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Integrated bean rust management

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INTEGRATED BEAN RUST MANAGEMENT

Compiled by John Brown

Queensland Horticulture Institute
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INTRODUCTION

The goal of this project was to develop an effective, cost efficient and useable bean rust management package. This involved studying the levels of infection across a number of varieties, establishing action levels, evaluating the effectiveness of chemical control and gaining a better understanding of the factors influencing rust epidemics.

In 1994 at the request of the Bean Sub-committee of Queensland Fruit and Vegetable Growers, a proposal to expand the scope of the project was initiated. This included research into root rot and insect pests to form an integrated pest management system.

RUST

Early detection of bean rust (*Uromyces appendiculatus*) is essential to reduce yield loss in French Beans. In experiments undertaken in the Burdekin and Bowen bean growing areas, significant yield reductions were seen. Infection occurred at the 2 leaf stage and weekly Mancozeb® applications from that stage through to pod set produced significantly higher yields, characterised by higher pod numbers. . There was no significant difference in yields between five weekly applications of the protectant fungicide Mancozeb® and 2 applications of either of the three systemic fungicides [Plantvax®, Folicur®, Baycor®] applied when rust infections were seen on new leaf growth. No treatment window was found in which rust did not effect yield.

Laboratory testing for resistance in rust to fungicides showed that there is no major resistance in local collections of rust to Plantvax® but Baycor® had some isolates classed as either moderately resistant or resistant which came from the Lockyer, Bowen and Gympie. In these areas it showed widespread tolerance had developed to Baycor®.

From a range of varieties tested for rust tolerance the most promising varieties in terms of rust resistance, pod quality and yield were Simba and Phoenix. Both lines have medium length are dark green and generally have straight pods. Additionally, Barracuda was a high yielding variety with low rust incidence and medium to long pods, although pod colour was mid green.

ROOT ROT

The use of incorporating a sorghum cover crop supplemented with the fertiliser Urea, to assist breakdown, contributed to higher yields than a bare fallow treatment. The difference in root rot severity between these treatments could only be seen at the early stages of plant growth. The addition of nitrogen as a side dressing could be implicated in red root development.

INSECTS

Thimet applied as a granule and Gaucho® as a seed dressing at planting showed that there was a possibility that they could affecting the germination of bean seeds. Gaucho® as a spray had nil affect on the germination. Bean fly damage was reduced by the use of Lannate®, Thimet® and Gaucho® at the seedling stage and both Thimet® and Gaucho® treatments extended this reduction in plant damage into the mature plant stage. Very little damage to the vegetative growth on the plants was seen in these trials though application of the insecticides at this stage reduced the population of thrips in the flowers. Gaucho® applied as a foliar spray during the vegetative stage produced significantly more good pods than the other treatments.

TECHNICAL SUMMARY

RUST

Commercial bean fields were surveyed in the Burdekin and Bowen areas during the cropping period from July to September. Rust incidence and severity were recorded on plants distributed along a "W" pattern. Rust samples were taken from the Lockyer, Gympie and Bowen and tested for fungicide resistance by Mr. R. O'Brien in Brisbane.

Experiments were conducted at Bowen and Ayr to analyse the effect of rust infections on yield at different growth stages. In the Bowen experiment heavy rust pressure existed throughout the growth cycle. Only treatments, which had rust control applied during early leaf, vegetative, flowering and podding had a significant yield increase. Mancozeb was the fungicide used for control. At Ayr, bean rust pressure was lower and significant yield increase were gained from initiating control at the early leaf and vegetative stages. The yield component significantly effected by rust infection was pod number. These results indicate the need for early detection of rust infections.

Fungicide experiments conducted at the Bowen Research Station evaluated Mancozeb, a protectant and three systemic fungicides Oxycarboxin, Bitertanol and Tebuconarzole. There were no significant yield differences between Mancozeb and the three systemics fungicides, where Mancozeb required five applications and the systemics required only two. This validates the use of systemics in a system that would use strategic applications based on disease incidence.

Bean samples were collected from the Lockyer, Gympie and Bowen to test for resistance to Bitertanol and Oxycarboxin. Of the eleven isolates, only one from Bundaberg was sensitive. Seven were low resistance (EC50 >1 <10), two were moderately resistant (EC50 >10 <25) and one was resistant (EC50 >25). For Oxycarboxin, there was much less variability between isolates. The most sensitive had an EC50 of 30 µg/mL while for the least sensitive it was 135 µg/mL, a resistance factor of about 4.

During the bean growing seasons of 1992 –1994, bean varieties supplied from a number of seed companies were planted on the Bowen Horticulture Research Station and evaluated for their susceptibility to bean rust. Due to poor naturally occurring rust populations, trial areas were subjected to a cover spray of rust spores obtained from infected bean crops. Determining tolerance of the varieties to rust development, a rating based on 0 = no development of rust pustules to 9 with severe to complete defoliation of leaves was used. From these trials a number of varieties rated 4 or below when no fungicides were used. Of those varieties, Simba and Phoenix showed tolerance to rust and agronomic characters required by industry. Another variety, Barracuda, also showed tolerance but had slightly different pod characters.

ROOT ROT

Red root is an increasing problem especially in fields with a long history of beans. Results from incorporating sorghum, used as a cover crop and urea fertiliser to assist in the breakdown, contributed to higher yields (11.8t/ha) than a bare fallow (7.4t/ha). The over use of nitrogen (450kg/ha urea) as a side dressing has been identified as cause that could be implicated in red root development, a rating level of 2.7 compared to 1.6 for a nil application of nitrogen. Yields, based on 100m of row were 6.88 kg for a nil fertiliser treatment and 7.5kg when 450kg/ha of urea was applied.

INSECTS

The application of a soil insecticide to delay the commencement of foliar sprays was successful in that bean fly damaged was reduced to levels afforded by conventional sprays of Lannate. Gaucho as a seed dressing was not as successful as when it is used as a cover spray. Both of these products reduced the extent of bean fly damage in mature plants. Gaucho was effective in reducing populations of thrips in the flowers and this product also produced more good pods than the other treatment.

1.0 GENERAL INTRODUCTION

At the request of the Bean Sub-committee of Queensland Fruit and Vegetable Growers, a proposal to expand the scope of the project in the 1993-94 season was initiated. This included research into root rot and insect pests to form an integrated pest management system. This extension of the project would benefit growers in the following way. When dealing with commercial growing situations, disease and insect pest management must be integrated. A total management package can be obtained with a minimum of chemical input and based on the knowledge of the whole system it can be developed to reduce the impact of any one pest.

1.1 RUST

The bean industry in Queensland has a gross annual production valued at more than $10 million with the main production being from April to December. Fresh bean production in North Queensland began on a commercial scale in the Burdekin area about 1975 and in the Bowen area in the early 1980's. The area grown has increased considerably in the last five years. Currently 12 growers in the Burdekin-Bowen area sow in excess of 2000 ha, producing about 70% of Queensland's annual harvest.

Beans are extremely sensitive to cold and this restricts bean production in Southern Australia to summer and autumn while the Burdekin - Bowen region is increasing as a major producer throughout this entire period. When present bean rust has a major affect on production.

In November 1991 the Bean Sub-Committee of the Queensland Fruit and Vegetable Growers identified bean rust as its highest priority problem. Despite annual costs of chemical control in Queensland of above $300 000, loses were estimated to be of at least similar value.

Severe epidemics of bean rust (*U. appendiculatus*) have periodically occurred in all bean-growing regions of Queensland. The foliar disease can cause plant death or severe yield reduction from infections during the cropping cycle. Control of bean rust in recent seasons has been perceived to be increasingly difficult, ineffective and requiring an excessive amount of chemical usage. Bean rust control recommendations to date have been mostly based on research conducted in a non-tropical environment, unlike the Bowen and Burdekin regions.

This project targeting strategic applications of effective fungicides and other control agents based on sound epidemiological, agronomic and economic information. This was required, particularly in a tropical environment, to develop an effective bean rust management system. Principles derived from these studies can be used as a basis for rust management in other bean growing districts. . The project involved a combined research and extension team. It included laboratory and field trials coordinated with surveys of systems used in commercial crops.

1.2 ROOT ROT

Root disease is of great significance not only in outright plant death, but also in reduced yields and plant stress. Root rot is also an increasing problem in bean crops, especially in fields with a long history of beans. Root function and development can be seriously affected, leading to plant death or yield decline. There is also the potential of impaired root function causing stress, which may predispose the plants to infection from rust epidemics. Related work on root rot in another project is being undertaken and indications are that agronomic factors such as irrigation, planting method, crop rotation and nutrition may play a significant role in lessening the impact of root rot. This project intends to utilise the best of the agronomic practices in an integrated approach to bean root rot and rust management as a whole rather than in isolation, since management of one disease problem may influence the other.

1.3 INSECTS

Bean fly (*Ophiomyia phaseoli*) is a key insect pest in beans. Early sprays for this pest tend to start growers on an pesticide treadmill and this would be interfering with the build up of beneficial insects in these crops. A targeted application of a systemic soil insecticide may lead to a reduction of foliar sprays. This may also give control of other pests while allowing parasites and predators to build up in the crop. Initial bean fly research was conducted in conjunction with field surveys of bean rust in the Burdekin – Bowen district during rust incidence sampling.

1.4 LIST OF TABLES

2.0 RUST

2.1 GENERAL

Bean rust has been seen periodically and when severe epidemics occur, the effects can be devastating. Developing a system which incorporates sampling, forecasting, suitable cultivars, effective and strategic chemical control applications could greatly increase the ability of growers to manage bean rust while minimising chemical usage. The seasonable nature of bean rust has lead to problems in field trials, however natural epidemics were augmented by artificial inoculation when necessary.
Field trials were conducted on the Bowen Horticultural Research Station and Ayr Research Station. Surveys were also conducted on grower properties.

2.2 SEVERITY/ YIELD RELATIONSHIP USED TO ESTABLISH ACTION LEVELS.

Epidemiology and yield loss experiments were conducted at Ayr. Rust control was initiated at different growth stages and incidence levels to determine rust severity /yield loss relationships. The following are trials undertaken to evaluate difference applications based on three methods.

1. Evaluating applications based on growth stages.
Mancozeb applied for the full growth period.
Mancozeb applied during the vegetative stage only.
Mancozeb applied during the flowering stage.
Mancozeb applied during the Pod stage.
Nil – no sprays

2. Evaluating applications based on disease incidence.
1% infection. Sprayed with Plantvax
5% “ “ “ “
10% “ “ “ “
15% “ “ “ “
30% “ “ “ “
Nil – no sprays
Schedule sprays with Mancozeb

3. Evaluations based different spray schedules using Mancozeb.
On sight or first signs of rust
2 weeks later
4 weeks later
6 weeks later

Results showed that bean yields were found to be very sensitive to early infection. For example, rust in the seedling stage reduced yields by 39% while rust from podding onwards reduced yields by 8%. Refer to Table 1.

TABLE 1. Effect of rust on bean yields when fungicides applied at different growth stages.

39% (↑ over the nil spray treatment)			
	24% ↑		
		18% ↑	
			8% ↑
Full sprays from 2 leaf stage	Sprays during vegetative stage.	During flowering	During Pod stage

In another two experiments conducted at Bowen and Ayr they showed the effect of rust infections on yield at different growth stages. In the Bowen experiment, heavy rust pressure existed throughout the growth cycle and all treatments that had rust control applied had a significant yield increase. Mancozeb was the fungicide used for control. At Ayr, bean rust pressure was lower and significant yield increase were gained by initiating control at the early leaf and vegetative stages. Refer to Table 2. The yield component significantly affected by rust infection was the pod number.

TABLE 2.. Effect of rust on bean yields when fungicides applied at different growth stages.

Start of Rust Control	**% Increase in Yield Over Nil Rust Control**	
(Weekly Mancozeb)	**Bowen**	**Ayr**
2 Leaf	48	60
Vegetative	32	12
Flower	22	9
Pod	12	1

These results, indicate the need for early detection of rust infections as yields are reduced with a delay in fungicide applications.

Three timing experiments were also conducted. Refer to Tables 3, 4 and 5. The purpose of these experiments was to measure the progress of rust epidemics and determine the effects of initiating control at different stages of epidemics. Throughout the season the progression of epidemics was rapid compared to other rust diseases on other crops; however, leaf severity or amount of pustules per leaf was not always at a high level.

TABLE 3. Effect on yields by applying controls at different levels of rust infection.

		Plant sample - first spray (Avg. top 3 Leaves)			
Plantvax Treatments	**No. of Sprays**	**% Incidence**	**Severity Rating 0-5**	**Growth Stage**	**Yield Kg/m**
First Sign	4	.50	.01	Vegetative	.94
+ 1 week	3	6.67	.08	Bud	.90
+ 2 week	2	89.00	.35	Flower	.85
+ 3 week	1	100.00	.85	Flower-Pod	.88
Nil	0	-	-	-	.80
				L.S.D. 0.05	0.087

TABLE 4. Effect on yields by applying controls at different levels of rust infection.

		Plant sample – first spray (Avg. Top 3 Leaves)			
Plantvax Treatments	**No. Sprays**	**% Incidence**	**Severity Rating 0-5**	**Growth Stage**	**Yield Kg/m**
First Sign	2	10.00	.03	Vegetative	.72
+ 1 week	2	58.00	.35	Bud	.65
+ 2 week	1	98.00	1.00	Flower	.51
+ 3 week	4	18.00	.06	Flower-Pod	.79
Nil	0	-	-	-	.44
				L.S.D. 0.05	0.141

TABLE 5. Effect on yields by applying controls at different levels of rust infection.

		Plant sample – first spray (avg. Top 3 Leaves)			
Plantvax Treatments	**No. Sprays**	**% Incidence**	**Severity Rating 0-5**	**Growth Stage**	**Yield Kg/m**
First Sign	2	3.00%	.01	Vegetative	.60
+ 1 week	1	100%	.67	Bud	.50
+ 2 week	1	100%	.75	Flower	.95
+ 3 week	4	3.00%	0.1	Flower-Pod	.59
Nil	0	-	-		.40
				L.S.D. 0.05	0.08

From these experiments, application of a systemic fungicide in the first or second week of a rust epidemic (as determined by sampling) reduced infections.

In Table 6, the cost of using the different strategies are given.

TABLE 6. Comparison of costs for the different control strategies.

Treatment code	**Fungicide**	**Registered rate**	**Cost/treat.**	**No. application**	**Chemical costs**	**Total cost* per ha.**
A	Mancozeb	2 kg/ha	$11.86	3	$36	$61
B	Baycor	0.5L/ha	$48.68	2	$98	$98
C	Plantvax	1kg/ha	$72.20	2	$142	$142
	Alternating			3A + B	$85	$135
	Alternating			3A + C	$108	$158
	Alternating			3A + B + C	$157	$232

* a single application costs $25/ha. It is assumed that there will be two insecticides sprays per crop coinciding with fungicide applications. Thus no extra application fee is included for two fungicide applications.

2.3 STUDY RUST ESTABLISHMENT IN FIELDS AND DEVELOP A QUICK AND RELIABLE SAMPLING TECHNIQUE TO IDENTIFY LEVELS OF INFECTION.

Commercial bean fields were surveyed from July to September. Rust incidence and severity was recorded on plants distributed along a "M" pattern. This involved sampling forty sites along a "M" pattern with each site being five consecutive plants. The middle trifoliate leaf was assessed for rust severity on the top three fully expanded leaves using a 0 - 5 scale. O = nil to 5 = high number of rust pustules present. From these surveys the distribution and severity of a rust epidemic was determined and used to develop a sequential sampling plan. A sequential sampling plan is a quick sampling technique with set thresholds in which the sampler can determine the following.

1. Being able to stop sampling after a minimum number of samples has been checked and determine if the level is so low that sampling can cease, and no sprays are necessary
2. That the threshold has been reached and spraying should be done or
3. That more sampling is required in able to make a decision.

Results showed that early infections tended to occur in distinct spots in the field and spread from there.

2.4 TEST THE EFFICACY AND COST EFFECTIVENESS OF CHEMICAL CONTROL OPTIONS.

Testing of current and potential fungicides and control agents against bean rust was carried out in liaison with chemical companies. These fungicide trials were carried out to validate the use of systemic fungicides in a strategic application program for rust. As most growers are aware, protectant fungicides must be applied before infection starts and so are usually applied on a regular basis. Systemic fungicides however have "curative" properties and can be applied in response to actual disease pressure.

In completing these trials, rust epidemics were surveyed and incidence severity measured using leaf area diagrams. Yields were taken using quadrat sampling. The following fungicides were evaluated in a number of trials.

Mancozeb
Baycor
Anvil
Saprol
Plantvax
Folicur
Raxil plus Folicur
Alto
Experimental sample from Ciba Geigy

TABLE 7. Yields from spraying fungicides a different number of times.

Fungicide	No. Sprays	Yield Kg/m
Mancozeb	4	1.36
Plantvax	2	1.32
Folicur	2	1.40
Saporol	2	1.12
Alto	2	1.28
Anvil	2	1.45
Ciba exp.	2	1.09
Nil	0	0.92
		LSD 0.05 0.27

Anvil, Folicur and Alto showed promising results and produced comparable yields to Mancozeb applied as a scheduled spray. A chemical rotation would be desirable in a systemic fungicide base strategy.

In Table 8 the results are given comparing a protectant and three systemic fungicides.

TABLE 8. Yields from spraying a protectant and 3 systemic fungicides.

Chemical*	Protectants vs. Systemics	
	No. sprays	Yield kg/m
Mancozeb (Protectant)	5	1.29
Oxycarboxin (Systemic)	2	1.25
Bitertanol (Systemic)	2	1.25
Tebuconazole (Systemic)	2	1.35
Nil	0	0.84

* *Not all of these are registered on beans*

There was no significant yield difference between the Mancozeb treatment and the three systemic fungicides. Mancozeb required five applications and the systemic fungicides required only two. This validates the use of a systemic fungicide in a system that would use strategic applications based on disease incidence. Though costs need to be taken into consideration.

However in order to use systemic fungicides effectively, several factors must be looked at. A quick and reliable sampling technique is required to determine if and at what level of rust is present in the field. Spraying at "first sign" is not specific enough and may lead to a waste of chemical or a disaster.

2.5 GAIN A BETTER UNDERSTANDING OF FACTORS INFLUENCING RUST EPIDEMICS.

A knowledge of the relationship between rust levels and other factors including weather, fungal and plant, are required in order to develop an action level for spraying at a rust level that will cause economic yield loss if no action is taken.

2.5.1 Weather factors

Leaf moisture is required for rust spores to germinate. This aspect was monitored by recording leaf moisture and temperature and linking it to the onset of infection in the field in order to give a "high risk period" prediction. Climatic information gathered at Ayr and Bowen was analysed in relation to rust epidemic development in trials and commercial fields in determining the effect of crop and climatic factors on rust epidemiology. Leaf temperatures were recorded using infra red thermography to determine if it can be used as an early indication of infection. Air temperature, canopy temperature, light, relative humidity, leaf moisture, wind speed/direction were the climatic factors measured. No conclusive results were obtained from this section of the work.

2.5.2 Fungal factors

Fungicides commonly used to control bean rust (*Uromyces appendiculatus*) in Queensland are Mancozeb (Dithane M45 etc), Bitertanol (Baycor) and Oxycarboxin (Plantvax). The latter two fungicides have a systemic mode of action and may be subject to fungicide resistance problems after continued use.

Preliminary tests showed some isolates of bean rust had become quite resistant to Bitertanol. In areas such as Gympie, growers have also noticed a lowered response. The alternative fungicide, Oxycarboxin, has not been widely screened for resistant strains.

On the basis of fungicidal activity, Bitertanol is much more toxic to *U. appendiculatus* than Oxycarboxin. This is reflected in the relative recommended field spray strengths of 150 µg/mL for Bitertanol and 750 µg/mL for Oxycarboxin.

The object of this study was to compare the fungicide sensitivities of isolates from different bean growing districts to judge whether fungicide resistance to these two fungicides is a widespread problem.

Eleven isolates were screened for sensitivity to Bitertanol and Oxycarboxin in a glasshouse experiment. Plants sprayed with the Bitertanol at rates of 0, 2.5, 10, 25 and 100 µg/mL and with Oxycarboxin at 0, 10, 25, 100 and 250 µg/mL were inoculated with the isolates and disease reactions noted.

For Bitertanol, EC50 values (the concentration of fungicide which lowers disease severity by 50%) ranged from sensitive (0.2 µg/mL) to resistant (40 µg/mL), a resistance factor of 200.

Of the eleven isolates, only one from Bundaberg was sensitive. Seven were low resistance (EC50 >1 <10), two were moderately resistant (EC50 >10 <25) and one was resistant (EC50 >25). Isolates classed as either moderately resistant or resistant came from the Lockyer, Bowen and Gympie showing widespread tolerance has developed to this fungicide.

For Oxycarboxin, there was much less variability between isolates. The most sensitive had an EC50 of 30 µg/mL while for the least sensitive it was 135 µg/mL, a resistance factor of about 4.

2.5.3 Plant factors

2.5.3.1 Effect of plant stress through root disease and irrigation

Irrigation experiments were conducted in the field and glasshouse. Initially, trickle irrigation was used as an experimental tool to apply irrigation with more accuracy. Drought stress, medium and over watered treatments were used. Rust severity and root infection and development were measured along with yield components. Glasshouse trials were also carried out in parallel to field trials. Soil moisture was determined using tensiometers and an infra-red thermometer was used to measure indications in stress via changes in leaf temperature.

Fertiliser experiments were also conducted in conjunction with irrigation experiments. Nitrogen was targeted for initial studies since nitrogen use may be the most widely misused fertiliser component. High and low rates were used in irrigation trials.

Table 9 shows the set up of the trial to evaluate the use of water and fertiliser use on disease incidence.

TABLE 9. Trial design to evaluate fertiliser and water use on plant stress.

Treatment	Fertiliser	No of irrigations	Treatment	Fertiliser	No of irrigations
A	0 fert	1	**E**	0 fert	2
B	200kg/ha urea	1	**F**	200kg	2
C	500kg	1	**G**	500kg	2
D	300kg + 500CaNO3	1	**H**	300kg + CaNO3	2

Results were inconclusive from this trial.

2.5.3.2 Varieties

At Bowen, field trials were conducted, evaluating potential bean cultivars (in liaison with seed companies) for use in a bean rust management system. Yield, marketability and rust resistance or tolerance was rated.

Trial 1992.

Thirty- five varieties were sown on the Bowen Horticulture Research Station in 1992 and supplied with basal fertiliser as well as side dressing with nitrogen. Two plots of each variety were sown with each plot on opposite sides of the block to allow one set of plots to be sprayed and the other unsprayed. The unsprayed plots were on the windward side to avoid spray drift. Weekly sprays of Mancozeb were applied to the treated plots from the first true leaf stage. At the three week stage the entire trial area was inoculated with rust spores by spraying a suspension of spores collected from washing infected leaves in water with detergent. This was undertaken to ensure that rust was present in the crop, as no natural occurring rust was evident on the plants at this stage. A rust severity rating with 0 = no rust pustules and 9 = very severe to complete defoliation by rust was used to measure infection.

Result

In Table 10, the varieties tested are given with the rust severity rating for each and comments on agronomic qualities on some of the varieties.

Table 10. Rust ratings on varieties and comments on growth.

Variety	**Severity**	**Comments**	**Variety**	**Severity**	**Comments**
NW146	4		NO250	0	Pod colour pale
NW148	7-8		NO97	3-4	
NW155	1		LINE200	3	
NW154	6-7		NO245	3-4	
NK089	7-8		ESP	4	
NK091	8-9	Late maturing	MONTANA	0	Lodging
AR0SA	5-6	Lodging –pale pods	GS104	0	Pale pods
XPB169	5		BLACK MAGIC	6-7	Slight lodging
XPB167	8-9	Yellow podded	LABRADOR	6	
XPB161	0	Short pod	BRONCO	8-9	
Colt	8-9		SUPERSTAR	6	
Line 135	0	Slight lodging	BRIGADEER	3-4	
M82	3-4	Lodging	VERONA	7-8	
NO103	0	Pods light green	BROKER	8-9	
NO197	0	Reasonable quality	BRIO	8	
NO40	0	Seedy pods	COVEY	8-9	
HI GERM	7	Lodging	ROVITA	8-9	
NO242	5-6				

0 = Nil rust
9 = Very severe to complete defoliation

Trial 1993

Twenty-six varieties were sown using standard fertiliser and irrigation practices. Varieties were rated for tolerance to rust as in the previous year except that the severity of rust in this crop was very low. In a second trial 14 varieties were evaluated as per 1992.

Result

In Table 11, fourteen varieties were evaluated.

Table 11. Average pod yields and number of pods/m of row with a rust severity rating for 14 varieties.

Variety	Av. Pod Yield g/m of row	Av. # of Pods /m	Rust Severity
Barracuda	1087	168	2
Simba	1002	184	3
RS226113	919	156	7
Line 35	884	203	0
Phoenix	871	165	4
RS226114	855	206	6
Hiway	822	153	2
BN102	789	276	3
Labrador	708	130	6
2341	642	122	6
NR607	619	140	6
BN100	547	135	5
NR69	494	109	8
RS226112	330	90	8

0 = Nil rust
9 = Very severe to complete defoliation

Trial 1994

Twenty-four varieties were evaluated including the more promising varieties, Matador, Phoenix, Simba and Barracuda with the standard commercial lines Labrador and Bronco. Sixteen new varieties were also evaluated as previously, for the first time.

No results could be made from this trial as rust populations were very low.

2.6 CONCLUSION

Early detection of bean rust (*Uromyces appendiculatus*) is essential to reduce yield loss in French Beans. In the experiments undertaken significant yield reductions were seen. Infection occurred at the 2 leaf stage and weekly Mancozeb® applications from that stage through to pod set produced significantly higher yields, characterised by higher pod numbers. . There was no significant difference in yields between five weekly applications of Mancozeb® and 2 applications of either of three systemic fungicides [Plantvax®, Folicur®, Baycor®] applied when rust infections were seen on new leaf growth. No treatment window was found in which rust did not effect yield.

Laboratory testing for resistance in rust to fungicides showed that there is no major resistance in local collections of rust to Plantvax® but Baycor® had some isolates classed as either moderately resistant or resistant which came from the Lockyer, Bowen and Gympie. In these areas it showed widespread tolerance had developed to Baycor®.

From a range of varieties tested for rust tolerance the most promising varieties in terms of rust resistance, pod quality and yield were Simba and Phoenix. Both lines have medium length are dark green and generally have straight pods. Additionally, Barracuda was a high yielding variety with low rust incidence and medium to long pods, although pod colour was mid green.

3.0 ROOT ROT MANAGEMENT

3.1 GENERAL

Root rot is an ever increasing problem especially in fields with a long history of beans. Root function and development can be seriously effected leading to plant death or yield decline. There is also the potential of impaired root function causing stress which may lead to more severe rust epidemics. Much work has been carried out on root rot including a QFVG/HRDC project by Dominie Wright. Indications are that agronomic factors such irrigation, planting method, crop rotation and nutrition may play a significant role in lessening the impact of root rot. This project intends to utilise the best of possible agronomic practices in an integrated approach to bean root rot and rust management as a whole rather than in isolation since management of one disease problem may influence the other.

3.2 TRIALS

Trails were established on two growers' farms in the Gympie region to compare different crop rotation systems on bean yield and root rot severity. Treatments consisted of: A. a cover crop, B. a cover crop + extra urea, C. a weed fallow and D. a bare fallow. The cover crop was either forage sorghum, or nutrifeed with dolichos. The cover crops were grown during the summer season (Nov-Mar). During this time the crop was slashed once and allowed to regenerate before being slashed and incorporated into the soil with a rotary hoe.

Results from one farm (sorghum cover crop) show that the yields were larger in the areas sown with the sorghum and the extra urea treatment (11.8 t/ha) compared to the bare fallow (7.4 t/ha). The area sown with sorghum with urea applied after the final slashing had a yield of 8.16 t/ha while the week fallow area had a yield of 9.76 t/ha. The addition of urea assisted with the breakdown of the sorghum and in the increase of biological activity in the soil. There was very little difference in root rot severity at this stage although, it seemed there were differences in the early stages of crop growth. These results are encouraging in terms of soil management and can have a big influence on yields and possibly disease levels.

A trial was completed in Ayr to look at the effects of fertiliser. The aim was to measure the influence of side dressing on both red root and yield. The results are tabled in Table 12.

Table 12. Effect of fertiliser side dressing on bean yield and root disease.

Side dressing treatment		Yield (g/5m of row)	Root rot*
1.	Zero	344	1.6
2.	Calcium Nitrate 300kg/ha	343	1.7
3.	Urea 100kg/ha	341	1.9
4.	Urea 225kg/ha	316	2.5
5.	Urea 450kg/ha	375	2.7

* (0 = low, 4 = high)

The results indicate that nitrogen side dressing may be implicated in red root.

3.3 CONCLUSION

The use of incorporating a sorghum cover crop supplemented with the fertiliser Urea, to assist breakdown, contributed to higher yields than a bare fallow treatment. The difference in root rot severity between these treatments could only be seen at the early stages of plant growth. The addition of nitrogen as a side dressing could be implicated in red root development.

4.0 INSECT PEST MANAGEMENT

4.1 GENERAL

There are a number of insect pests found in bean crops and although some of them do not cause significant damage or losses there are three major pests and they occur at three distinct growth stages. Bean fly (*Ophiomyia phaseoli*) is a key insect pest on beans. Early sprays for this pest tend to start growers on an insecticide treadmill by interfering with the build up of beneficial insects in the field. Bean fly is a pest at the seedling stage. The other pests are thrips which cause flower drop and deformity of pods and bean pod borer which chew into the pods making them unmarketable.

To fit into an integrated management system being developed for this project, trials were designed to look at the possible use of a granular insecticide that would control the insects at the seedling and flowering stages which may also have some effect on insects at the pod stage. The success of a granular insecticide would reduce the need to apply routine sprays and this would fit in with strategic use of limiting fungicide applications needed for rust control.

4.2 TRIAL 1.

Table 13, gives the treatments used in trial 1. The treatments were designed to give comparisons in controlling the different insect pests at three different growth stages, seedling, vegetative and flowering. As Methomyl (Lannate ®) is registered for bean fly control it was used as the standard to compare Phorate (Thimet ®) and Imidacloprid (Gaucho ®) for bean fly control at the seedling stage. At the vegetative and flowering stages other insecticides were super imposed on the seedling treatments. These were Dipel ®, Endosulfan (Thiodan ®), Lannate, and Gaucho. The evaluation undertaken in this trial was based on 4 replications.

Table 13. Treatments applied to the different growth stages.

	Treatment	**Seedling**	**Vegetative**	**Flowering**
A	Thimet only at planting	Thimet		
B	Thimet at planting and Bt	Thimet	Bt's	Bt's
C	Thimet at planting and Lannate	Thimet	Lannate	Lannate
D	Lannate	Lannate	Lannate	
E	Lannate	Lannate		
F	Lannate	Lannate	Lannate	Lannate
G	Lannate and Thiodan	Lannate	Thiodan	Thiodan
H	Lannate and Gaucho	Lannate	Gaucho	Gaucho
I	Gaucho	Gaucho	Gaucho	Gaucho
J	Control Nil treatment			

The Thimet treatment was applied to the rows at planting with the granules placed just below the seed. The other treatments were applied as cover sprays.
The rates at which the the chemicals were applied were; Thimet @ 10kg/ha of product, Lannate, Thiodan and Gaucho @ 100ml/100L and Bt @ 800gm/100L.

Results.

SEEDLING STAGE

The results from holding 100 seeds at 22° C under laboratory conditions gave a 96% germination count after 3 days.

Following planting, the first sprays were applied at 7 days later and then 4 days and 7 days after the first spray. Applications were made through a motorised knapsack sprayer. The first germination count was made 9 days after planting and the second 11 days after planting. Counting seedlings along 1m of row with 4 replications per plot were undertaken.

In Table 14, the average number of plants that emerged is given for both counts.

Table 14. Average number of seedlings that emerged in 1m of row at 2 different times.

Treatment	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	Prob.
1st	30.0	30.5	37.5	31.5	32.75	41.5	29.75	31.25	33.5	35.5	0.803
2nd	45.75	45.25	42.5	46.75	38.25	49.0	43.0	51.0	44.5	43.0	0.640

There were no significant differences between the treatments and this shows that Thimet had no adverse effect on the germination of bean seedlings.

In Table 15, the average number of plants per block with damage to stems caused by bean fly is given. This assessment followed 3 sprays of Lannate or Gaucho spaced at 3-4 day intervals and counts were made on 10 plants per plot. Following the initial bean fly assessment, sprays were undertaken on a 7day schedule.

Table 15. Average number of plants with stem damage at the first assessment caused by bean fly.

Treatment	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	Prob.
1st	0.75 a	0.5 a	0.25 a	0.25 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	6.5 b	<0.001

Numbers followed by the same letter are not significantly different P = <0.05.

As can be seen from Table 15, the initial assessment showed that all of the treatments had significantly less damaged plants than the control treatment (J).

VEGETATIVE STAGE

A rating system based on 0 – 3, [0 = nil leaf damage, 1 = tip chewed, 2 = tip + a bit chewed, 3 = ½ of leaf chewed] was used to measure the extent of damage to leaves by leaf chewing insects. Five plants per plot were examined. There was no significant difference between the treatments in the number of undamaged leaves or the extent of damaged leaves. The results are given in Table 16.

Table 16. Average number of non chewed or chewed leaves per plot from 5 plants per plot.

Treatment	Non chewed	Tip only chewed	Tip + chewed	½ of leaf chewed	Total leaves
A	61.0	28.0	0.0	0.0	89.0
B	54.0	33.0	0.25	0.0	87.25
C	60.0	28.0	1.25	0.75	90.0
D	60.0	48.5	0.75	0.0	109.25
E	49.0	39.25	0.5	0.0	88.75
F	41.0	33.5	0.5	0.0	75.0
G	55.75	32.75	1.0	0.5	90.0
H	63.0	48.75	0.5	0.0	112.25
I	81.25	9.0	0.5	0.0	90.75
J	58.5	32.5	1.75	1.25	94.0
Probability	0.449	0.151	0.687	0.198	0.114

A second assessment on leaf damage was made at harvest and the results are given in Table 17.

Table 17. Average number of leaves chewed per plot from 5 plants per plot.

Treatment	Non chewed	Tip only chewed	Tip + chewed	½ of leaf chewed
A	55.75	38.5^{bcde}	0.5	0.5
B	68.75	27.5^{abcd}	0.25	0.0
C	81.0	18.0^{ab}	0.0	0.0
D	39.75	41.5^{cde}	0.25	0.0
E	49.5	52.5^{e}	1.0	0.5
F	68.75	13.0^{a}	0.75	0.25
G	69.75	23.75^{abc}	0.5	1.0
H	45.25	50.0^{de}	2.5	0.0
I	49.0	34.25^{abcde}	0.25	0.25
J	56.0	34.25^{abcde}	1.0	0.0
Probability	0.072	0.026	0.109	0.698

Numbers followed by the same letter are not significantly different $P = <0.05$.

Lannate applied at all stages (F), Thimet followed by Lannate (C) and Lannate followed by Thiodan (G) at the vegetative and flowering stage had significantly less damaged on tips of leaves than Lannate at the seedling stage (E) or Lannate followed by Gaucho at the vegetative and flowering stage (H). Thimet followed by Bt at the vegetative and flowering stage (B) had significantly less damage to the tips of leaves than the Lannate at the seedling stage only (E). Lannate at the three stages (F) also had significantly less damage in the tips of the leaves than Lannate at the seedling and vegetative stage (D) and also significantly less than Thimet at the seedling stage (A). Thimet followed by Lannate at the vegetative and flowering stage (C) had significantly less damage to the tips of the leaves than Lannate at the seedling and vegetative stage (D).

FLOWERING STAGE

At the same time as the first evaluation of leaf damage, the pods on these plants were also examined for maturity (Table 18) and damage (Table 19).

Table 18. Average number of mature, ¾ mature and developing pods on 5 plants/plot.

Treatment	Mature pods	¾ mature	Immature	Total
A	8.25	77.0	39.75^{ab}	125.0^{abc}
B	11.5	62.75	50.5^{ab}	124.8^{abc}
C	11.75	67.0	29.25^{a}	108.0^{ab}
D	18.25	82.0	62.75^{bc}	163.0^{cd}
E	17.5	62.0	33.5^{a}	113.0^{ab}
F	6.25	62.25	34.5^{a}	103.0^{a}
G	13.0	80.25	34.0^{a}	127.3^{abc}
H	23.25	71.0	83.75^{c}	178.0^{d}
I	15.5	71.0	40.0^{ab}	126.5^{abc}
J	11.75	84.0	50.0^{ab}	145.8^{bcd}
Probability	0.336	0.515	0.006	0.016

Numbers followed by the same letter are not significantly different P = <0.05.

From this data there were no significant differences between the treatments in the number of mature or near mature pods. With the immature pods, Lannate followed by Gaucho (H) had significantly more immature pods than the other treatments except the Lannate at the seedling and vegetative stage (D) treatment. This latter treatment (D) also had significantly more immature pods than the Thimet followed by Lannate (C), the Lannate at the seedling stage only (E), the Lannate followed by Thiodan (G) and Lannate at all stages (F) treatments.

In total pods, the Lannate followed by Gaucho (H) had significantly more pods than all the other treatments except Lannate at the seedling and vegetative stage (D) and the Control (J) treatments. The Lannate at the seedling and vegetative stage (D) treatment had significantly more pods than the Lannate at all stages (F), Lannate following Thimet (C)and the Lannate at the seedling stage only (E) treatments. The Control (J) treatment had significantly more pods than Lannate at all stages (F) treatment.

Damage to pods was categorised by either damage by thrips (twisted and possiblly scared pods) or caterpillar damage(chewed and possibly marked pods). Results from the different types of damage within the three maturity categories, Table 18, show that there were no significant differences between the treatments for any of the different categories in either of the mature or ¾ mature pod counts.

Table 19. Average number of damaged pods on 5 plants /plot for mature, ¾ mature and immature pods.

Mature pods						
Treat.	**Good**	**Twisted**	**Scared**	**Chewed**	**Marked**	**Total**
A	1.0	0.25	7.0	0.0	0.0	8.25
B	2.75	1.75	6.75	0.25	0.0	11.5
C	3.0	1.25	7.0	0.25	0.25	11.75
D	4.75	0.75	11.75	1.0	0.0	18.25
E	4.5	0.25	5.0	0.0	0.5	17.5
F	0.75	0.0	12.25	0.5	0.0	6.25
G	2.75	0.0	9.25	0.75	0.25	13.0
H	11.0	0.5	10.25	0.75	0.75	23.25
I	3.75	1.25	10.25	0.0	0.25	15.5
J	6.75	0.0	4.75	0.025	0.0	11.75
Prob.	0.077	0.732	0.316	0.625	0.312	0.336
¾ Mature						
A	34.25	1.0	36.5	3.0	2.25	77.0
B	27.0	4.25	25.5	3.25	2.75	62.75
C	28.0	4.0	32.5	1.25	1.25	67.0
D	45.25	1.0	33.25	1.5	1.0	82.0
E	28.25	1.0	29.25	0.5	3.0	62.0
F	20.25	2.25	36.75	2.0	1.0	62.25
G	34.0	2.75	35.0	3.5	5.0	80.25
H	39.0	0.75	29.0	0.75	1.5	71.0
I	33.75	1.0	31.75	2.0	2.5	71.0
J	49.75	0.25	31.5	1.75	0.75	84.0
Prob.	0.076	0.383	0.964	0.490	0.299	0.515
Immature pods						
A	20.25^{ab}	0.5	15.5^{ab}	2.0	1.5	39.75^{ab}
B	17.25^{ab}	7.25	18.25^{abc}	3.25	4.5	50.5^{ab}
C	15.5^{a}	3.75	8.75^{a}	0.5	0.75	29.25^{a}
D	34.0^{bc}	1.75	25.75^{bc}	1.0	0.25	62.75^{bc}
E	21.0^{ab}	1.25	8.5^{a}	0.75	2.0	33.5^{a}
F	12.75^{a}	3.5	15.75^{ab}	1.0	1.5	34.5^{a}
G	18.5^{ab}	2.25	9.75^{a}	1.0	2.5	34.0^{a}
H	43.5^{c}	5.75	29.75^{c}	3.75	1.0	83.75^{c}
I	20.25^{ab}	1.75	14.25^{ab}	0.75	3.0	40.0^{ab}
J	28.5^{abc}	0.0	17.5^{abc}	1.0	3.0	50.0^{ab}
Prob.	0.034	0.190	0.045	0.141	0.219	0.006

Numbers followed by the same letter are not significantly different P = <0.05.

With the immature counts the Lannate followed by Gaucho (H) treatment had significantly more good pods than all the other treatments except the Control (J) or Lannate at the seedling and vegetative stage (D) treatments. This latter treatment (D) had significantly more pods than the Thimet followed by Lannate (C), Lannate at the seedling stage (E), Lannate followed by Thiodan (G) and the Lannate at all stages of growth (F) treatments.

There was no significant difference between the treatments for twisted pods in this immature stage.

With the scared pods, the Lannate followed by Gaucho (H) treatment had significantly more good pods than all the other treatments except the Control (J), Lannate at the seedling and vegetative stage (D) and Thiment followed by Bt's (B) treatments.

Lannate at the seedling and vegetative stage (D) had significantly more pods than the Thimet followed by Lannate (C), Lannate at the seedling stage (E) and Lannate followed by Thiodan (G) treatments.

With total immature pods, the Lannate followed by Gaucho (H) treatment had significantly more good pods than all the other treatments except the Lannate at the seedling and vegetative stage (D). Lannate at the seedling and vegetative stage (D) had significantly more pods than the Thimet followed by Lannate (C), Lannate at the seedling stage (E), Lannate followed by Thiodan (G) and Lannate at all stages (F) treatments.

In evaluating control of thrip populations, thrip numbers were assessed by randomly collecting 20 flowers per block and counting the number of thrips. Again counting the number of thrips in the flowers nearer plant maturity made a second count. Refer to Table 20.

Table 20. Average number of thrips in 20 flowers per block 1st assessment and the average number per flower /block in the 2nd assessment.

Treatment	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**Prob.**
1st count	22.25 cd	22.25 cd	5.25 ab	15.0 abcd	21.25 bcd	8.25 abc	22.0 cd	4.25 a	4.5 a	30.75 d	0.018
2nd count	12.29 de	7.26 bc	7.15 bc	12.85 e	13.38 e	11.0 de	9.16 cd	2.89 a	4.62 ab	24.46 f	<0.001

Numbers followed by the same letter are not significantly different P = <0.05.

As can be seen from this table, in the first count the use of Gaucho as a treatment at planting (I) or as a cover spray (H) had significantly less thrips than the Control (J), Thimet at planting (A) and also when followed by Bt (B) and Lannate followed by Thiodan (G) or Lannate at the seedling stage (E) treatments. Thimet followed by Lannate (C) also had significantly less thrips than the Control (J), Thimet at planting (A) and also when followed by Bt (B), and Lannate followed by Thiodan (G) treatments. Lannate applied at each stage (F) had significantly less thrips than the Control (J) treatment.

In the second count all treatments had significantly less thrips than the Control (J) treatment. Also both of the Gaucho treatments (H and I) and Thimet followed by Lannate (C) or Bt (B) had significantly less thrips than Thimet at planting (A) or Lannate at the seedling (E), or seedling and vegetative stage (D) or Lannate at each stage (F) treatments. Also Lannate followed by Thiodan (G) had significantly less thrips than the Lannate at the seedling stage (E) or seedling and vegetative stage (D) treatments. Also both Gaucho treatments (H and I) had significantly less thrips than the Lannate followed by Thiodan (G) treatment and Lannate followed by Gaucho (H) had significantly less thrips than Thimet followed by either Lannate (C) or Bt (B) treatments.

A second assessment on bean fly damage was also undertaken on the plants made 1 day before the plants were harvested. All leaf nodes were examined on 5 plants per plot and damaged recorded. Refer to Table 21.

Table 21. Average number of nodes damaged in the second assessment caused by bean fly.

	A	B	C	D	E	F	G	H	I	J	Prob.
2nd count	19.5 b	6.0 ab	14.5 ab	34.5 c	33.75 c	12.75 ab	9.5 ab	4.5 a	2.0 a	37.25 c	<0.001

In the second assessment of bean fly damage at harvest, all treatments, except Lannate at the seedling stage (E) and Lannate at the seedling and vegetative stage (D), had significantly less damaged nodes than the Control (J) treatment. Also Lannate followed by Gaucho (H) and Gaucho applied at the three stages (I) had significantly less damaged nodes than the Thimet at planting (A) treatment.

In Table 22 the average yield (kg) for each treatment is shown.

Table 22. Average weight of beans harvested off 3metres of row.

Treatment	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**
Yield	2.97	2.82	3.18	2.98	3.14	2.93	3.04	3.41	2.85	2.59

There were no significant differences between the treatments in the weight of beans harvested.

4.3 TRIAL 2.

Table 23 gives the treatments used in trial 2. In this trial Imidacloprid (Gaucho ®) used as a seed dressing was the main chemical to be evaluated. The evaluations undertaken in this trial were based on 4 replications.

Table 23. Treatments applied to control Bean Fly or Thrips.

Insect		**Bean fly**			**Thrips**					
Spray days after germination		**3**	**7**	**14**	**21**	**28**	**31**	**35**	**38**	**42**
Treatment							**1st**	**2nd spray**	**3rd**	
A	**Control Nil spray**									
B	**Lannate 3, 7, 14**	Y	Y	Y						
C	**Lannate 3, 7 weekly**	Y	Y	Y	Y	Y	Y	Y	Y	
D	**Lannate Weekly**		Y	Y	Y	Y	Y	Y	Y	
E	**Thimet 1.5kg**									
F	**Thimet 3kg**									Y
G	**Gaucho & then Lannate weekly**			Y	Y	Y		Y		
H	**Gaucho Seed dressing**									Y
I	**Lannate 3, 7, 14 & then 3 thrip sprays**	Y	Y	Y			Y	Y	Y	Y
J	**Lannate 3, 7, 14 & then 2 thrip sprays**	Y	Y	Y				Y	Y	Y
K	**Lannate 3, 7, 14 days & then 1 thrip spray**	Y	Y	Y					Y	

Y = this treatment sprayed.

The Thimet treatment was applied to the rows at planting with the granules placed just below the seed. Lannate was applied as cover sprays @ 100ml/100L. Seed treatment with Gaucho was 600mls/100kg of seed.

Results.

SEEDLING STAGE

Following planting, the first sprays were applied at 7 days after planting and then 4 and 11 days later. Application was made through a motorised knasack sprayer. The germination count was made 14 days after planting. Counting seedlings along 1m of row with 4 replications per plot made evaluations.

In Table 24, the average number of plants that emerged is given.

Table 24. Average number of seedlings that emerged in 1m of row.

Treatment	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	Prob.
	53.0	54.75	53.0	53.0	39.75	43.5	44.0	45.5	51.5	53.0	55.25	<0.001
	c	c	c	c	a	a	a	ab	bc	c	c	

Numbers followed by the same letter are not significantly different P = <0.05.

Both the Thimet (E and F) and one of the Gaucho (G) treatments had significant less germination than all the Lannate (B C D I J K) and Control (J) treatments. Gaucho as a seed dressing only (H) had significantly less germination than the Lannate (B C D J K) and Control (A) treatments.

In Table 25, the average number of plants per block with damage to stems caused by bean fly is given. This assessment followed 3 sprays of Lannate. Counts were made on 5 plants per plot.

Table 25. Average number of plants with stem damage caused by bean fly.

Treatment	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	Prob.
	1.75	1.25	2.25	2.50	1.25	1.50	2.50	2.25	1.75	0.50	2.00	0.340

There were no significant differences between the treatments in the number of damaged plants.

In evaluating control of thrip populations, thrip numbers were assessed by randomly collecting 20 flowers per block and counting the number of thrips. Three counts were made 31, 35 and 38 days after plant emergence. This equated to evaluating a nil, one or two sprays for thrip control on top of the other treatments. As well as counting total thrips they were separated into black (mature), white (winged) and immature (wingless) stages. Refer to Tables 26, 27 and 28.

Table 26. Average number of thrips in 20 flowers @ 31 days after emergence.

Treatment	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**Prob**
Black	55.2 c	32.5 bc	3.5 a	17.3 ab	19.3 ab	18.8 ab	6.5 a	20.8 ab	8.0 ab	12.8 ab	26.5 ab	0.017
White	91.2	76.5	10.5	28.3	29.3	40.5	29.0	28.5	26.5	17.0	43.2	0.169
Immature	23.3 c	15.0 bc	1.25 a	2.0 a	5.25 a	4.25 a	4.0 a	6.75 ab	5.0 a	6.5 ab	4.75 a	0.002
Total	169 c	124 bc	15.3 a	47.5 ab	53.8 ab	63.5 ab	39.5 a	56.0 ab	39.5 a	28.8 a	67.0 ab	0.014

Numbers followed by the same letter are not significantly different P = <0.05.

With black thrips at 31 days after planting, all treatments except Lannate at 3, 7 and 14 day (B) had significantly less thrips than the Control (A) treatment. Lannate applied for bean fly and then weekly sprays (C) and the Gaucho followed by weekly Lannate sprays (G) also had significantly less thrips than Lannate applied at 3, 7 and 14 day (B) for bean fly control only treatment.

With white (winged) thrips, there were no significant differences between the treatments.

With immature thrips, all treatments except Lannate at 3, 7 and 14 days (B) had significantly less thrips than the Control (A) treatment. Also all treatments except Lannate for bean fly control (J) prior to a thrip spray and Gaucho seed dressing (H) treatments had significantly less thrips than the Lannate used for bean fly control only (B) treatment.

Looking at total thrips count, all treatments except the Lannate for bean fly control only (B) had significantly less thrips than the Control (A) treatment. Also, Lannate at 3 and 7 days followed by weekly sprays (C), Lannate for bean fly control prior to a thrip spray (J), Gaucho followed by weekly Lannate sprays (G) and Lannate for bean fly control prior to thrip spray (I) had significantly less thrips than Lannate for bean fly control only (B).

Table 27. Average number of thrips in 20 flowers @ 35 days after emergence.

Treatment	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**Prob**
Black	31.5 d	23.8 cd	5.7 ab	3.2 a	26.0 cd	23.0 cd	18.5 abcd	25.8 cd	18.5 abcd	15.0 abc	20.3 bcd	0.027
White	64.5	22.5	9.3	9.5	14.0	24.5	20.8	25.5	32.7	13.5	28.3	0.075
Immature	83.0 c	75.5 bc	23.3 a	8.3 a	20.3 a	19.8 a	16.3 a	34.7 ab	39.5 ab	41.7 abc	51.0 abc	0.018
Total	154 d	121 cd	37.5 ab	21.0 a	60.2 abc	67.2 abc	55.5 abc	86.0 abcd	90.7 bcd	70.2 abc	99.5 bcd	0.027

Numbers followed by the same letter are not significantly different P = <0.05.

At 35 days after planting, Lannate applied weekly with one thrip spray (D) or at 3 and 7 days and then weekly with one thrip spray (C) had significantly less thrips than the Control (A), both of the Thiment treatments (E, F), the Gaucho seed dressing only (H) and the Lannate for bean fly control only (B) treatments. Also weekly sprays of Lannate with one thrip spray (D) had significantly less thrips than Lannate for bean fly control prior to a thrip spray (K) treatment. Lannate for bean fly control prior to a spray for thrips (J) had significantly less thrips than the Control treatment (A).

With white thrips, there were no significant differences between the treatments.

With immature thrips, all treatments except Lannate for bean fly control only (B) and (K) or with one spray for thrips (J) had significantly less thrips than the Control (A) treatment. Also all treatments except the Lannate for bean fly control (K) and prior to a thrip spray (J) and only one spray for thrips (I) and Gaucho seed dressing (H) had significantly less thrips than the Lannate for bean fly control only (B).

With total thrips count, Lannate with one thrip spray (D) or at 3 and 7 days followed by weekly sprays plus a thrip spray (C), Gaucho and then Lannate weekly, both rates of Thimet (E, F) and Lannate for bean fly control and prior to a thrip spray (J) had significantly less thrips than the Control treatment (A). Also Lannate weekly with one thrip spray also had significantly less thrips than the Lannate for bean fly control only (B and K) or for bean fly control plus one spray for thrips (I). Also Lannate weekly with one thrip spray (C) had significantly less thrips than Lannate for bean fly control alone (B).

Table 28. Average number of thrips in 20 flowers @ 38 days after emergence.

Treatment	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**Prob**
Black	29.3 b	48.5 c	3.7 a	2.0 a	16.3 ab	24.8 b	2.7 a	28.5 b	2.7 a	3.2 a	29.5 b	0.001
White	94.2 d	61.5 bcd	31.2 abc	15.3 a	42.5 abc	61.0 bcd	25.8 ab	72.0 cd	16.7 a	29.5 abc	55.7 abcd	0.013
Immature	175 c	187 c	16.7 a	9.7 a	83.2 ab	83.7 ab	21.8 ab	110 bc	17.3 a	33.0 ab	195 c	0.001
Total	299 d	297 d	52.0 ab	27.0 a	142 abc	170 bcd	50.0 ab	211 cd	37.0 ab	66.0 ab	280 d	0.001

Numbers followed by the same letter are not significantly different P = <0.05.

At 38 days after planting all treatments had significantly less thrips than the Lannate for bean fly control only (B). Also Lannate weekly with two thrip sprays (D), Gaucho seed dressing plus Lannate weekly and one thrip spray (G), Lannate for bean fly control with one (J) and two (I) thrip sprays and Lannate at 3 and 7 days followed by weekly sprays and two thrip sprays (C) had significantly less thrips than Lannate for bean fly control only (K), the Control (A), Gaucho as seed dressing (H) and the Thiment at 3kg (F) treatments.

With white thrips, Lannate weekly with two thrip sprays (D) or with bean fly control and two thrip sprays (I), Gaucho and then Lannate weekly with one thrip spray (G), Lannate for bean fly control with one thrip spray (J), Lannate at 3 and 7 day followed by weekly sprays of Lannate and two thrip sprays (C) and Thimet at 1.5kg (E) had significantly less thrips than the Control (A). Also Lannate weekly with two thrip sprays (D) or with bean fly control and two thrip sprays (I) had significantly less thrips than the Gaucho seed dressing treatment (H), the Lannate for bean fly control only (B)and the Thimet at 3kg (F) treatments. Also Gaucho followed by weekly Lannate sprays and one thrip spray (G) had significantly less thrips than the Gaucho seed dressing treatment(H).

With immature thrips, Lannate weekly with two thrip sprays (D) or at 3 and 7 days then weekly with two thrip sprays (C) or for bean fly control and one or two thrip sprays (J and I), Gaucho followed by Lannate weekly and one thrip spray (G) and both rates of Thimet (E and F) had significantly less thrips than the Control (A), Lannate for bean fly control only (B and K). Also Lannate weekly with two thrip sprays (D) or at 3 and 7 days then weekly with two thrip sprays (C) and bean fly control and one or two thrip spray (I) had significantly less thrips than the Gaucho seed dressing treatment (H).

With total thrips count, Lannate weekly with two thrip sprays (D) or with bean fly control and one or two thrip sprays (J and I), Gaucho followed by Lannate weekly and one thrip spray (G), Lannate at 3 and 7 days followed weekly with Lannate and two thrip sprays (C) had significantly less thrips than the Control (A), Lannate for bean fly control (B and K) and Gaucho as a seed dressing (H). Also Lannate weekly with two thrip sprays (D) had significantly less thrips than the Thimet 3kg treatment (F). Thimet at 1.5 kg (E) had significantly less thrips than the Control (A), Lannate for bean fly control only (B and K).

4.4 CONCLUSION

Thimet applied as a granule and Gaucho® as a seed dressing at planting showed that there was a possibility that they could affecting the germination of bean seeds. Gaucho® as a spray had nil affect on the germination. Bean fly damage was reduced by the use of Lannate®, Thimet® and Gaucho® at the seedling stage and both Thimet® and Gaucho® treatments extended this reduction in plant damage into the mature plant stage. Very little damage to the vegetative growth on the plants was seen in these trials though application of the insecticides reduced the population of thrips in the flowers. Gaucho® applied as a foliar spray during the vegetative stage produced significantly more good pods than the other treatments.

5.0 DISCUSSION

The strategic use of systemic fungicides allows for a response to actual disease pressure in the field; however, in order to use them effectively several factors must be looked at.

The use of a quick reliable sampling technique to decide if and at what level rust is present in the field. Spraying at "first sign" is not specific and may lead to a waste of chemical or a disaster.

A better knowledge of the relationship between rust severity and yield has been developed and should be used as an action level or used to start spraying at a rust level at which an economic yield loss will occur if action is not taken. Bean plants can withstand a level of infection without an economic loss in yield and through the use of systemic fungicides can be applied at different growth stages.

Weather and plant condition can also impact the course of rust infections. Leaf moisture is required for rust spores to germinate. This aspect needs to be considered by growers in identifying the "high risk period" and use this information when monitor their fields.

The condition of the plant plays a role in rust epidemics. Plant stress through root disease infection or water stress may predispose plants to rust infection. The excessive use of nitrogen fertilisers may also put the plants under pressure with increased instances of red root.

Cultivars allow for a reduction in the impact of rust if agronomically suitable. Three cultivars have been identified for immediately use and more promising cultivars for the topics have been identified.

Fungicide resistance may become a problem especially if chemicals are misused such as spraying half rates of a systemic weekly. Fungicide resistance to Baycor has been shown and this needs to be managed.

Bean fly is identified as a major pest in establishing bean crops. During these trials there were no pests identified that needed control in the vegetative stage though when plants flowered the presence of thrips was noticeable. Control of these populations with insecticides saw increased yields and a reduction in damage to the pods.

6.0 TECHNOLOGY TRANSFER

6.1 EXTENSION AND PUBLICATION

Extension played a key role in the project. The principle researchers had a close liaison with bean growers and agribusiness in the region as well as outside the region, getting feedback and relaying information. Routine field walks were conducted on growers properties to identify and discuss all pest problems. Articles were published in appropriate grower magazines and scientific journals. A workshop was held at

Bowen in the second year to impart results to all interested parties and discuss the future development of an Integrated Pest Management package for beans.

6.2 LISTS OF PUBLICATIONS, FIELD DAYS, WORKSHOPS ETC

The following were undertaken.

1. A field day and workshop were held at Bowen Horticulture Research Station in September 1992.
2. Grower Field Day, Bowen Research Station, 7 October 1992
3. Grower Field Day, Bowen Research Station, 23 July 1993
4. QFVG Article, June 17 1993, Integrated Pest Management in Beans
5. Protect Your beans – Grower Field Day Booklet
6. A bean rust research booklet was produced and distributed to interested bean growers outlining rust management concepts and current work taking place.

7.0 RECOMMENDATIONS

Due to the uncertainty in the development of bean rust in crops between one year and the next, some of the proposed work could not be completed. The study on the interaction of weather and the incidence/build up of rust needs to be completed. A management plan in the use of the systemic fungicides will need to be developed in order that resistance can be managed or delayed prior to chemicals failing to give control of their targets. The treatment of bean seed with systemic insecticides is difficult due to the hard testa of the seed and further development is required if this method is to be investigated further.

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The chief investigators, Dr. M. Cole and Mr. P. Anning of this project have resigned from the Department. Other researchers, Mr. J. Brown, Mr. R. Wright and Mr. N. Meurant are still with the Department while Mr. R. O'Brien has since retired.

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