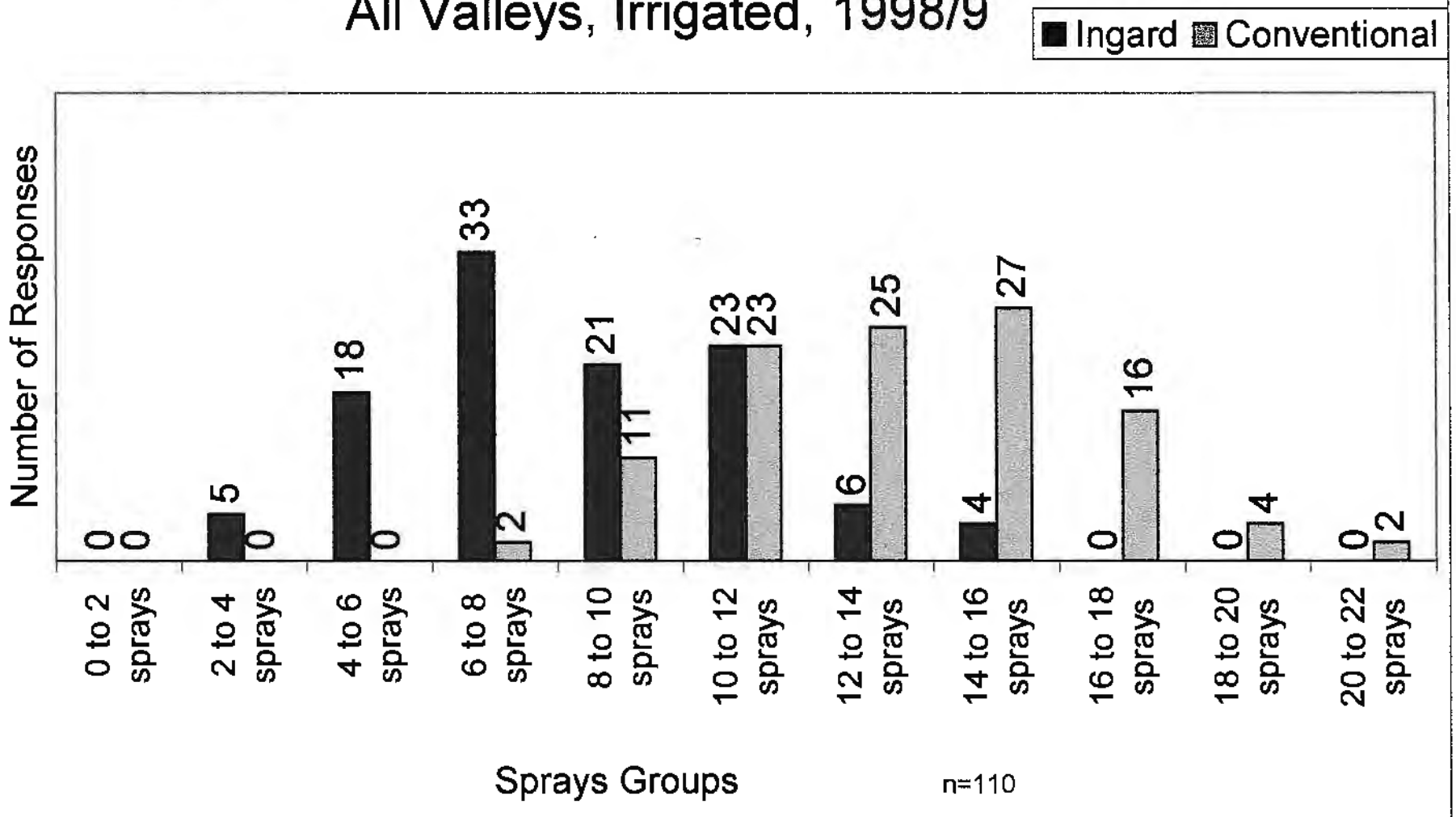


Figure 6: AVERAGE NUMBER OF SPRAYS BY PEST, 1998/9 SEASON, Page 1 of 2

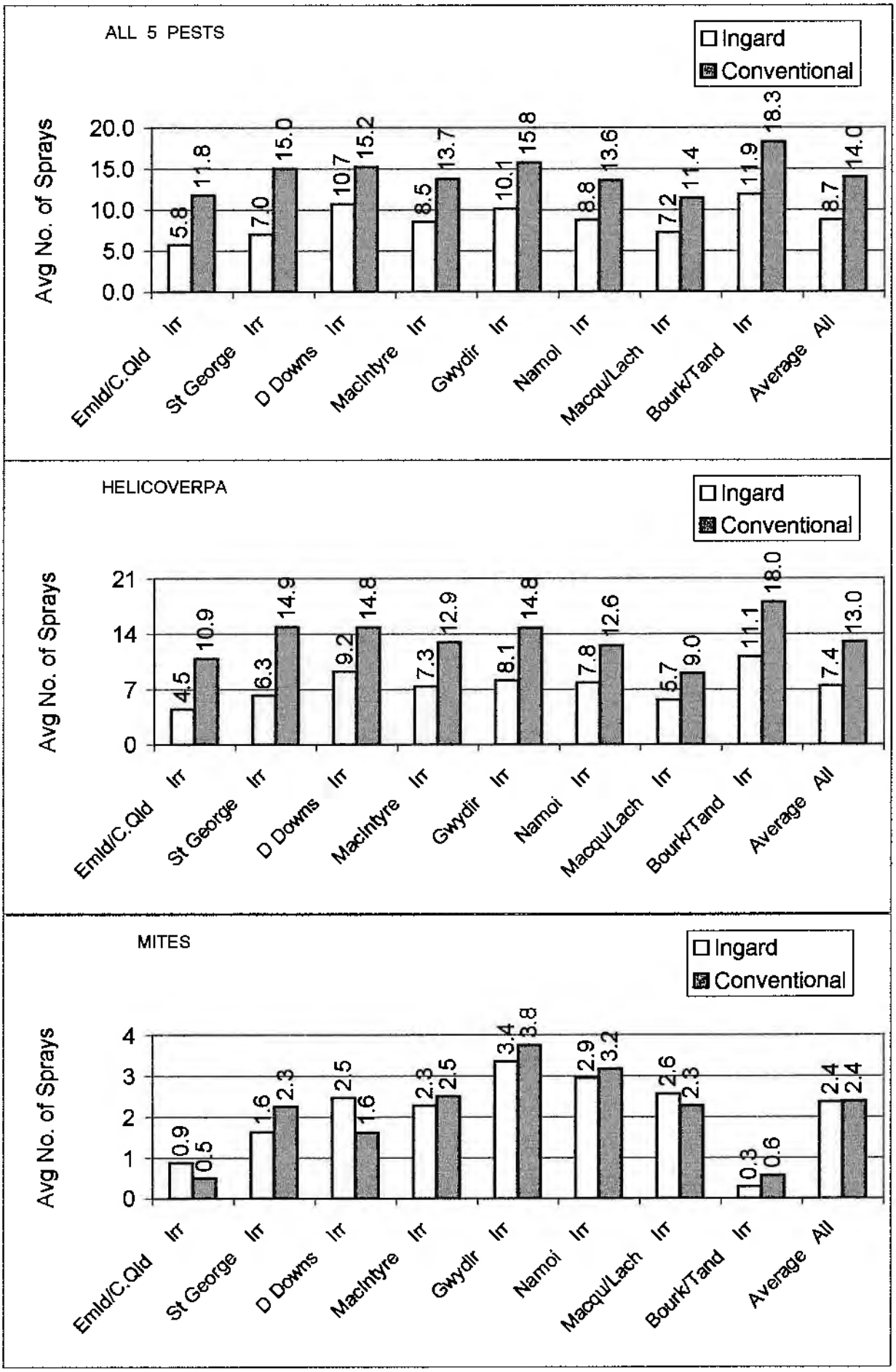


Figure 6: AVERAGE NUMBER OF SPRAYS BY PEST, 1998/9 SEASON, Page 2 of 2

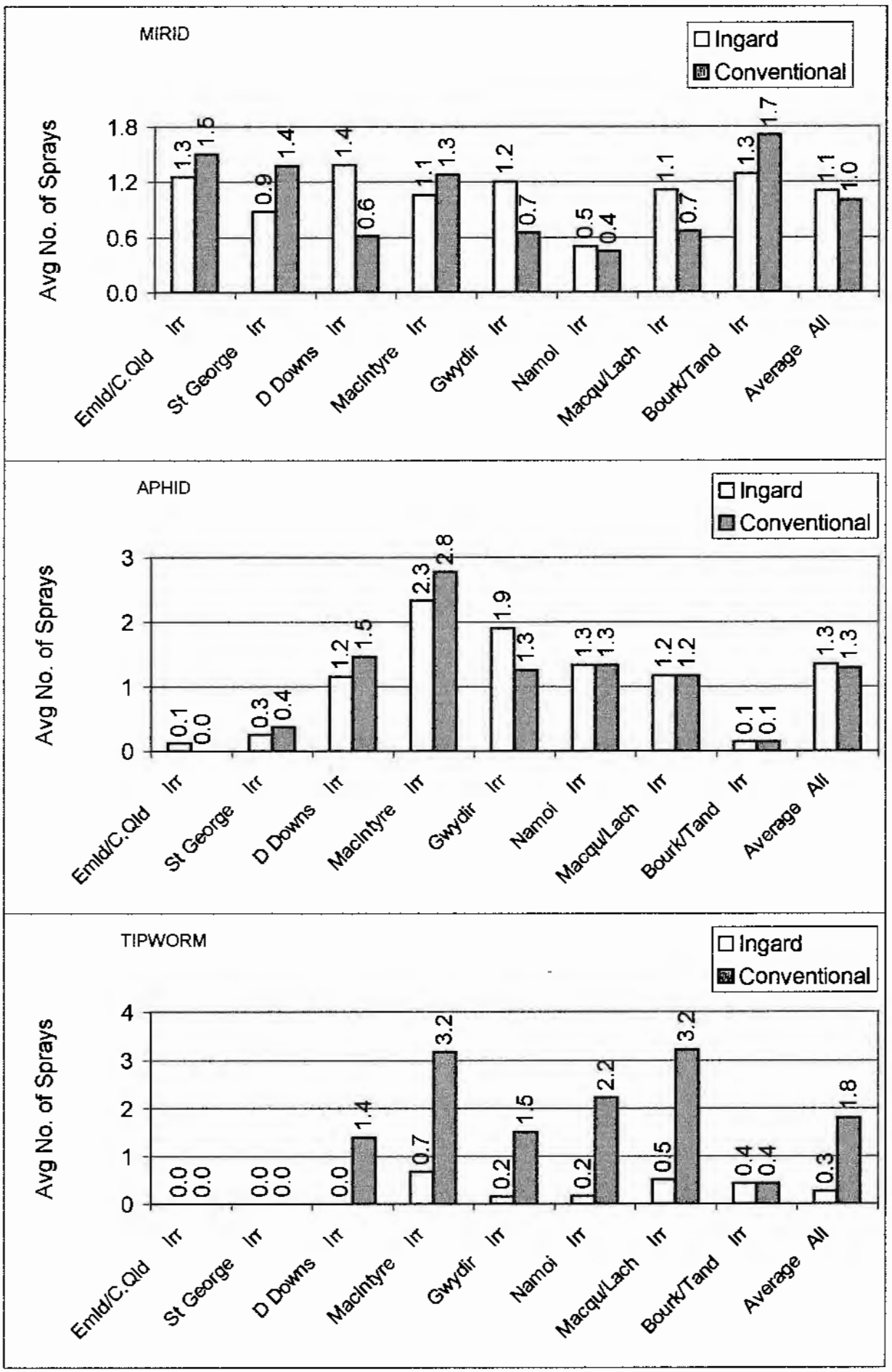


Figure 7: AVERAGE NUMBER OF SPRAYS BY TIME OF CROP GROWTH, 1998/9

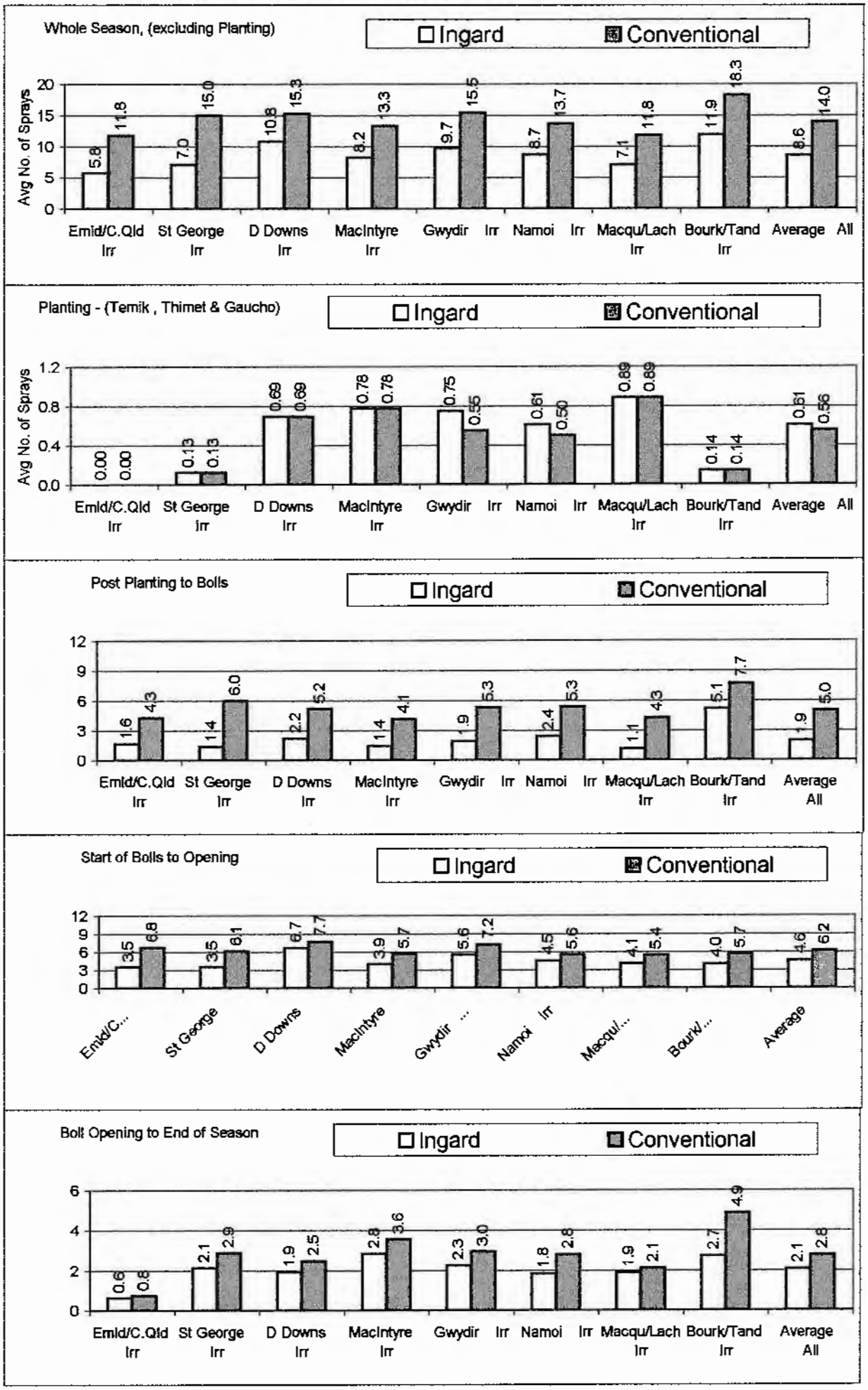


Figure 8: AVERAGE NUMBER OF SPRAYS BY PRODUCT, 1998/9 SEASON, Page 1 of 5.

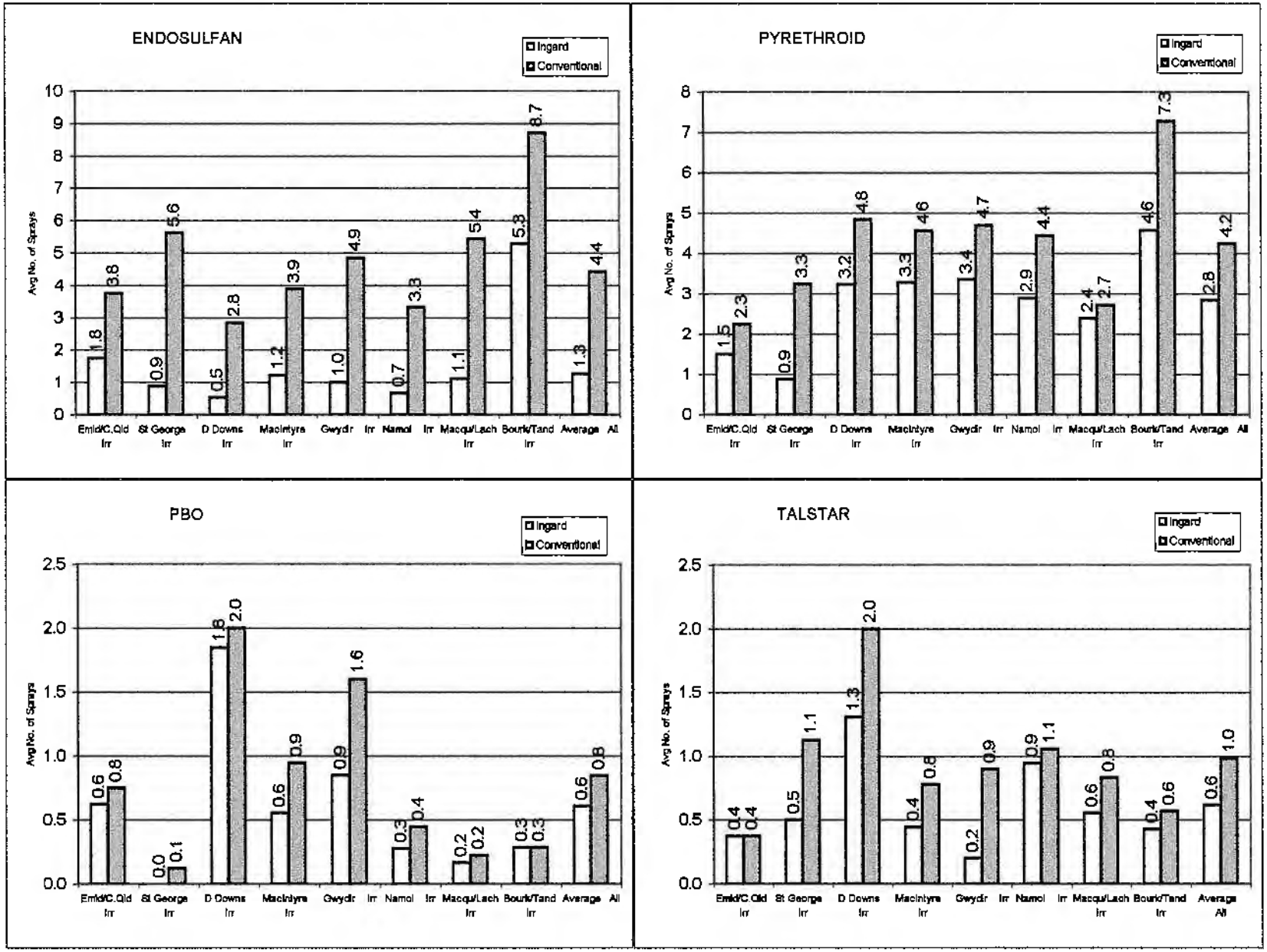


Figure 8: AVERAGE NUMBER OF SPRAYS BY PRODUCT, 1998/9 SEASON, Page 2 of 5

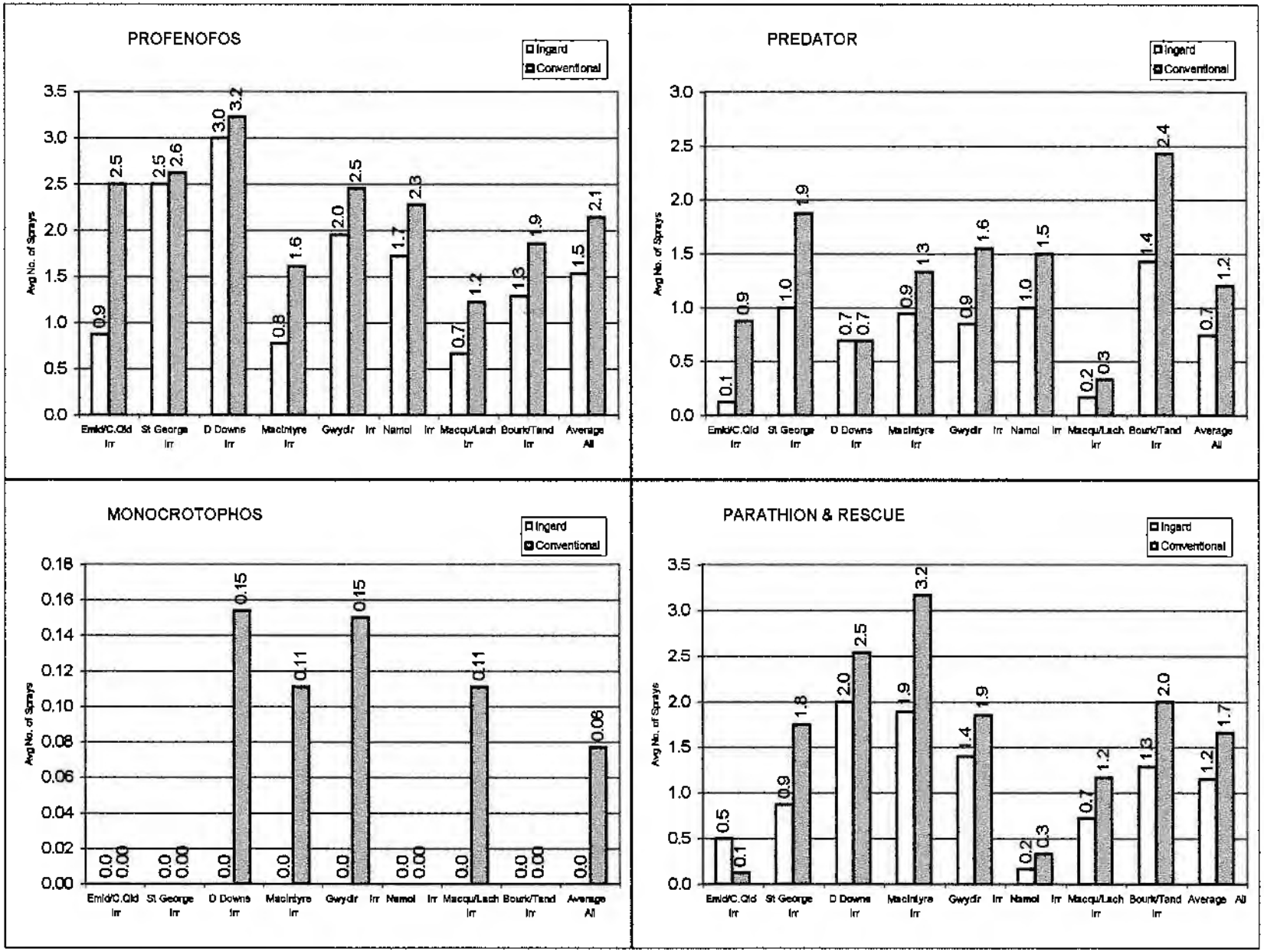


Figure 8: AVERAGE NUMBER OF SPRAYS BY PRODUCT, 1998/9 SEASON, Page 3 of 5.

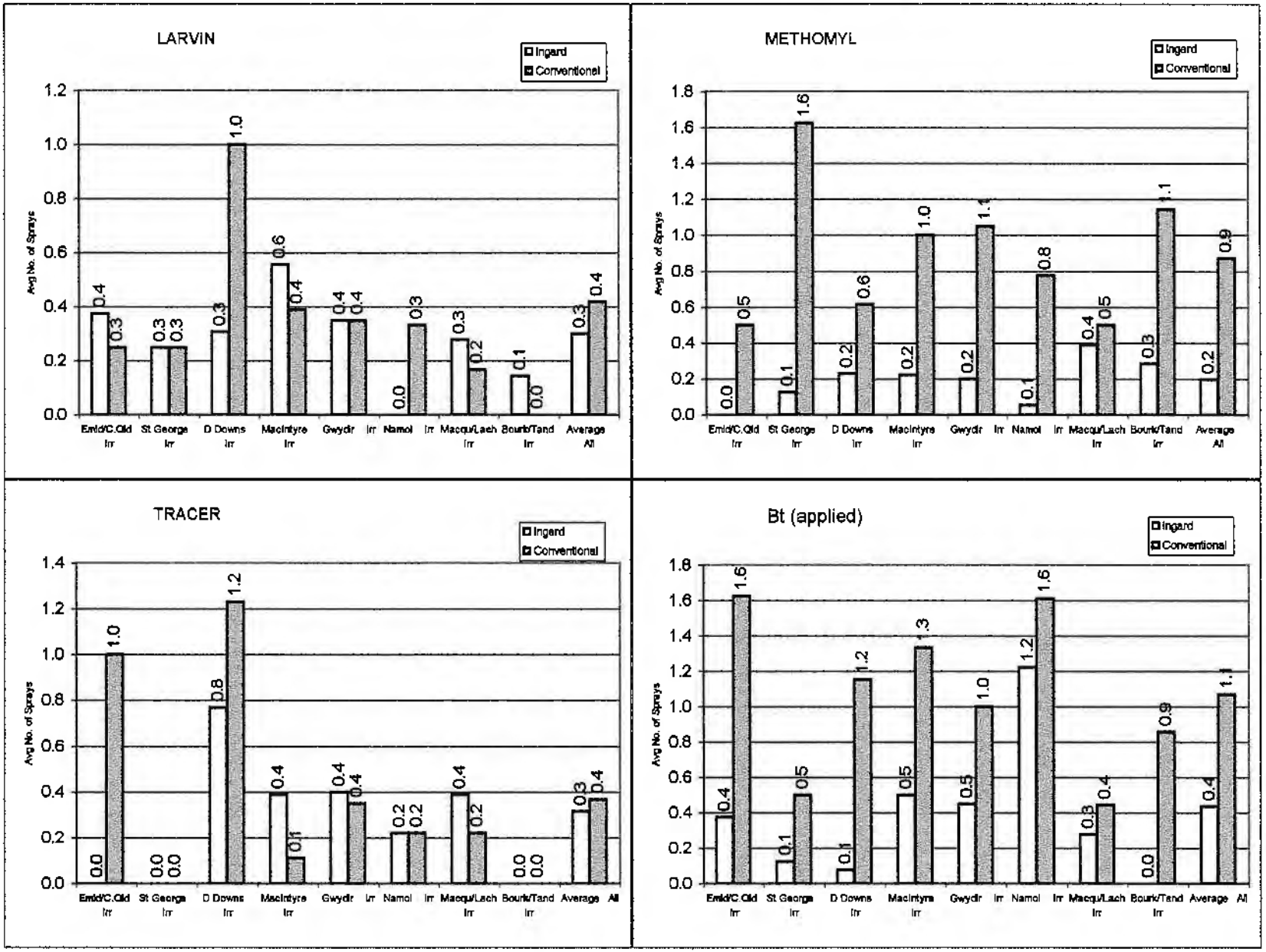


Figure 8: AVERAGE NUMBER OF SPRAYS BY PRODUCT, 1998/9 SEASON, Page 4 of 5

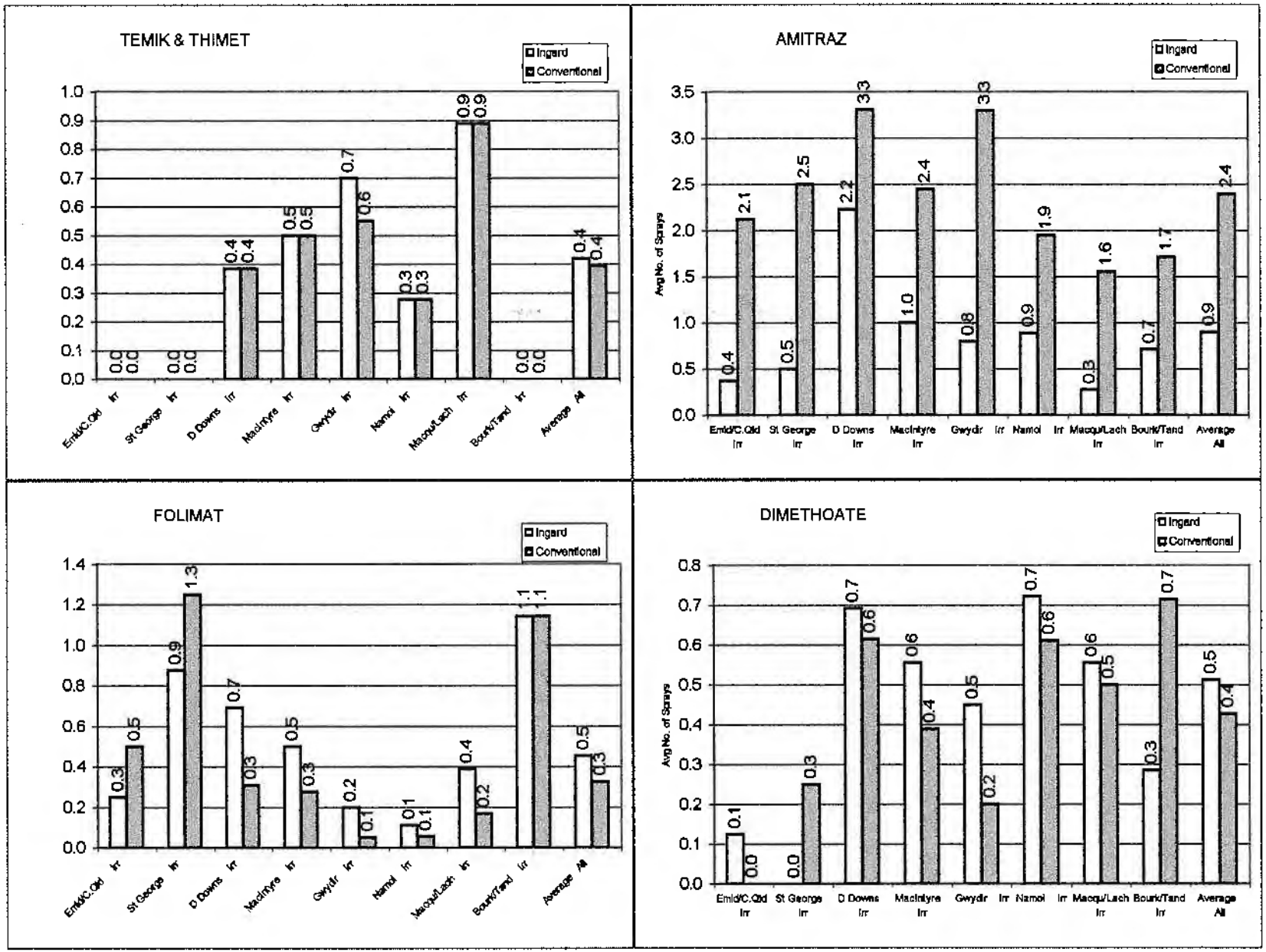
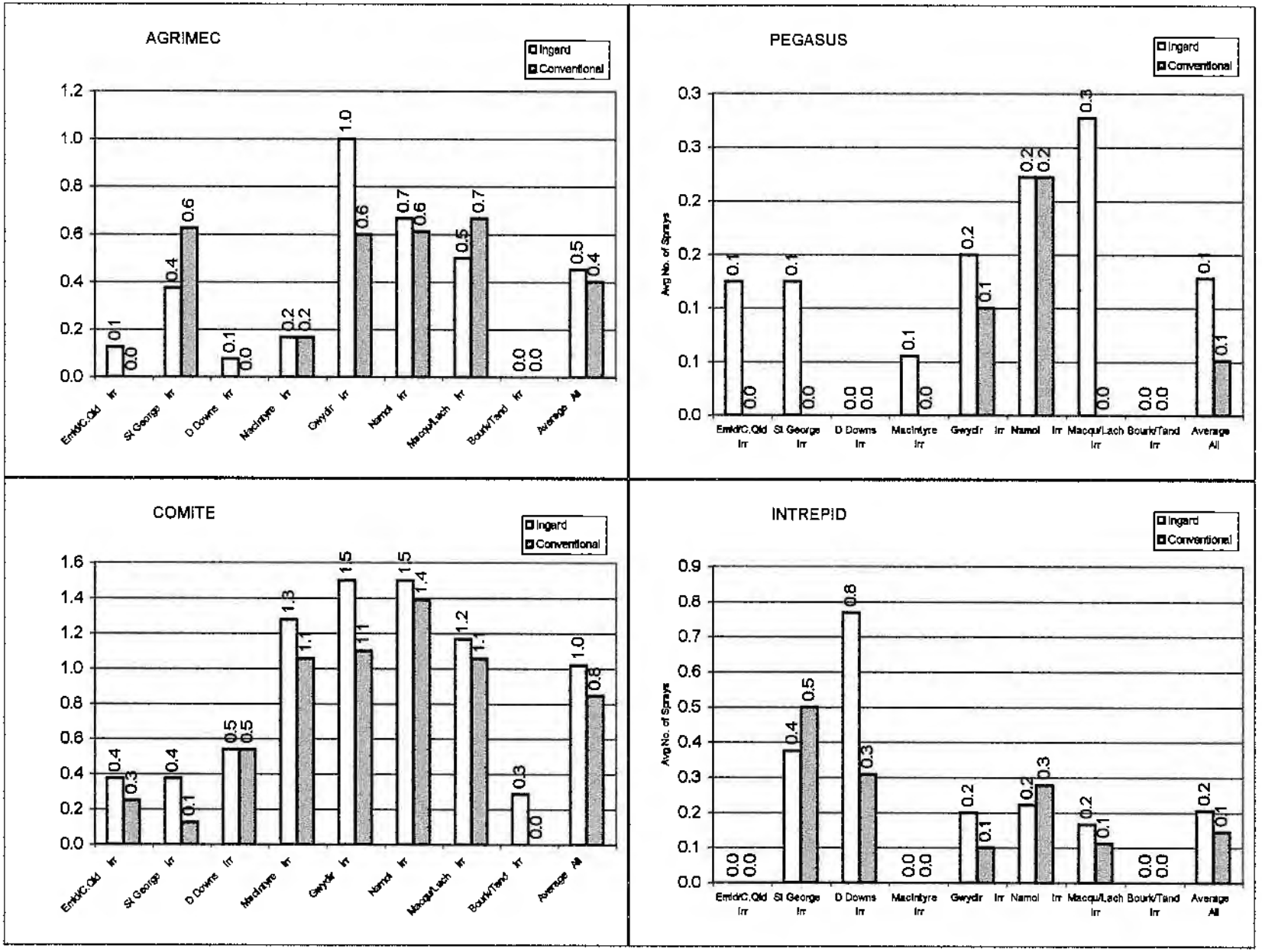


Figure 8: AVERAGE NUMBER OF SPRAYS BY PRODUCT, 1998/9 SEASON, Page 5 of 5



REPORT ON THE ECONOMIC PERFORMANCE OF INGARD COTTON FOR THE 1998-99 SEASON

Report prepared by
Tony Long
Michael Boyce & Co
19 Montague Street
GOULBURN NSW 2580

Phone (02) 4821 1466
Fax (02) 4821 4364

19 August 1999

REPORT ON THE ECONOMIC PERFORMANCE OF INGARD COTTON FOR THE 1998-99 SEASON

BACKGROUND

This report has been prepared from information collected by Cotton Consultants Australia Inc. on behalf of Cotton Research and Development Corporation and is based on the detailed economic data provided in surveys completed by 43 cotton consultants on behalf of their farming clients. The completed surveys cover all major cotton growing districts.

All Ingard fields surveyed were compared with similar conventional cotton fields on the same farm. In total, 117 surveys were presented, (110 related to irrigated fields). For the purpose of analysing economic performance, dryland crops were excluded due to the small sample size and incompatibility.

After eliminating the above information, 110 surveys remained in the sample for economic analysis.

The number of Ingard fields surveyed and compared with conventional fields in each district are as follows.

Emerald / Central Queensland (ECQ)	8
St George (SG)	8
Darling Downs (DD)	13
MacIntyre Valley (MV)	18
Gwydir Valley (GV)	20
Namoi Valley (NV)	18
Bourke / Tandou (BT)	7
Macquarie Valley (MQ)	18

	110
	===

BACKGROUND CONTINUED

All surveys have been reviewed, and cross-checked by Michael Boyce & Co, Chartered Accountants, to ensure the information contained in the surveys is accurate and logical.

To eliminate possible variances in different regions accepted industry standard data has been used in analysing the economic data.

- An average net price per bale of $500 has been used throughout. This figure was arrived at after discussions with a number of cotton merchants to determine the likely final returns per bale to farmers from the 1998-99 crop. This figure is strongly supported by data received to date for inclusion in the 1999 Michael Boyce & Co Cotton Comparative Analysis.

- Spraying costs (air and ground rig) have been based on average quoted prices from a number of chemical application contractors.

- Chemical costs have been based on an industry standard price list, provided by Cotton Consultants Australia Inc.

In total 7,634 hectares of Ingard cotton were analysed and compared with 9,210 hectares of conventional cotton.

All data has been prepared on a per hectare basis.

THE RESULTS

- AVERAGE NUMBER OF SPRAYS

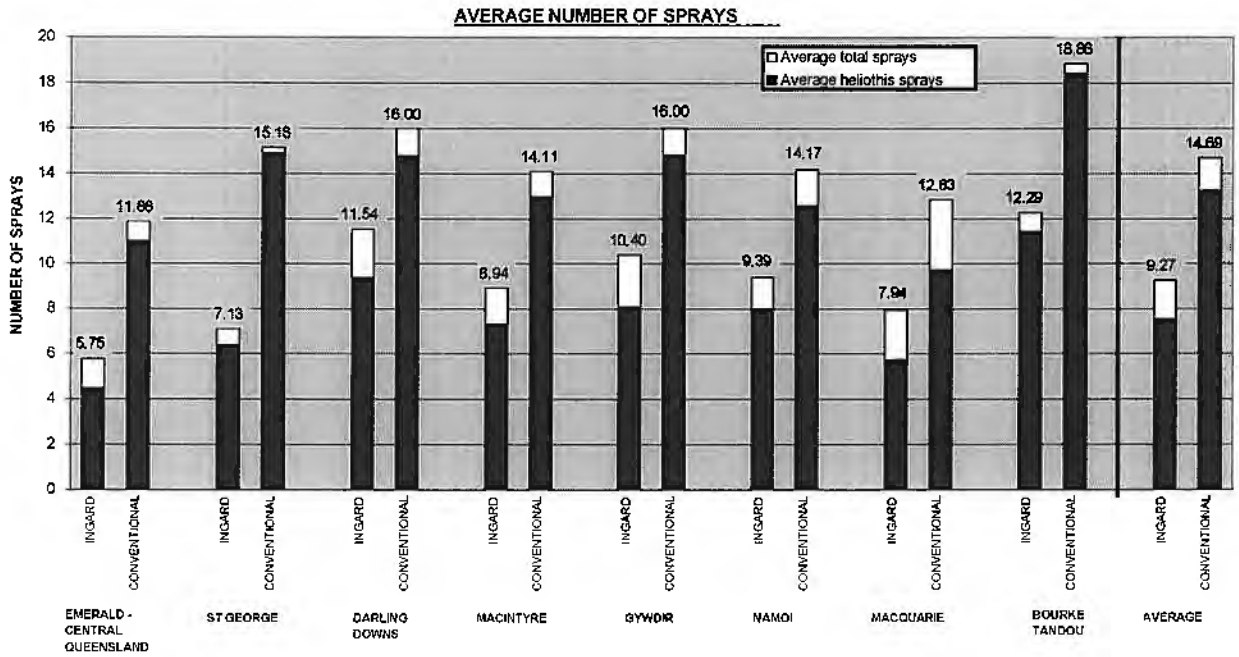
On Ingard fields, farmers have generally applied between 4 and 11 heliothis sprays during the 1998-99 season, with the average being 7.55 heliothis sprays. This was highly variable compared to last year and inconsistent between the valleys.

For instance, the heliothis spray numbers for Emerald/Central Queensland ranged from 1 to 7, while for Bourke/Tandou spray numbers ranged from 7 to 14. In most areas, farmers generally applied two other sprays separately on Ingard fields for mirids, mites or aphids, (Overall average – 9.27 sprays). The average numbers of sprays are significantly higher than for the last two years.

	Average heliothis sprays	Average total sprays
1999	7.55	9.27
1998	4.72	5.69
1997	3.99	4.99

On conventional fields, farmers have generally applied between 9 and 16 heliothis sprays during the 1998-99 season, with the average being 13.25 heliothis sprays. Average figures indicate that there were slightly more "stand alone" sprays applied for the season. In this survey, all dual-purpose sprays are counted as heliothis sprays. The overall average on conventional fields was 14.69 sprays, which is approximately 5 more sprays than last year.

		Ingard sprays	Conventional sprays	% reduction
1999	Economic analysis sample (110)	9.27	14.69	37%
1998	Economic analysis sample (103)	5.69	10.07	44%
1997	Economic analysis sample (210)	4.99	10.29	52%



- AVERAGE COST PER SPRAY

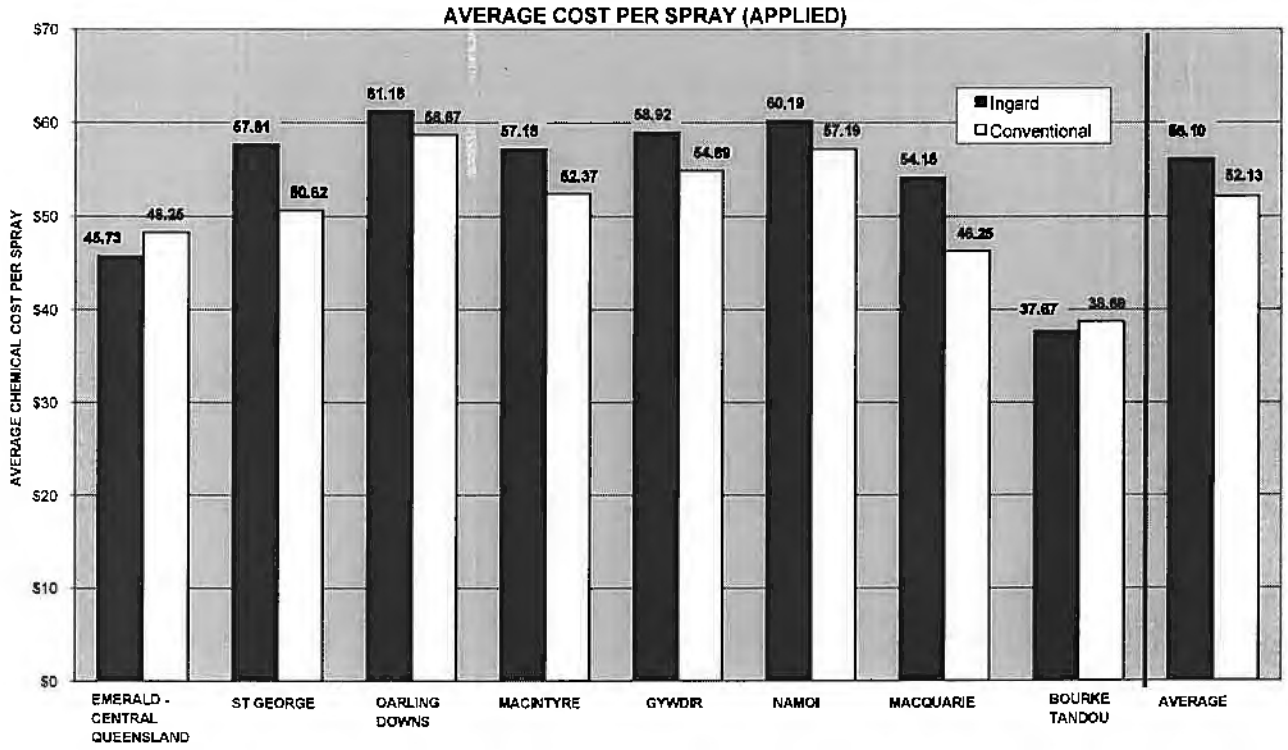
On Ingard fields, the average cost per spray (per hectare) was $56.10, compared with $52.13 for conventional fields. The average difference was $3.97.

This year's difference is slightly lower than last year. It appears that in years of extreme insect pressure, the difference in the average cost per spray is likely to be insignificant.

	Cost difference
1999	$3.97
1998	$4.17
1997	$7.34

The average chemical cost per spray per hectare, on conventional fields' rose to $52.13, an overall increase of 15% over the $45.30 cost of last year. This rise during the last twelve months is due to the following factors:

- The need to apply heavier rates of chemical to regain or maintain control over insects.
- Price increases
- Use of more expensive alternatives after initial spray failures using cheaper chemicals



AVERAGE COST PER HECTARE

The surveys provided comprehensive details of all insecticide sprays applied to the selected fields, as well as additional costs incurred as a consequence of growing Ingard cotton. For comparative purposes, the cost of Ingard licences of $155 per hectare was added to the applied chemical costs on Ingard fields, for comparison with applied chemical costs on conventional field. (Licence fees:- 1998 = $210, 1997 = $245)

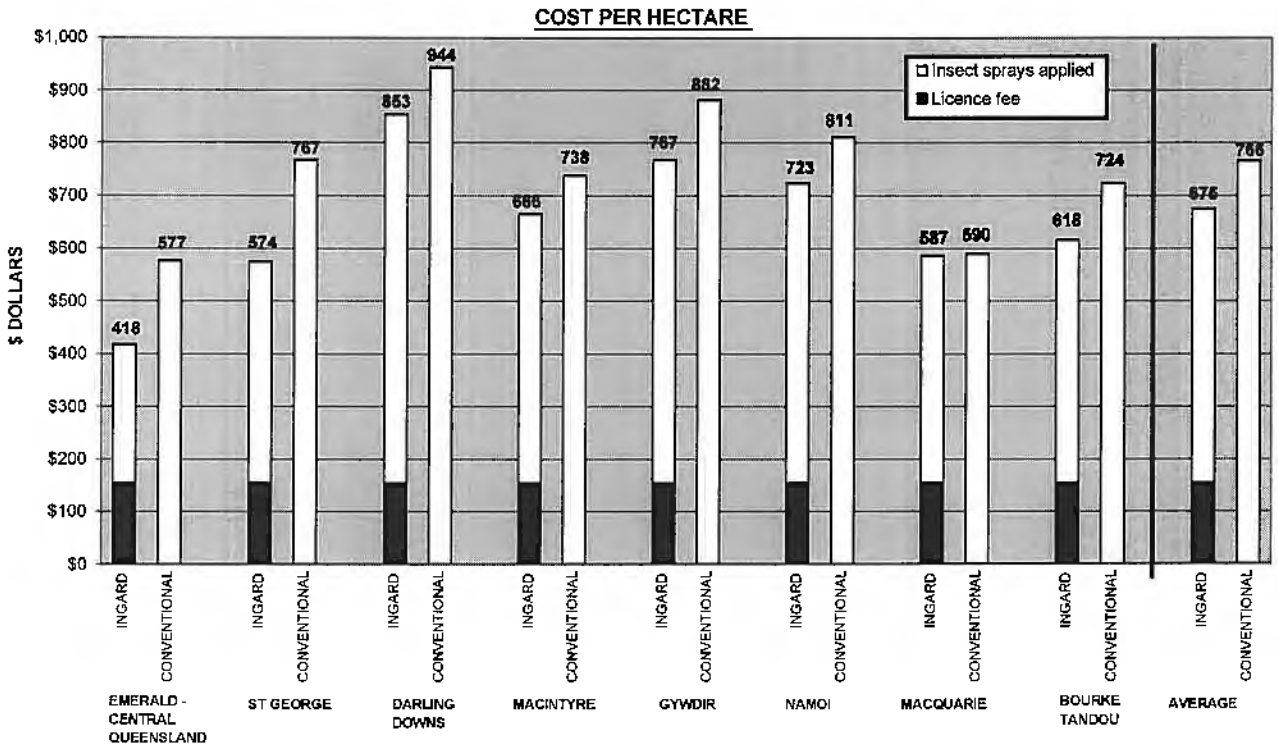
The costs per hectare on Ingard fields were, on average, $90.74 lower, as shown in the following table.

	Ingard	Conventional
Average number of sprays	9.27	14.69
Average cost per spray	56.10	52.13
Total chemical cost per hectare	520.05	765.79
Ingard licence fee	155.00	-
TOTAL COST PER HECTARE	$675.05	$765.79

Difference $90.74

No allowance was made for the impact of the price difference between Ingard planting seed and conventional planting seed. (Due to lack of information on planting rates).

Ingard planting seed is generally between 15% and 20% more expensive. This would translate to an additional cost on most Ingard fields of approximately $7 per hectare.

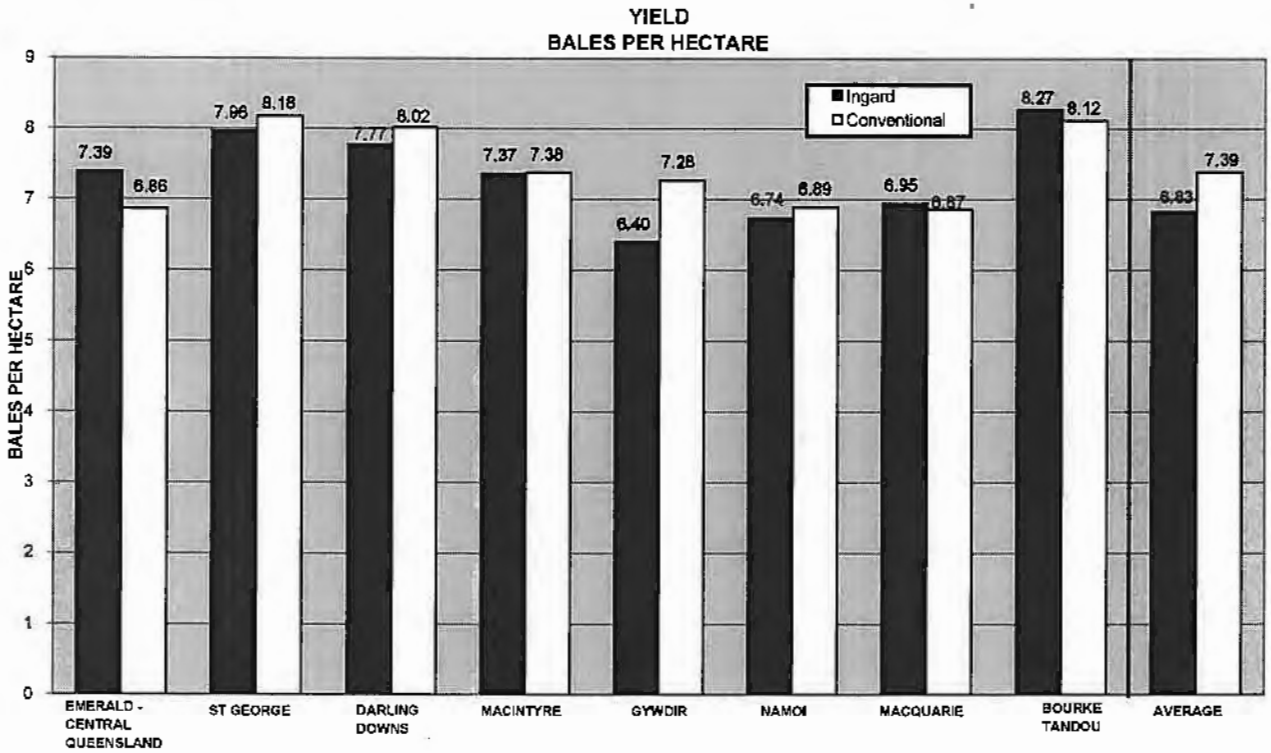


- AVERAGE YIELD PER HECTARE

The 1998-99 season produced disappointing yields in most districts.

The overall average yield of the area planted to Ingard cotton was over 0.5 bales less than the conventional area (a difference of 8% overall).

Significant variations occurred between the valleys, with Ingard in the Emerald/Central Queensland area showing exactly the opposite trend to the overall average. The other valleys were usually very close in yield except for the Gwydir Valley where average conventional yields were almost 0.9 bales per hectare better than Ingard.



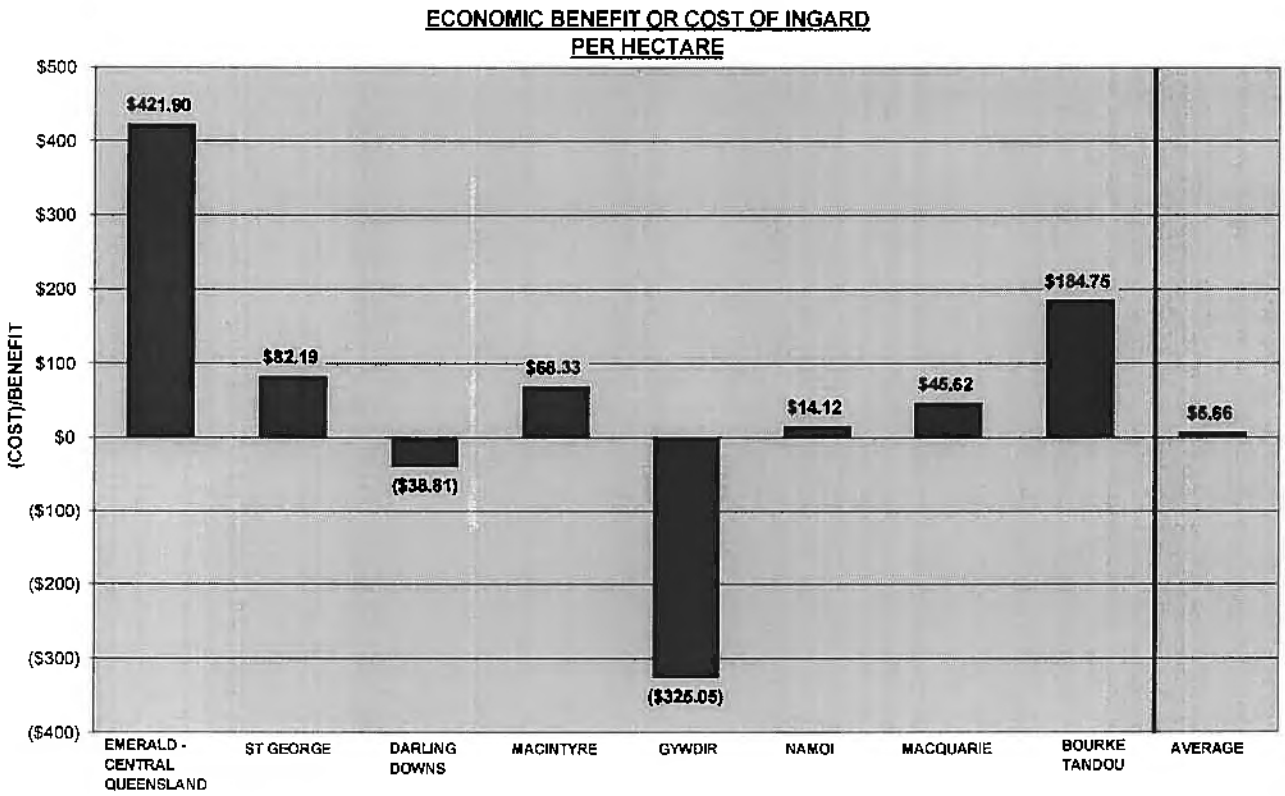
- OVERALL ECONOMIC BENEFIT OR COST OF GROWING INGARD COTTON (PER HECTARE)

  The economic benefit or cost of growing Ingard cotton for the third year varied dramatically from valley to valley in the 1998-99 season.

  Of the 110 farms included in the final analysis, 60% recorded some economic benefit from growing Ingard cotton, with the overall average economic benefit being close to break even at $5.66 per hectare.

  In the survey, 67% of the fields analysed were in the MacIntyre, Gwydir, Namoi and Macquarie valleys as opposed to 85% last year.

  Again the results on individual farms could only be described as being extremely inconsistent. Although the average was close to a break-even result, the extremes were very broad.



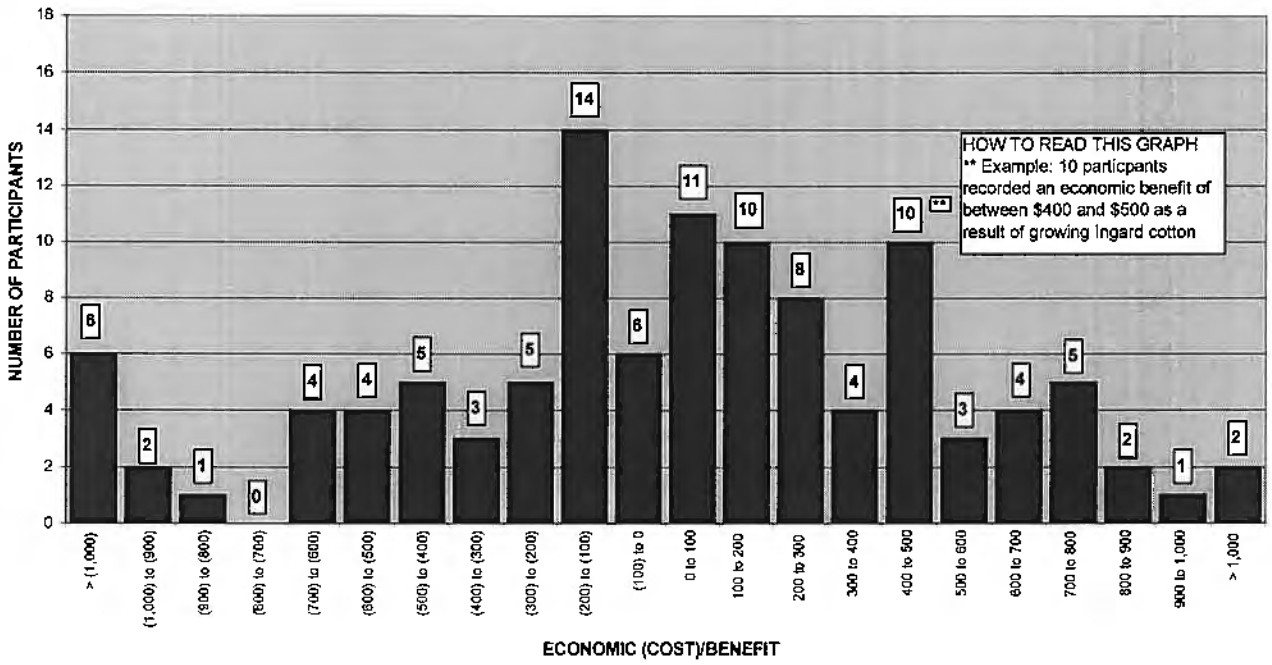
Farms recording an economic benefit.

- 27 farms recorded an economic benefit of over $400 on Ingard fields.
- 2 farms recorded an economic benefit of over $1,000 on Ingard fields.

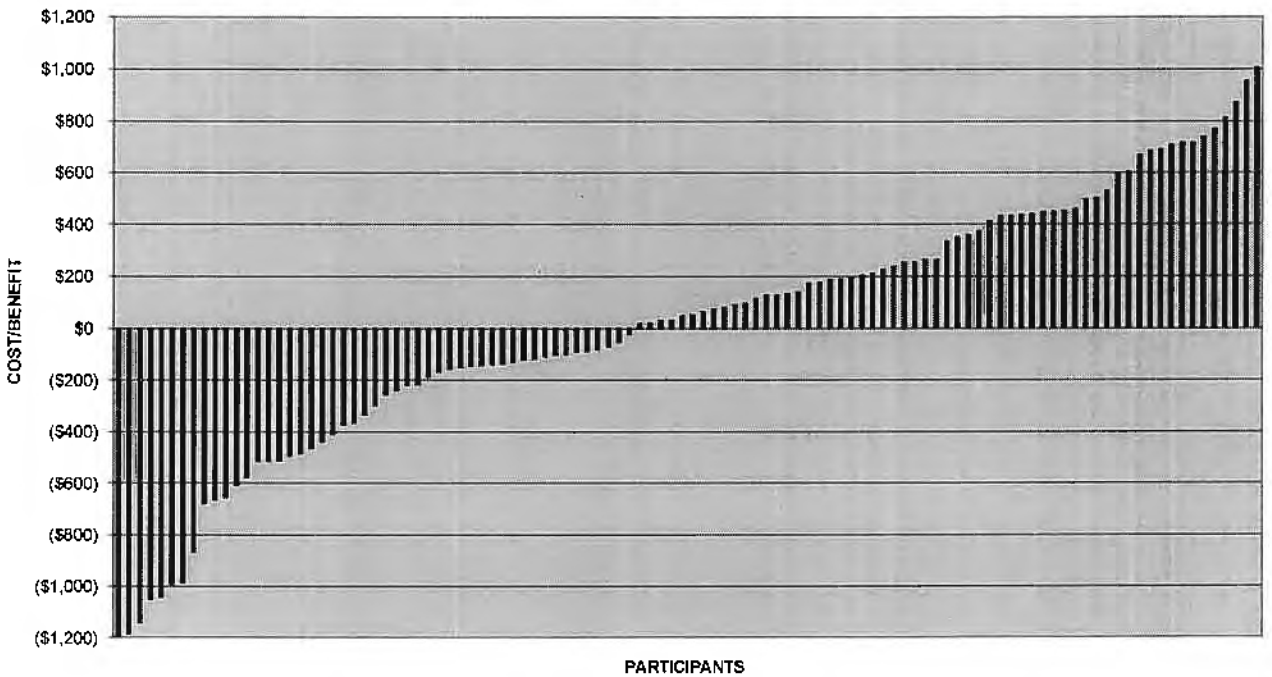
Farms recording an economic cost.

- 22 farms recorded an economic cost of over $400 on Ingard fields.
- 6 farm recorded an economic cost of over $1,000 on its Ingard field.

NUMBER OF PARTICIPANTS FALLING WITHIN AN ECONOMIC BENEFIT OR COST RANGE AS A RESULT OF GROWING INGARD



PARTICIPANTS' RESULT FOR YEAR



SUMMARY OF RESULTS

1. Ingard cotton has resulted in a reduction in the total number of sprays for the irrigated farms surveyed. (37% reduction)

2. The average cost per spray on Ingard fields was marginally higher by $3.97 per hectare.

3. The average cost of growing Ingard cotton was approximately $91 lower per hectare.

4. There were significant differences with regard to yields on Ingard fields compared with conventional fields. (0.56 bales difference)

5. Overall the performance of Ingard cotton again proved to be inconsistent.

The 1998-99 season was for many farmers the worst year ever with regard to insect control. High insect control costs and disappointing yields were responsible for some significant trading losses in the industry.

While many farmers were happy with the performance of Ingard fields generally, equal numbers were extremely disappointed. The likely final economic result of growing Ingard cotton continues to be unpredictable.

COTTON CONSULTANTS AUSTRALIA Inc.

1998/9 INGARD SURVEY

Office Use
List
Entered
Confirmed
Changes

Confidential June, 1999

If you are directly involved in the agronomy of cotton, you are requested to complete this survey.

This survey is in three parts.

- Part A is general information - it asks about your involvement in cotton including Conventional and Ingard areas.
- Part B asks for details on comparisons between Ingard and Conventional cotton.
- Part C asks for your thoughts on Ingard

PART A.

1. Your Name .....

2. Which of the following group were you in during 1998/9 ? - please tick:

I was directly involved in the agronomy of cotton and
Checked Ingard cotton of similar varieties, please complete the remaining questions
or
Checked Ingard cotton but varieties were quite different, or
Valid comparison area not available, (reason.....) or
Did not have any Ingard cotton.
Please answer question 1 to 7 and return this page so we don't send you reminders.

I was not involved directly in cotton agronomy.
Please fill in your name at Question 1 and return this page so we don't send you reminders.

I was involved in cotton agronomy but another person is completing my part of the survey.
Please name that person here ....., answer Question 1 and return this page

don't know. Please contact us so we can work out whether you need to answer the survey.

3. Note: if possible, please return by the 25th June, 1999 (or earlier!) to:

David Clark
P.O. Box 1,
Warren, 2824

ph 02 6847 3088
mob 0418 638 369
fax 02 6847 4398

4. Type of operation (must only be one): Corporate O or Independent O

5. This reply is for (must only be one): Irrigated O or Dryland O

6. Indicate Region that this reply is for (must only be one):

Emerald	O	MacIntyre	O	Bourke	O
Central Qld	O	Gwydir	O	Tandou	O
St George	O	Namoi	O	Lachlan	O
Darling Downs	O	Macquarie	O	Other	O.

7. Approximate Area of cotton that you are responsible for:

Ingard..... Ha + Conventional .....Ha = Total .....Ha

copied

1) CROP DETAILS

	INGARD	Conventional	Comments (optional)
Crop ID, e.g. farm, field.			
Area, Ha			
Previous Season's Crop			
Planting Date			
Variety			
First Defoliation Date			
Picking Date			

2) INSECTICIDE DETAILS: fill in separately for Ingard and Conventional; please refer to codes.

Ingard - Attach extra page if needed

Timing	Date	Product/s	Rate/Ha	Applied	Band	Target Pest/s
Planting						

Conventional – Also next page, add extra page if needed

Timing	Date	Product/s	Rate/Ha	Applied	Band	Target Pest/s
Planting						

Timing: Approximate timing with respect to growth of the crop, include Planting / Seed treatment: P =planting to 1st squares, S =squaring to 1st flowers, B= 1st flowers to 1st open boll, O= opening.

Applied By: G = Ground, A = Aerial, assume aerial application to be 100%

Key for Pest: List main pest first, then other pests:
A = Aphid; C = Cutworm; Md = Mirid; H= Heliothis; Mt= Mites;
Tw= Tipworm; Th = Thrip; W= Wireworm; Others?

3) Describe the Pest Pressure: 0= Nil; 1= Very Low, 2= Low, 3= Medium, 4= High, 5= Very High

	Ingard			Conventional		
	Squaring	Boll fill	Opening	Squaring	Boll Fill	Opening
Aphid						
Helicoverpa						
Tipworm						
Mirids						
Mites						

4) Indicate control of Helicoverpa & Tipworm: 0= not relevant, 1 = very poor, to, 5 = very good

	Ingard			Conventional		
	Squaring	Boll fill	Opening	Squaring	Boll Fill	Opening
Helicoverpa						
Tipworm						

5) Yield

In bales per hectare, give the yield for the: 1) Ingard ..... 2) Conventional .....

.....

Were there any notable differences in quality? No / Yes, being ?.....

PART C. OTHER OBSERVATIONS. You only need to answer this section once for all crops.

1) Compared to Conventional Cotton, did Ingard generally have less, similar, or more for the following:

	Considerably Less (5)	Slightly Less (4)	The Same (3)	Slightly More (2)	Considerably More (1)	Not Present (0)	Don't Know (-1)
a) Time needed per check	•	•	•	•	•	❑	❑
b) Frequency of checks	•	•	•	•	•	❑	❑
c) Bacterial Blight	•	•	•	•	•	❑	❑
d) Verticillium Wilt	•	•	•	•	•	❑	❑
e) Fusarium	•	•	•	•	•	❑	❑
f) Black Root Rot	•	•	•	•	•	❑	❑
g) Bonsai Bunchy Top	•	•	•	•	•	❑	❑

2) For the Ingard crop:

	Always (4)	Mostly (3)	Rarely (2)	No (1)
Did it perform as originally promoted	•	•	•	•
Did it perform to your expectations	•	•	•	•
Did you follow industry thresholds	•	•	•	•
Allow 2 consecutive checks before spraying	•	•	•	•

List the thresholds you used (if not industry recommendations) .....

.....

3) Please give reason/s for growing Ingard (most important first) .....

.....

4) How do you see Ingard fitting into your insect management program?.....

.....

5) Is Ingard value for money? Very poor.....poor.....even.....good.....very good

(5) (4) (3) (2) (1)

6)For 1998, what percent of your Ingard cotton received good pupae control

0.....25.....50.....75.....100

For 1998, what percent of your conventional cotton got good pupae control

0.....25.....50.....75.....100

Possible reasons for poorer control .....

.....

7) General comments regarding Ingard .....

.....

.....

.....

Thank you