Evalution of grain legumes for wheatbelt rotations in Western Australia 1986 -1987

G H. Walton
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EVALUATION OF GRAIN LEGUMES FOR WHEATBELT ROTATIONS IN WESTERN AUSTRALIA

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Division of Plant Industries
WESTERN AUSTRALIAN DEPARTMENT OF AGRICULTURE

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SUMMARY OF MAJOR FINDINGS

Conclusions about the geographic and climatic limitations to the economic production of some pulse species in Western Australia cannot be too definite after only two years of gathering data. The yield results confirm the superior adaptation of field pea and narrow-leaf lupin over the faba bean, chickpea, narbonne bean and lentil. In 1987, a relationship was found within specific crop cultivars/accessions, between seed yield and the spring (September + October) rainfall. It is expected that soil type will influence the yield response through variations in moisture retention capacity, fertility and root penetration. Any relationship between yield and environmental factors will probably also have to include a crop factor such as level of disease perhaps as a function of rainfall?

The expression of the seed yield potential requires that the plant development fits into the growing period when the environmental conditions are optimal for growth. The chickpea requires slightly earlier flowering, together with the ability to fertilize these early formed flowers under cool temperatures. The lentil needs much earlier flowering, along with taller plant height to facilitate more efficient harvesting. The faba bean requires better nodulation to improve its ability to tolerate diseases. However, early applications of fungicide to prevent the disease infecting flowers and pods has given significant yield increases. Faba bean lines with greater tolerance to these diseases have been identified.

The narbonne bean has, at present, a pod shatter problem which restricts harvested seed yield.

The field (dry) pea species is the legume crop most successfully adapted to Western Australia. In 1986, eighty crossbred lines were evaluated for their seed yield, maturity and seed type. In 1987, forty of these crossbreds were further evaluated, including their propensity to lodge. A combined (1986 and 1987) regression analysis of seed yield identified the cultivar Wirrega as the highest yielding accession with a strong yield response to the environmental index. In the combined cluster analysis, the environmental index is the site mean yield. It is assumed that a substantial part of this index is contributed by total rainfall and its distribution during the growing season. A linear relationship between site mean yield and winter rainfall (June and July) with an R² of 0.74 exists for the lower rainfall sites up to 123 mm of winter rainfall (corresponds to a seasonal rainfall of about 250 mm). Sites with higher winter rainfall gave lower seed yield. The cause of this yield loss is thought to be crop emergence problems and poor growth under transient waterlogged soil conditions and higher levels of disease.

1. INTRODUCTION

The benefits derived from an association between a legume and a cereal in farm rotations are known to all farmers. These benefits are improved soil fertility, lower incidence of soil-borne diseases, better weed control strategies, a diversification of farm crop income and the availability of protein feeds. If for livestock enterprises.

In the cereal growing areas of Western Australia, a ley farming system developed with the use of subterraneum clover as the legume component in the rotation. A run of poor seasons and low wool prices in the late 1960s and 1970s, saw narrow-leafed lupin displace the clover component on the deeper, sandy-textured soils. Falling wheat prices have more recently resulted in greater economic prominence given to the lupin component in the wheat: lupin rotation. This awareness of the lupin, valued overseas as a high protein feed, has led to the identification on overseas markets of other cool season
pulse crops. In particular, dry peas, chickpea and lentil are marketed in
both Western Europe and Asia, with India having a projected demand for pulses
of 25 million tonnes by the year 2000, compared with 12 million tonnes at
present (R. Rees, 1988). Previous research in Western Australia comparing the
yield of twelve pulse species showed the adaptative superiority of field pea
and narrow-leaved lupin over the common vetch, faba bean, chickpea and lentil
(Walton and Trent, 1988). The current project aimed to determine the
geographic and climatic limitations to the economic production of various
pulse species; to identify the agronomic factors limiting the expression of
the potential seed yield and to screen for improved plant types and yield
amongst crossbred lines within the best adapted pulse species.

2. BACKGROUND TO THE PROJECT

In the late 1960s and into the 1970s after a period of wheat quotas and a
decline in wool prices, there was increasing interest in the feasibility of
growing and marketing alternative crops to wheat. The narrow-leaved lupin
industry expanded rapidly in the northern agricultural district whilst the
problems of weed control and lupinosis restricted the development in the
southern agricultural region. Lupin varieties suitable for the short growing
season environment of the eastern wheatbelt were not available and the hard
setting loam/clay soils common in this environment are not suitable for lupin
growth.

Commencing in the late 1970s, the Western Australian Department of Agriculture
introduced twelve selected grain legume species to test their potential growth
and yield in the Western Australian wheatbelt. From that research, the field
pea, faba bean and the common vetch were identified as potentially high
yielding although the vetch lacked markets (Walton and Trent, 1988). The
chickpea and lentil had poor adaptation to the wheatbelt environment, however
their potential market (with a corresponding high price) was favourable.
These new legume crops also had the potential of complementing the lupin
industry developing on the deeper sands, by being adapted to the heavier
textured and the shallow duplex soil types. Their role on the heavier soils
would not be as important within a cereal rotation system because the more
fertile nature of those soils will restrict their N₂-fixation. The new
legumes would need to be a major economic proposition to the farm.

This project aimed to examine those selected grain legume species to delineate
their climatic and geographic limitations to growth, to establish their yield
potential, to identify those agronomic factors that limit the realization of
their potential seed yield (and adaptation) and to screen for varietal
improvement within those legume species.

3. EXPERIMENTAL METHODS

To delineate the climatic and geographic limitations to crop growth and to
screen new crossbred material requires evaluation of the crop x environment
interaction. To increase the range of environments within any year, a number
of experimental sites were selected (Table 1). Sites were chosen to give a
.range in seasonal rainfall and temperature with soils that were either sandy
duplex or clay/loam textured. The soil at each site in 1987 was sampled at
three depths, 0-10 cm, 20-30 cm and 40-50 cm and analyses carried out for pH,
potassium and organic carbon. It was planned to 'describe' the soil type in
terms of the chemical nature and relate the 'description' to the suitability
of the soil for the growth of the crop species. The [K] and pH are possible
indicators of clay content and fertility (respectively). For example, Jessop
and Mahoney (1982) found the dry weight production of field pea, chickpea and
faba bean to be a maximum between pH 7 and 8, while lupin maximized at pH 6 and declined at pH above 7. The level of potassium in soil has a strong correlation with its clay content (W. Bowden, pers. comm.), and the organic carbon content may be useful as an indicator of soil structure.

**Grain legume species comparison**

Thirteen sites were used in the two years. In 1986, the plot size was 8 rows (1.4 m) x 15 metres length, in 1987 the plot size was 4 rows (0.7 m) x 10 metres in length. The treatments were arranged in randomized blocks with three replications. All trials were located on cereal stubble with agronomic management designed to eliminate weeds, provide sufficient fertilizer to mask soil deficiencies and control insect pests. Presowing herbicides, principally duiro (1986), and Bladex (1987) and post-emergent Fusilade, were used for weed control. The legume seeds were inoculated with the appropriate rhizobium. Various insecticides were applied to control Red Legged Earthmite, Heliophthis species and pea weevil. Six weeks after planting, the seedling emergence was estimated by counting within a quadrat. The date of flowering of treatments was observed in most, but not all sites. At maturity, all except the lentil plots were harvested with a machine having 1.25 m cutter width. The lentil plots were quadrat sampled by hand for yield.

Each trial was statistically analysed to determine the level of yield differences between treatments. In 1987, a linear relationship between yield and the September + October rainfall was calculated for each legume species. It is planned to further define the soil limitations to each species growth using a multiple regression analysis which will include the soil parameters with the rainfall data.

**Agronomic trials**

In 1987, the yield response to seeding rate and time of planting was examined for selected pea, chickpea, lentil and faba bean cultivars. The site was at Avondale Research Station on a York Gum, red loam soil carrying a cereal stubble. All seeds were inoculated and the faba bean seed lime pelleted. The appropriate management was given to the trials for control of weeds and pests and fertilizer application. The density trial was sown on June 10, which was later than desired, however, that season prevented an earlier planting. The time of planting trial had four sowing dates from May 20 to June 25. The plot size was 8 rows x 10 metres in length. All plots had the seedling emergence counted in quadrats about six weeks after sowing. After maturity, the plots were machine harvested.
Table 1. The location, seasonal (May to October) rainfall and soil descriptive parameters of the experimental sites for grain legume, field pea variety and faba bean screen trials

<table>
<thead>
<tr>
<th>Experimental title</th>
<th>Location</th>
<th>M-O rainfall (mm)</th>
<th>pH (H2O)</th>
<th>K (ppm)</th>
<th>Organic carbon (%)</th>
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<td>Chapman R.S.</td>
<td>430</td>
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<td>species comparison</td>
<td>'Daisy Downs',</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Mullewa</td>
<td>249</td>
<td>6.7-7.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Nyabing</td>
<td>179</td>
<td>6.0-6.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Salmon Gums R.S.</td>
<td>238</td>
<td>8.0-9.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Graham Lease</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Block, Salmon Gums</td>
<td>238</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>West Binnu</td>
<td>333</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1987</td>
<td>Avondale R.S.</td>
<td>261</td>
<td>6.0-6.8</td>
<td>132</td>
<td>0.50</td>
</tr>
<tr>
<td></td>
<td>Chapman R.S.</td>
<td>305</td>
<td>6.4</td>
<td>213</td>
<td>0.51</td>
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<td>Katanning</td>
<td>212</td>
<td>6.4-7.3</td>
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<td></td>
<td>Nugadong</td>
<td>283</td>
<td>6.4-8.5</td>
<td>212</td>
<td>0.61</td>
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<td>499</td>
<td>6.3</td>
<td>79</td>
<td>1.70</td>
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<td>7.7-7.0</td>
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<td>Esperance R.S.</td>
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<td></td>
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<td>0.66</td>
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<td>6.0-6.5</td>
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<td>7.4-7.0</td>
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<td>1987</td>
<td>Katanning</td>
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<td>5.6-6</td>
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<td>212</td>
<td>6.4-7.3</td>
<td>111</td>
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(1) Range of pH from 0-10 cm to 40-50 cm depth.
(2) Average value over 0-50 cm depth.
An experiment to examine the relationship between yield and the level of disease in faba bean was carried out at the Manjimup Horticultural Research Centre in 1987. The site chosen had been a faba bean variety trial site in 1986 on which considerable levels of Chocolate Spot disease had been noted. The trial was sown on May 29, the inoculated and lime pelleted seeds were sown with 100 kg/ha of double superphosphate and 140 kg/ha of 3:2 super and potash fertilizer was topdressed before seeding. The plot size was 8 rows x 10 metres in length. The percentage of leaf area affected by disease was estimated in mid-October by selecting one leaf approximately one-quarter of the way up the stem on ten plants per plot.

Logarithmic transformations were done on the percentage values for disease to satisfy statistical homogeneity before the significant levels of difference between treatments were calculated. The plots were machine harvested at maturity.

**Field pea variety evaluation**

Over the two years, 1986 and 1987, twelve sites were used to evaluate the growth and yield of field pea crosses bred (Table 1). In the first year the plot size was 4 rows x 6 metres in length and in the second, the plot size was 8 rows x 10 metres. Each trial was designed as a randomized block with three replications. The management of the trials was designed to provide for control of weeds and insect pests and allow optimum growth of the peas. The basic weed control programme involved the pre-planting application of diuron with the post-emergence use of Fusilade. The peas were inoculated with commercial rhizobium and sown with sufficient trace element fertilizer to eliminate nutrient deficiencies. Insecticides were applied to the plots for the control of pea weevil and *Heliothis* spp.

Six weeks after planting, an estimate of seedling emergence was done by counting the plants within a quadrat of known size. During crop growth, the date at which 50% of plants in each plot had flowered was recorded and at near maturity, the plots were rated for the extent of crop lodging and pod dehiscence. The plots were harvested by machine with a 1.25 metre width cut when the last plot had dried off. In 1987 each site was sampled to a depth of 50 cm for soil analysis of pH (in H₂O), potassium, organic carbon, phosphorus and nitrogen.

The seed yield for each treatment was statistically analysed as a randomized block design for each site to determine the significant level of yield differences. The yield data for all sites and treatments were combined for statistical analyses involving multiple regressions between yield and an environmental index. Two methods of analyses were used, the Finlay and Wilkinson method (1963) which is a linear regression model based on regression of the treatment performance on an index of the test environment, and the cluster analysis (Williams and Gillard, 1971) which summarizes the data in terms of the relationships (dissimilarities) between patterns of genotypic response to the environment.

To identify factors contributing to the environmental index (site mean yield), a multivariate regression analysis was done with seasonal rainfall (May to October), rainfall distribution in winter (June + July, and August + September) and soil pH.
Interstate pea crossbred trial

Crossbred pea lines coming out of the Australian breeding programmes as fourth generation or later selections are supplied to co-operative research personnel in small quantities. A season of seed multiplication is necessary before this material can be included in the widespread field evaluation trials. During the seed multiplication stage, a single trial is established to provide a preliminary description of their growth and yield in Western Australia. Two trials in two years (Table 1) were established, with flowering date, lodging, pod shatter and yield evaluated. The plot size in 1986 was 8 row x 6 metres and in 1987, 4 rows x 8 metres. Similar agronomy was applied to these trials as in the pea variety trial programme.

Faba bean screening

In 1984 a faba bean international screening nursery from the International Centre for Agricultural Research in the Dry Areas (ICARDA) was introduced. By 1986, the seed had come through quarantine and multiplied to a level of supply for field testing. Two sites providing a contrast in growing season rainfall were sown each year (Table 1).

The management of the sites was based on the pre-planting application of simazine for weed control and various chemicals for the control of insect pests. The seeds were inoculated and lime pelleted to improved plant nodulation (Walton 1986) with trace element fertilizer applied with the seed. Superphosphate:potash mix fertilizer was topdressed at seeding. In 1986, the plot size was 8 rows x 6 metres and in 1987 the size was 4 rows x 6 metres in length. The number of seedlings emerged was counted six weeks after planting. The plots were harvested when the last plot had dried off, with a machine having a 1.25 metre width cut.

The treatment yields were analysed for the level of statistically significant yield difference.

4. RESULTS

Grain legume species comparisons

The harvested seed yields, seedling establishment density, some flowering dates and details of the site and the management are given in Appendix 10.1. At each site, the field pea significantly outyielded the chickpea, lentil, faba bean and narbonne bean. The lupin generally remained significantly similar in yield to the pea in 1986, however the 1987 season and sites gave lupin yields significantly lower than the pea.

Expressing the yields as a percentage of field pea and comparing the highest yielding line within each crop species (Table 2), illustrates the superior yield of pea on the soil types chosen. In 1987 the flowering dates were recorded at two sites. Compared to the pea accessions (Table 3), the Fiord faba bean commenced flowering two weeks earlier, the other crop species flowered from 7 days to 25 days after the pea. The chickpea and lentil accessions were the last to start flowering, which would contribute to their lower seed yields.

The seed yield of the highest yielding cultivar or accession within each crop species produced a good linear relationship with the combined September and October rainfalls at each site in 1987 (Table 4). The coefficients of determination ($R^2$) for the linear regressions ranged from 0.80 to 0.92.
except for the lentil accession 5728 which gave an $R^2$ of 0.67. The regression coefficient ranges from 0.02 to 0.10 and indicates the order of the yield response to the change in rainfall. Thus the lupin and pea yields respond the most to increasing September and October rainfall, while the lentil yield gave the least response and could be said to be relatively unresponsive to rainfall.

Agronomic trials

Seeding rate

The seed yield responses to plant density for four legume crop species sown at Avondale Research Station are given in Appendix 10.2.1. The pea cultivar Dundale, Tyson chickpea and Laird lentil did not give a statistically significant yield response to the increasing density. However, the trend follows a yield response to about 50 plants/m$^2$. The chickpea cultivar Amethyst gave a significant yield response to 35 plants/m$^2$ while Fiord faba bean's response was to 51 plants/m$^2$.

Placing a value on the seed sown and on the grain harvested and calculating the net return for each seeding rate (Table 5) showed an optimum economic rate of 95 kg seed/ha for the pea, 95 kg/ha for Tyson and 102 kg/ha for Amethyst chickpea, 34 kg/ha for Laird lentil and 256 kg seed/ha for Fiord faba bean. These seeding rates correspond to plant densities of from 40 (lentil) to 60 (Tyson) per m$^2$.

Time of planting

The plant densities and seed yields corresponding to the dates of planting for four legume crop species sown at Avondale Research Station are presented in Appendix 10.2.2. All crop treatments gave the highest yield with the earliest time of planting of May 20 (significant at $P < 0.05$). The plant densities increased with the last two plantings in June, presumably because of better soil moisture conditions for germination.

In all crops except Amethyst chickpea, the last planting date produced the highest seed yield loss. The rate of yield loss for that 8 day delay in planting ranged from 20.5 kg/ha/day for lentil to 88.6 kg/ha/day for pea (Table 6). For the 28 day period between May 20 and June 17, the rate of yield loss varied from 9.4 kg/ha/day in lentil to 30.8 kg/ha/day in Amethyst chickpea.

Yield response to disease in faba bean

At Manjimup in 1987, up to 6.6% of the leaf area selected was affected by Chocolate Spot disease (corresponding to a log transformed disease score of 0.82 in the results presented in Appendix 10.2.3.). This level of disease found on Fiord produced a significant (at $P < 0.05$) yield decline. A linear regression of seed yield on the disease score found on Fiord and Servilliana Local faba bean cultivars accounted for 83% of the variation in yield (figure 1). For these two faba bean cultivars there is a significant loss of yield as the level of disease increased. Significantly higher yielding accessions than Fiord were found in the treatment without disease control. The accessions HB-B-3 and HB-R-2 outyielded Fiord irrespective of the level of disease score for those lines.
Field pea variety evaluation

The seed yield results for each pea variety trial site, together with the statistically significant (at 5% level) yield difference, are given in Appendix 10.3.1.

A multiple regression analyses based on the Finlay and Wilkinson (1963) method was carried out on the seed yields for the 44 pea lines that are common in both the 1986 and 1987 treatments. The analysis showed a significant (P < 0.001) genotype x environment interaction which reveals that a variation exists between pea lines in their yield response to the sites. The sites are represented by the index of the average yield across all pea treatments at each site. For each of the pea lines a linear regression relating its yield to the environmental (site) index is calculated. The coefficient of determination (R²) for the 44 regressions varied between 0.58 and 0.98. The results can best be visualized by graphing the regression coefficient against the mean seed yield of each pea line across all 11 sites (the East Broomehill site was not included), (Figure 2). The horizontal line (A) corresponds to the average regression co-efficient (slope of the yield response) for all peas. The vertical line (B) corresponds to the average yield over all peas. Each of the 44 pea lines are represented on the graph by a number. Those peas to the right-hand side of line B have above-average seed yield with either a high response (slope) to changing environments (e.g. pea line number 27 = cultivar Wirrega) or a below average response (stable yields across sites) to changing environments (e.g. pea line number 26 = cultivar Derrimit). Only those pea accessions with above-average yield were chosen for further testing in 1988.

A multivariate cluster analysis was carried out on the same set of yield data for the 44 pea accessions in order to identify those lines having similar yield response to the environmental index.

Peas with similar patterns of yield response to environment are grouped together. The dendrogram in Figure 3 identifies the 10 groups of pea accessions which make up the total of 44 lines. The major difference in the pattern of yield response occurs between nodes B and C, as indicated by the scale of the increment within-group sum of squares. The mean yields are relatively important in determining the discontinuities at node C, as the range of yields in groups I and IV was lower than that existing for groups under nodes B and D.

The different patterns of yield response to environment for the 10 groups are depicted graphically in Figure 4. The groups IX and X show a steady response with the mean yield above the site mean yield. Group VIII (which consists only of cultivar Wirrega) shows a more erratic response with much higher than average yield at the higher yielding sites. Groups V, VI and VII show yields similar to the environmental yield, but more erratic. Group IV has a yield response lower than the site mean yield, except for the response at the highest environmental yield. Groups I, II and III show lower than average yields at each site.

In the same way as the pea accessions were grouped, the site mean yields were grouped according to similarities in pattern of response to the pea accessions within each site. Figure 5 shows the dendrogram that creates 5 groups out of the 11 sites. The average yield of the groups seem to be the main differences between them. Merredin and Chapman Valley provided different yield responses in different years. There does not appear to be much duplication of yield responses in the selection of sites, except in 1987, where many sites elicited the same pattern of yield response (Group 2).
Correlations between the site mean yields for eleven pea trial sites in 1986 and 1987 and the rainfall parameters and soil pH were very low (Table 7). Fitting the spring (August + September) rainfall and soil pH parameters into a linear regression with site mean yields accounted for only 9.9% of the variance. Within the eleven sites, there is a linear yield response ($R^2 = 0.63$) between sites having the lowest winter (June + July) rainfall and those with up to 123 mm winter rainfall. Sites with higher winter rainfall gave lower yields (Figure 6).

**Interstate pea crossbred trials**

The seed yields and descriptions of crop growth of the introduced pea crossbreds in the Interstate Pea Crossbred trials are given in Appendix 10.3.2. The yields and growth (e.g. flower date, lodging and pod shatter) are compared with current pea cultivars to decide on the most likely region of adaptation and suitability for production. Some of the crossbreds sent by the Victorian breeding programme exhibit considerable pod shatter. The worst of these lines are not chosen for further testing.

**Faba bean screening**

The seed yields for each trial is given in Appendix 10.4. The line HB35 gave the highest yield at both Manjimup sites. In 1986, its yield was significantly ($P < 0.05$) higher than that of the cultivar Fiord. The northern European lines (e.g. Danas, Kristall, Deiniol) were all inferior yielding to Fiord. Several of the Middle Eastern and Mediterranean lines introduced with the ICARDA material have proven to yield consistently higher than Fiord.

5. **DISCUSSION**

**Grain legume species comparisons**

The Farm Management Branch of the Western Australian Department of Agriculture have calculated that the "break event" field pea yield with an expected pea price of $220/t is 0.77 t/ha (Barton 1988). These figures give a gross return of $170/ha. If producers seek a minimum profit of $30/ha, the Gross Return rises to $200/ha, which at the pea price requires an 'economic' yield of 0.90 t/ha. The other legume crops (except lupin) had the 'economic' yields calculated on the basis of achieving the same Gross Return of $200/ha (Table 8).

The linear relationships given in Table 4 between seed yield and the September + October rainfall, were used to calculate the rainfall required to produce an 'economic' yield for each of the species.

The meteorological tables of climatic averages (Director of Meteorology 1968) were used to draw in the isolines for the first quartile value for 12 mm, 23 mm, 34 mm and 43 mm totals for the September plus October rainfall. Figure 7 represents the postulate that with the cultivars/accessions, soil types and conditions similar to those at the 1987 trial sites, field pea produces an 'economic' yield with a September and October rainfall of 12 mm (e.g. eastern wheatbelt), the chickpea and lentil with 23 mm rainfall (e.g. central wheatbelt) and faba bean requires 34 mm rainfall, (e.g. western wheatbelt). The narrow-leafed lupin on the heavier and shallow soil types requires 28 mm September + October rainfall, limiting it to the western wheatbelt.
Finding better adapted, higher yielding genotypes within each legume species raises the profit with no extra costs to production. In all of these crops, improved plant type with better pod set on the early flowering nodes would improve seed yield under the wheatbelt conditions. In field pea, setting two pods per node or more seed per pod is one objective. The chickpea yield suffers from having no pod set on the first flowering nodes. Depending on climatic conditions, the first six or seven flowering nodes set no pods. A mean temperature of less than 15°C has been found to be detrimental to the flowers (Saxena and Singh, 1987). The chickpea requires slightly earlier flowering together with the ability to fertilize these earlier formed flowers under cool temperatures. The lentil has problems with lodging, height of pods above the ground and pod losses at maturity. The lentil lines introduced are of late maturity, taking in excess of 100 days to flower. The lentil needs much earlier flowering to improve its yield potential, along with taller plant height to facilitate more efficient harvesting. The faba bean species suffers nodulation deficiency which is only partially overcome with the use of lime pelleted seed or the addition of lime to the soil (Walton, 1986). Lack of vigour through sub-optimal plant nutrition as a result of nodulation failure in faba bean contributes to the high susceptibility to fungal diseases such as Chocolate spot (Botrytis spp.) and Ascochyta leaf blight. The faba bean requires better nodulation to improve the plants ability to tolerate disease and better pod set through higher autofertility or honey-bee activity.

The significant relationship between yield and Chocolate Spot disease shown in Figure 1 illustrates the importance of either finding faba bean lines resistant to the disease or, as in the South Australian industry, controlling the disease with the application of fungicides. The yield potential of the faba bean in Western Australia requires a substantial increase in order to warrant the cost of multiple sprays to control disease. Part of the increase in yield potential could come from replacing the existing commercial rhizobium with an improved strain (J. Howieson, pers. comm.) and part from selecting higher yielding lines.

The seed yield of the pulse species has also been limited by susceptibility to insects, especially Heliobasis spp. The pod walls remain green and soft for a considerable length of time, allowing the Heliobasis larva easy access into the pod. The chickpea and lentil species are especially vulnerable because they mature much later than other legume crops. In chickpea, volatile plant chemicals may play an important role in resistance/susceptibility by acting as attractants (ICRISAT, 1988).

The 1987 time of planting trial illustrates the susceptibility of the grain legume crops to rapid onset of moisture stress in the short growing conditions of the Western Australia wheatbelt.

The decline in seed yield with delay in planting highlights the need for early flowering of these crops to maintain yield potential. The seeding rate trial demonstrated the yield response to plant densities in the vicinity of 50 plants/m².

Pea variety evaluation

Over the two seasons, 1986 and 1987, the new pea cultivar Wirrega consistently outperformed all other accessions and varieties. Both analyses showed Wirrega to have above average yield with its yield showing the largest response to the increase in the environmental index (Figures 2 and 4).
Grouping the pea lines according to their differences in yield response patterns (Figure 3) can allow us to see if the pea crosses bred within each group share a common breeding or collection origin. Of the 10 groups, those with the highest mean yields (Groups VIII to X) consist of South Australian crossbred lines. The lines within group X come from the breeding crosses to produce high yielding crossbreds. In Group IX, the lines are from the Ascochyta resistance breeding programme, with the addition of the Dundale cultivar. The lowest yielding groups, II and III, contain three of the four New Zealand lines tested. The Victorian bred lines tend to have a response pattern about average or slightly below average.

The eleven sites were selected into five groups on the basis of similar pea responses (Figure 5). The 1986 season seems to have provided a greater diversity of yield patterns between sites than 1987. The 1986 season had higher rainfall and better distribution in spring (September and October). For maximum variation of yield responses, it appears that trials are best done over a number of seasons rather than over many sites within one season, such as the 1987 season.

If it is possible to realistically model the yield response of each legume crop to the climate and environmental factors so as to predict their yields at any location, it will be necessary to define the site components which influence the yield response. Sites within a group may have a different level of rainfall, yet still give similar average yield responses. For example group I includes Esperance which in 1986 gave transient waterlogging with seasonal rainfall of 411 mm and Merredin in 1987 which had 184 mm rainfall. The lack of correlation in the multivariate regression between the site mean yield and the seasonal rainfall, rainfall distribution and soil pH provides no predictive model as yet. The good linear response by yield to winter rainfall, up to the level of 123 mm rainfall in June + July, in addition to the relationship found with the grain legume species, suggests that rainfall has a major contribution to the yield model. The decline in yields at sites receiving more than 123 mm (which corresponds to about 250 mm seasonal rainfall) is thought to result from transient waterlogging giving rise to crop emergence and growth problems and higher levels of disease. It is proposed to continue to model for yield by including these factors such as disease and soil parameters.

**Faba bean screening**

Under the experimental conditions imposed on the screening trials, lines of faba bean having yields higher than the commercial cultivar Fiord were identified. Possibly the most important accessions were those that gave significantly higher seed yields under conditions of Chocolate Spot disease in the 1987 Manjumup disease nursery trial. The lines HB-B-3 and HB-R-2 are accessions from ICARDA that were introduced as having recognized resistance to Botrytis spp. (Chocolate spot) and Rust (Uromyces spp.) respectively. As mentioned previously, improvement in nodulation within the faba bean crop should increase the tolerance to disease and improve yield.
Table 2. The seed yield of the highest yielding accession within each crop species expressed as a percentage of the field pea yield over all sites in 1986 and 1987

<table>
<thead>
<tr>
<th></th>
<th>1986 (6 sites)</th>
<th>1987 (7 sites)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Field pea</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Narrow-leafed lupin</td>
<td>65*</td>
<td>60</td>
</tr>
<tr>
<td>Chickpea</td>
<td>25*</td>
<td>47</td>
</tr>
<tr>
<td>Lentil</td>
<td></td>
<td>31</td>
</tr>
<tr>
<td>Faba bean</td>
<td></td>
<td>45</td>
</tr>
<tr>
<td>Narbonne bean</td>
<td></td>
<td>35</td>
</tr>
<tr>
<td>Average yield (pea) kg/ha</td>
<td>1,716</td>
<td>4,208</td>
</tr>
</tbody>
</table>

* Heliophis spp. damage.

Table 3. The number of days to flower, relative to the earliest pea variety at two sites in 1987

<table>
<thead>
<tr>
<th></th>
<th>Avondale</th>
<th>Salmon Gums</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pea cv Dundale</td>
<td>:</td>
<td>0 (79d)</td>
</tr>
<tr>
<td>Danja lupin</td>
<td>:</td>
<td>0 (90d)</td>
</tr>
<tr>
<td>Tyson chickpea</td>
<td>:</td>
<td>+ 10</td>
</tr>
<tr>
<td>Amethyst chickpea</td>
<td>:</td>
<td>+ 16</td>
</tr>
<tr>
<td>Laird lentil</td>
<td>:</td>
<td>+ 14</td>
</tr>
<tr>
<td>Lentil accession 5728</td>
<td>:</td>
<td>+ 29</td>
</tr>
<tr>
<td>Fiord faba bean</td>
<td>:</td>
<td>+ 14</td>
</tr>
<tr>
<td>Narbonne bean accession 14115</td>
<td>:</td>
<td>+ 10</td>
</tr>
</tbody>
</table>

Table 4. The linear relationships for seed yield (t/ha) of each crop as determined by the combined September and October rainfalls (mm) at each site in 1987. The coefficient of determination (R²) indicates the amount of variation in the yield accounted for by the rainfall variable

<table>
<thead>
<tr>
<th>Crop species</th>
<th>Linear equation</th>
<th>R²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Field pea</td>
<td>( Y = 0.54 + 0.09 (S + 0) )</td>
<td>0.80</td>
</tr>
<tr>
<td>Narrow-leafed lupin</td>
<td>( Y = -1.44 + 0.10 (S + 0) )</td>
<td>0.82</td>
</tr>
<tr>
<td>Chickpea</td>
<td>( Y = -0.77 + 0.07 (S + 0) )</td>
<td>0.87</td>
</tr>
<tr>
<td>Lentil</td>
<td>( Y = 0.28 + 0.02 (S + 0) )</td>
<td>0.67</td>
</tr>
<tr>
<td>Faba bean</td>
<td>( Y = -1.24 + 0.08 (S + 0) )</td>
<td>0.83</td>
</tr>
<tr>
<td>Narbonne bean</td>
<td>( Y = -0.94 + 0.06 (S + 0) )</td>
<td>0.92</td>
</tr>
</tbody>
</table>
Table 5. The net return (gross return - seed cost) ($/ha) for the yield response, to seed rate (kg/ha) for each legume crop

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>47 514.18</td>
<td>23 240.70</td>
<td>34 186.60</td>
<td>17 167.35</td>
<td>86 147.57</td>
</tr>
<tr>
<td>95 566.80</td>
<td>47 251.80</td>
<td>69 367.10</td>
<td>34 211.70</td>
<td>172 145.20</td>
</tr>
<tr>
<td>141 554.07</td>
<td>70 327.00</td>
<td>102 383.55</td>
<td>51 201.55</td>
<td>256 358.77</td>
</tr>
<tr>
<td>190 466.22</td>
<td>95 370.00</td>
<td>138 358.95</td>
<td>69 156.45</td>
<td>344 281.79</td>
</tr>
<tr>
<td>235 393.62</td>
<td>117 341.60</td>
<td>171 373.90</td>
<td>85 112.75</td>
<td>428 110.23</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Seed cost</th>
<th>Price of grain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pea 40¢/kg</td>
<td>$210/t</td>
</tr>
<tr>
<td>Chickpea 35¢/kg</td>
<td>$250/t</td>
</tr>
<tr>
<td>Lentil 45¢/kg</td>
<td>$500/t</td>
</tr>
<tr>
<td>Faba bean 45¢/kg</td>
<td>$210/t</td>
</tr>
</tbody>
</table>

S.R. = Seed rate (kg/ha)  N.R. = Net return ($/ha)

Table 6. The calculated rate of seed yield loss (kg seed/ha/day) between planting on May 20 and June 17 and between June 17 and June 25, for the legume crop treatments at Avondale 1987

<table>
<thead>
<tr>
<th>Crop</th>
<th>May 20 - June 17</th>
<th>June 17 - June 25</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dundale pea</td>
<td>26.1</td>
<td>88.6</td>
</tr>
<tr>
<td>Tyson chickpea</td>
<td>10.9</td>
<td>47.0</td>
</tr>
<tr>
<td>Amethyst chickpea</td>
<td>30.8</td>
<td>28.5</td>
</tr>
<tr>
<td>Laird lentil</td>
<td>9.4</td>
<td>20.5</td>
</tr>
<tr>
<td>Fiord faba bean</td>
<td>11.5</td>
<td>26.1</td>
</tr>
</tbody>
</table>

Table 7. Correlation matrix for the mean seed yields of eleven field pea variety trial sites, 1986 and 1987

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Site mean yield (SMY)</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Seasonal (May - October) RF</td>
<td>0.028</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Winter (June + July) RF</td>
<td>0.126</td>
<td>0.803</td>
<td>1.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Spring (August + September) RF</td>
<td>-0.330</td>
<td>0.587</td>
<td>0.289</td>
<td>1.000</td>
<td></td>
</tr>
<tr>
<td>5. Soil pH (surface)</td>
<td>-0.234</td>
<td>-0.420</td>
<td>-0.262</td>
<td>-0.424</td>
<td>1.000</td>
</tr>
</tbody>
</table>

-13-
Table 8. The September + October rainfall necessary to produce an 'economic' yield in each of the legume crop species

<table>
<thead>
<tr>
<th>Crop</th>
<th>'Economic' yield (t/ha)</th>
<th>Experimental yield (t/ha)</th>
<th>September + October R.F. (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Field pea</td>
<td>0.90</td>
<td>1.50</td>
<td>11</td>
</tr>
<tr>
<td>Narrow-leafed lupin</td>
<td>0.80</td>
<td>1.33</td>
<td>28</td>
</tr>
<tr>
<td>Chickpea (desi-type)</td>
<td>0.50</td>
<td>0.83</td>
<td>23</td>
</tr>
<tr>
<td>Lentil (red type)</td>
<td>0.40</td>
<td>0.70</td>
<td>21</td>
</tr>
<tr>
<td>Faba bean</td>
<td>0.90</td>
<td>1.50</td>
<td>34</td>
</tr>
<tr>
<td>Narbonne bean</td>
<td>1.00</td>
<td>1.67</td>
<td>43</td>
</tr>
</tbody>
</table>

(1) Calculated on the assumption that the producer has a Gross Return of $200/ha.

The price received for pea = $220/t
   chickpea = $240/t for 40% and $500/t for 60% of yield
   lentil = $500/t
   faba bean = $200/t and
   narbonne bean = $200/t

The Gross Return for lupin is taken at $144/ha with a price of $180/t.

(2) The experimental yields are taken as 167% of the paddock yields because of uniform site and edge effects with small plot.

6. ACKNOWLEDGEMENTS

This project would not have obtained as much information without the assistance of its main technical officer Mr Tim Trent and his assistants Mr Wayne Pluske (1986) and Mr Andrew Gannon (1987). The linear regressions and multivariate analysis techniques were carried out by the Biometrics Section, Western Australian Department of Agriculture.

7. REFERENCES


8. LIST OF PUBLICATIONS AND SUMMARY OF EXTENSION ACTIVITIES

Walton, G.H. (1986). Producing pulse crops in Western Australia. Western Australian Department of Agriculture Farmnote 52/86.

Walton, G.H. (1986). Growing field peas in Western Australia. Western Australian Department of Agriculture Farmnote 28/86.


----------- (1986). Desirable field pea phenotypes for the Western Australian environment. Poster session, ------------------------.

----------- (1986). Nodulation failure in faba bean (Vicia faba) sown in acid soils. poster session, ------------------------.


Field days

Salmon Gums Research Station, October 7, 1987
Merredin Research Station, October 14, 1987
Goomalling Farm Improvement Group, September 3, 1987

Seminars and Workshops

Primary Industries Association Seminar, "To pea or not to pea", Muresk Institute of Agriculture, March 1987.

Western Australian Department of Agriculture "Cropping Alternatives" Seminar, Boyup Brook, April 1987.

Plan farm seminar, Wongan Hills, September 1986.


Narrogin District Regional Research Committee Meeting, "Research into Alternative Crops", Narrogin, October 1987.

Western Australian Department of Agriculture, Strategies and tactics for the wheatbelt crisis, Perth, November 1987.
9. **FINANCIAL SUMMARIES**

Actual costs to the G.L.R.C. over the duration of the project, July 1986 to June 1988.

<table>
<thead>
<tr>
<th></th>
<th>1986/87</th>
<th>1987/88</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salaries</td>
<td>12,330</td>
<td>14,007</td>
</tr>
<tr>
<td>Travel</td>
<td>4,000</td>
<td>3,000</td>
</tr>
<tr>
<td>Operating</td>
<td>1,400</td>
<td>5,600</td>
</tr>
<tr>
<td>Capital</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>16,730</td>
<td>22,607</td>
</tr>
</tbody>
</table>
Figure 1. The linear relationship between seed yield of faba bean and Chocolate Spot disease score (logarithm transformed % leaf area diseased).

\[ Y = 2146 - 1733.6 \times X \]

\[ R^2 = 0.83 \]
Figure 2. Graphic representation of the slope of the linear yield response (Finlay and Wilkinson) to the 11 environments and the mean yield for each of the 44 pea accessions evaluated in 1986 and 1987.
<table>
<thead>
<tr>
<th>Group</th>
<th>Field pea accession</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Collegian, P-31, P-sL-11, P-SL-52, P-SL-55</td>
</tr>
<tr>
<td>II</td>
<td>Huks, P-SL-59</td>
</tr>
<tr>
<td>III</td>
<td>P-SL-41, P-SL-47</td>
</tr>
<tr>
<td>IV</td>
<td>P-15, P-18, P-50, P-55, P-57</td>
</tr>
<tr>
<td>V</td>
<td>P-29, P-59, P-SL-25</td>
</tr>
<tr>
<td>VI</td>
<td>Derrinut, Maitland, P-41, P-SL-28</td>
</tr>
<tr>
<td>VII</td>
<td>Pennant, P-30, P-45, P-SL-10, P-SL-54</td>
</tr>
<tr>
<td>VIII</td>
<td>Wirrega</td>
</tr>
<tr>
<td>IX</td>
<td>Alma, Dundale, P-A-5, P-A-14</td>
</tr>
</tbody>
</table>

Figure 3. Seed yield dendrogram for the classification of 44 pea accessions over 11 sites.
Figure 4. The patterns of mean yield response to 11 environments for the 10 groups of pea accessions, 1986 and 1987.
<table>
<thead>
<tr>
<th>Group</th>
<th>Site location</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1986, Esperance; 1987, Merredin</td>
</tr>
<tr>
<td>2</td>
<td>1987, Meckering, Nugadong, Salmon Gums, Chapman Valley; 1986, Nyabing</td>
</tr>
<tr>
<td>3</td>
<td>1986, Chapman Valley, Newdegate</td>
</tr>
<tr>
<td>4</td>
<td>1986, Merredin</td>
</tr>
<tr>
<td>5</td>
<td>1986, Goonalling</td>
</tr>
</tbody>
</table>

**Figure 5.** Seed yield dendrogram for the classification of 11 sites across 44 pea accessions.
Figure 6. Site mean yield response to winter (June + July) rainfall. A linear response up to 123 mm ($R^2 = 0.63$), over all sites $R^2 = 0.14$.

$$\text{SMY} = -2007.7 + 39.12 \ (J + Jy)$$

Site mean yield (kg/ha)

June + July rainfall, mm.
Figure 7. The isolines having \( \geq 75\% \) probability of receiving the September+October rainfall indicated. These isolines mark the limits to the 'economic' yield of various grain legume crops as calculated from the linear relationships between yield and rainfall, (see text).

\[
\begin{align*}
\text{Field pea} &= 12 \text{ mm} \\
\text{Narrow-leaf lupin} &\quad \text{cv. Danja} = 28 \text{ mm} \\
\text{Chickpea cv. Dooen} &= 23 \text{ mm} \\
\text{Lentil acc.} &\quad \text{ILL5728} = 21 \text{ mm} \\
\text{Faba bean cv.} &\quad \text{Fiord} = 34 \text{ mm} \\
\text{Narbonne bean acc.} &\quad \text{14115} = 43 \text{ mm}
\end{align*}
\]
10. APPENDICES

10.1. Legume species comparisons, 1986

<table>
<thead>
<tr>
<th>Accession/variety</th>
<th>Plant density (per m²)</th>
<th>Seed yield (kg/ha)</th>
<th>Relative yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>Derrimut pea</td>
<td>54</td>
<td>1,926 AB</td>
<td></td>
</tr>
<tr>
<td>75A259 lupin</td>
<td>35</td>
<td>2,480 A</td>
<td></td>
</tr>
<tr>
<td>Tyson chickpea</td>
<td>40</td>
<td>585 C</td>
<td>100</td>
</tr>
<tr>
<td>C-58 chickpea</td>
<td>5</td>
<td>236 C</td>
<td>40</td>
</tr>
<tr>
<td>C-59 chickpea</td>
<td>38</td>
<td>595 C</td>
<td>102</td>
</tr>
<tr>
<td>Amethyst (C-60) chickpea</td>
<td>49</td>
<td>713 C</td>
<td>122</td>
</tr>
<tr>
<td>56288 (ex Wagga) chickpea</td>
<td>19</td>
<td>671 C</td>
<td>115</td>
</tr>
</tbody>
</table>

See yield LSD (P < 5%) = 636 kg/ha.
Soil type: Red silty loam.  
Crops: Derrimut, inoculated with Group E, 120 kg/ha. Lupin inoculated with Group G, 90 kg/ha. Chickpeas inoculated with Cicer group, 120 kg/ha.  
Seeding date: 21/5/86.  
Basal: Superphosphate 70 kg/ha.  
Herbicide: Diuron 1.5 L/ha, 21/5/86.  
Insecticide:  
Fungicide:  
Plot size: 8 rows (18 cm) x 10 metres, 3 replications.  
Rainfall: May – August = 430 mm, September and October = 32 mm.  

<table>
<thead>
<tr>
<th>Accession/variety</th>
<th>Plant density (per m²)</th>
<th>Seed yield (kg/ha)</th>
<th>Relative yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>Derrimut pea</td>
<td>58</td>
<td>618</td>
<td>100</td>
</tr>
<tr>
<td>Alma pea</td>
<td>50</td>
<td>384</td>
<td>62</td>
</tr>
<tr>
<td>P-23 pea</td>
<td>47</td>
<td>936</td>
<td>151</td>
</tr>
<tr>
<td>P-25 pea</td>
<td>44</td>
<td>1,150</td>
<td>186</td>
</tr>
<tr>
<td>P-26 pea</td>
<td>44</td>
<td>994</td>
<td>161</td>
</tr>
<tr>
<td>P-27 pea</td>
<td>41</td>
<td>637</td>
<td>103</td>
</tr>
<tr>
<td>P-A-14 pea</td>
<td>39</td>
<td>373</td>
<td>60</td>
</tr>
<tr>
<td>P-SL-25 pea</td>
<td>45</td>
<td>459</td>
<td>74</td>
</tr>
<tr>
<td>P-SL-29 pea</td>
<td>35</td>
<td>242</td>
<td>39</td>
</tr>
<tr>
<td>75A259 lupin</td>
<td>43</td>
<td>564</td>
<td>117</td>
</tr>
<tr>
<td>Tyson chickpea</td>
<td>50</td>
<td>564</td>
<td>91</td>
</tr>
<tr>
<td>56288 (ex Wagga) chickpea</td>
<td>19</td>
<td>387</td>
<td>63</td>
</tr>
<tr>
<td>C-58 chickpea</td>
<td>7</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>C-59 chickpea</td>
<td>37</td>
<td>355</td>
<td>57</td>
</tr>
<tr>
<td>Amethyst (C-60) chickpea</td>
<td>51</td>
<td>477</td>
<td>77</td>
</tr>
</tbody>
</table>

See yield LSD (P < 5%) = 340 kg/ha.

Soil type: Red silty loam.  
Crops: Peas inoculated with Group E, 150 kg/ha. Lupin inoculated with Group G, 90 kg/ha. Chickpea inoculated with Cicer group, 120 kg/ha.  
Seeding date: 23/5/86.  
Basal: Superphosphate 50 kg/ha.  
Herbicide: Diuron 2 L/ha, 23/5/86, Diuron 0.5 L/ha, 26/5/86.  
Plot size: 8 rows (18 cm) x 15 metres, 3 replications.  
Rainfall: May – August = 249 mm, September and October = 23 mm.
Diuron toxicity symptoms were evident on all plots in July. The crops made a considerable recovery to produce these yields.

**Number:** 86KA9  
**Location:** Nyabing  
**Officer:** I. Pritchard (Katanning District Office)  
**Co-operator:** Goodchild (Farmer)

<table>
<thead>
<tr>
<th>Accession/variety</th>
<th>Plant density per m²</th>
<th>Flower development (1)</th>
<th>Colour</th>
<th>Crop height (cm)</th>
<th>Seed yield** (kg/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Derrimut pea</td>
<td>51</td>
<td>5</td>
<td>Purple</td>
<td>35</td>
<td>1,042</td>
</tr>
<tr>
<td>75A259 lupin</td>
<td>36</td>
<td>5</td>
<td>White</td>
<td>35-40</td>
<td>474</td>
</tr>
<tr>
<td>Tyson chickpea</td>
<td>39</td>
<td>0</td>
<td></td>
<td>16</td>
<td>22</td>
</tr>
<tr>
<td>C-58 chickpea</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C-59 chickpea</td>
<td>14</td>
<td>1</td>
<td></td>
<td>19</td>
<td>24</td>
</tr>
<tr>
<td>Amethyst (C-60) chickpea</td>
<td>39</td>
<td>1</td>
<td></td>
<td>11</td>
<td>15</td>
</tr>
<tr>
<td>56288 (ex Wagga) chickpea</td>
<td>13</td>
<td>2.5</td>
<td>Magenta</td>
<td>17</td>
<td>*</td>
</tr>
<tr>
<td>NEL 349 lentil</td>
<td>75</td>
<td>2</td>
<td></td>
<td>13</td>
<td>*</td>
</tr>
<tr>
<td>NEL 504 lentil</td>
<td>104</td>
<td>3</td>
<td>Violet</td>
<td>14</td>
<td>*</td>
</tr>
<tr>
<td>NEL 155 lentil</td>
<td>39</td>
<td>2.5</td>
<td>Violet/white</td>
<td>14</td>
<td>*</td>
</tr>
<tr>
<td>NEL 497 lentil</td>
<td>94</td>
<td>1</td>
<td>Violet</td>
<td>11</td>
<td>*</td>
</tr>
<tr>
<td>NEL 544 lentil</td>
<td>64</td>
<td>0</td>
<td>Violet</td>
<td>10</td>
<td>*</td>
</tr>
<tr>
<td>NEL 623B lentil</td>
<td>134</td>
<td>0</td>
<td>Violet</td>
<td>11</td>
<td>*</td>
</tr>
<tr>
<td>SA 12102 lentil</td>
<td>78</td>
<td>3</td>
<td>Violet</td>
<td>10</td>
<td>*</td>
</tr>
<tr>
<td>SA 14697 lentil</td>
<td>96</td>
<td>4</td>
<td>Violet</td>
<td>11</td>
<td>*</td>
</tr>
</tbody>
</table>

* Crop too low and insufficient pods for harvest.  
** Derrimut and lupin machine harvested, chickpea plots hand harvested.  
(1) Flower development 0 = Not flowering  
  1 = First bud present  
  2 = First flowers open  
  3 = First flowers senescing  
  4 = Young pods  
  5 = Pods developed

**Soil type:** Grey clay 0-10 cm, pH (water) = 5.8-6.5  
Brown clay 10-50 cm, pH (water) = 6.0-6.3  
Orange mottled clay 40 cm.

**History:** Pasture preceding barley 1984 and pasture 1985.

**Crops:** Derrimut pea inoculated with Group E, 120 kg/ha. Lupin inoculated with Group G, 90 kg/ha. Chickpeas inoculated with Cicer Group, 100 kg/ha. Lentils inoculated with Group E, 70 kg/ha.

**Seeding date:** 11/6/86.

**Basal:** Superphosphate Cu, Zn, Mo, No.1, 150 kg/ha.

**Herbicide:** Treflan 2 L/ha + Diuron 1 L/ha, 11/6/86. Fusilade 212 0.5 L/ha, post emergence.

**Plot size:** 8 rows (18 cm) x 10 metres, 3 replications.

**Rainfall:** May - August = 179 mm, September and October = 36 mm.
The lentils showed *Ascochyta* sclerotia on leaf and severe root rot problems leading to heavy plant mortality. The dry season restricted plant growth and podding. By December 2, the lentils were 12-15 cm tall with the pods only 8 cm above the ground surface. The chickpea pods were 12 cm above the surface.

<table>
<thead>
<tr>
<th>Variety/accession</th>
<th>Plant density per m²</th>
<th>Seed yield (kg/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Derrimut pea</td>
<td>74</td>
<td>2,179</td>
</tr>
<tr>
<td>Alma pea</td>
<td>58</td>
<td>1,978</td>
</tr>
<tr>
<td>P-23 pea</td>
<td>54</td>
<td>2,087</td>
</tr>
<tr>
<td>P-25 pea</td>
<td>53</td>
<td>1,946</td>
</tr>
<tr>
<td>P-26 pea</td>
<td>56</td>
<td>2,211</td>
</tr>
<tr>
<td>P-27 pea</td>
<td>42</td>
<td>1,670</td>
</tr>
<tr>
<td>P-A-14 pea</td>
<td>44</td>
<td>1,913</td>
</tr>
<tr>
<td>P-SL-25 pea</td>
<td>84</td>
<td>2,153</td>
</tr>
<tr>
<td>P-SL-28 pea</td>
<td>42</td>
<td>1,520</td>
</tr>
<tr>
<td>P-SL-29 pea</td>
<td>38</td>
<td>568</td>
</tr>
<tr>
<td>75A259 lupin</td>
<td>39</td>
<td>476</td>
</tr>
<tr>
<td>Tyson chickpea</td>
<td>69</td>
<td>322</td>
</tr>
<tr>
<td>56288 (ex Wagga) chickpea</td>
<td>22</td>
<td>*</td>
</tr>
<tr>
<td>C-58 chickpea</td>
<td>2</td>
<td>*</td>
</tr>
<tr>
<td>C-59 chickpea</td>
<td>51</td>
<td>*</td>
</tr>
<tr>
<td>Amethyst (C-60) chickpea</td>
<td>69</td>
<td>*</td>
</tr>
<tr>
<td>NEL 349 lentil</td>
<td>78</td>
<td>*</td>
</tr>
<tr>
<td>NEL 504 lentil</td>
<td>109</td>
<td>*</td>
</tr>
<tr>
<td>NEL 155 lentil</td>
<td>60</td>
<td>*</td>
</tr>
<tr>
<td>NEL 497 lentil</td>
<td>97</td>
<td>*</td>
</tr>
<tr>
<td>NEL 344 lentil</td>
<td>56</td>
<td>*</td>
</tr>
<tr>
<td>NEL 623B lentil</td>
<td>116</td>
<td>*</td>
</tr>
<tr>
<td>SA 12102 lentil</td>
<td>68</td>
<td>*</td>
</tr>
<tr>
<td>SA 14697 lentil</td>
<td>89</td>
<td>*</td>
</tr>
</tbody>
</table>

* Not harvested - no worthwhile seed.

Soil type: Kumari clay, 0-15 cm brown clay loam, 15-60 cm brown clay with calcareous nodules.


Crops: Peas inoculated with Group E, 150 kg/ha. Lupins inoculated with Group G, 90 kg/ha. Chickpeas inoculated with *Cicer* Group, 120 kg/ha. Lentils inoculated with Group E, 70 kg/ha.

Seeding date: 13/6/86.

Basal: Superphosphate 112 kg/ha.

Herbicide: Fusilade 212 0.5 L/ha post emergence.

Plot size: 8 rows (18 cm) x 15 metres, 3 replications and 8 rows x 10 metres for the lentil plots.

Rainfall: May - August = 238 mm, September and October = 45 mm.
All plots except peas severely damaged by *Haliotis* spp. The chickpeas suffered the most damage.

**Number:** 86SG2  
**Location:** Graham Lease block, Salmon Gums Research Station  
**Co-operator:** D. Collins (Manager)

<table>
<thead>
<tr>
<th>Variety/accession</th>
<th>Plant density per m²</th>
<th>Flowering (1)</th>
<th>Crop height (cm)</th>
<th>Seed yield** (kg/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Derrimut pea</td>
<td>69</td>
<td>5</td>
<td></td>
<td>2,020</td>
</tr>
<tr>
<td>Alma pea</td>
<td>70</td>
<td>5</td>
<td></td>
<td>1,869</td>
</tr>
<tr>
<td>P-23 pea</td>
<td>53</td>
<td>4.55</td>
<td></td>
<td>1,472</td>
</tr>
<tr>
<td>P-25 pea</td>
<td>50</td>
<td>6</td>
<td></td>
<td>1,548</td>
</tr>
<tr>
<td>P-26 pea</td>
<td>49</td>
<td>6</td>
<td></td>
<td>1,255</td>
</tr>
<tr>
<td>P-27 pea</td>
<td>40</td>
<td>5.5</td>
<td></td>
<td>1,089</td>
</tr>
<tr>
<td>P-A-14 pea</td>
<td>38</td>
<td>4.5</td>
<td></td>
<td>1,718</td>
</tr>
<tr>
<td>P-SL-25 pea</td>
<td>57</td>
<td>6</td>
<td></td>
<td>1,605</td>
</tr>
<tr>
<td>P-SL-28 pea</td>
<td>41</td>
<td>6</td>
<td>45</td>
<td>1,156</td>
</tr>
<tr>
<td>P-SL-29 pea</td>
<td>34</td>
<td>5.5</td>
<td></td>
<td>274</td>
</tr>
<tr>
<td>75A259 lupin</td>
<td>36</td>
<td>5</td>
<td>30-35</td>
<td>119</td>
</tr>
<tr>
<td>Tyson chickpea</td>
<td>63</td>
<td>3</td>
<td>20-25</td>
<td>58.4</td>
</tr>
<tr>
<td>56288 (ex Wagga) chickpea</td>
<td>19</td>
<td>3</td>
<td>25-30</td>
<td>34.5</td>
</tr>
<tr>
<td>C-58 chickpea</td>
<td>2</td>
<td>4</td>
<td>25-30</td>
<td></td>
</tr>
<tr>
<td>C-59 chickpea</td>
<td>41</td>
<td>3.5</td>
<td>30-35</td>
<td>27.3</td>
</tr>
<tr>
<td>Amethyst (C-60) chickpea</td>
<td>55</td>
<td>3</td>
<td>30</td>
<td>44.3</td>
</tr>
<tr>
<td>NEL 349 lentil</td>
<td>90</td>
<td>3</td>
<td>20</td>
<td>*</td>
</tr>
<tr>
<td>NEL 504 lentil</td>
<td>110</td>
<td>4</td>
<td>25</td>
<td>*</td>
</tr>
<tr>
<td>NEL 155 lentil</td>
<td>58</td>
<td>4</td>
<td>20</td>
<td>*</td>
</tr>
<tr>
<td>NEL 497 lentil</td>
<td>80</td>
<td>2</td>
<td>18-20</td>
<td>*</td>
</tr>
<tr>
<td>NEL 344 lentil</td>
<td>64</td>
<td>3</td>
<td>20</td>
<td>*</td>
</tr>
<tr>
<td>NEL 6238 lentil</td>
<td>121</td>
<td>2</td>
<td>20</td>
<td>*</td>
</tr>
<tr>
<td>SA 12102 lentil</td>
<td>54</td>
<td>4</td>
<td>20</td>
<td>*</td>
</tr>
<tr>
<td>SA 14697 lentil</td>
<td>72</td>
<td>5</td>
<td>20</td>
<td>*</td>
</tr>
</tbody>
</table>

* Too low for mechanical harvest.

(1) Flower development  
0 = Not flowering  
1 = First bud present  
2 = First flowers open  
3 = First flowers senescing  
4 = First young pods  
5 = Pods developed  
6 = Flowering completed

Soil type: Circle Valley sand, grey sand 0-10 cm over sandy clay with calcareous nodules.


Crops: Peas inoculated with Group E, 150 kg/ha. Lupins inoculated with Group G, 90 kg/ha. Chickpeas inoculated with *Cicer* Group, 120 kg/ha. Lentils inoculated with Group E, 70 kg/ha.
Seeding date: 11/6/86.
Basal: Superphosphate 112 kg/ha.
Herbicide: Roundup 2 L/ha, 20/5/86. Hoegrass 0.8 L/ha, 2/7/86 (2 leaf stage).
Plot size: 8 rows (18 cm) x 15 metres, 3 replications and 8 rows x 10 metres for the lentils.
Rainfall: May - August = 238 mm, September and October = 45 mm.

Comments:
The lupin, chickpea and lentil plants suffered from very heavy Heliotris damage. The field peas had earlier maturity and suffered less damage.

Number: 86GE31
Location: West Binnu
Officer: P. Nelson (Geraldton District Office)
Co-operator: Drage (Farmer)

<table>
<thead>
<tr>
<th>Variety/accession</th>
<th>Seed yield (kg/ha)</th>
<th>Seed yield (kg/ha) after allowing for pig damage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Derrimut pea</td>
<td>1,904</td>
<td>1,980</td>
</tr>
<tr>
<td>Dundale pea</td>
<td>1,765</td>
<td>1,765</td>
</tr>
<tr>
<td>Collegian pea</td>
<td>1,894</td>
<td>2,118</td>
</tr>
<tr>
<td>Buckley pea</td>
<td>2,202</td>
<td>2,202</td>
</tr>
<tr>
<td>75A259 lupin</td>
<td>1,765</td>
<td>2,408</td>
</tr>
<tr>
<td>Tyson chickpea</td>
<td>469</td>
<td>622</td>
</tr>
<tr>
<td>56288 (ex Wagga) chickpea</td>
<td>400</td>
<td>796</td>
</tr>
</tbody>
</table>

Soil type: Sandy loam, slightly acidic.
History: Pasture.
Seeding date: 5/6/86.
Basal: Superphosphate 85 kg/ha.
Herbicide: Nil.
Plot size: 8 rows (18 cm) x 40 metres.
Rainfall: May - August = 333 mm, September and October = 23 mm.

Comments:
The chickpeas were heavily damage by Heliotris. Pig damage to 50-80% of some plots.

GRAIN LEGUME SPECIES COMPARISON, 1987

Number: 87A2
Location: Avondale Research Station, paddock 2C
Co-operator: Ken Burchell (Manager)
Soil type: 40 cm red/brown sandy loam over gritty clay loam
History: Lupin 1985, cereal variety trial 1986
Crop: Seeds inoculated and sown at; Peas 160 kg/ha, faba bean 260 kg/ha, Narbon bean 140 kg/ha, Kiev Mutant 200 kg/ha, Danja lupin 90 kg/ha, Chickpeas 110 kg/ha and Lentils 79 kg/ha

Seeding date: 10/6/1987
Basal: 80 kg/ha superphosphate drilled prior to seeding
140 kg/ha 3:2 super potash topdressed after seeding
Herbicide: Diuron at 1.5 L/ha 18/5/1987
Fusilade on 30/6/1987
Insecticide: Lemat 30/6/1987, Lorsban
Fungicide: Benlate at 500 g/ha on 16/7/1987
Plot size: 4 rows (0.7 m) x 10 metres, 3 replicates
Sampling: Plant count 23/7/1987. All plots machine harvested
Rainfall: May–October 261 mm

Number: 87C2
Location: Chapman Valley Research Station, paddock 16B
Co-operator: Mr Bob Murray (Manager)
Soil type: 30 cm yellow/brown loamy sand over ironstone gravel sandy clay. pH (water) 6.10–6.80 at 50 cm depth
History: Wheat 1986
Crop: Seeds inoculated and sown at; Peas 160 kg/ha, faba bean 260 kg/ha, Narbon bean 140 kg/ha, Kiev Mutant 200 kg/ha, Danja lupin 90 kg/ha, Chickpeas 110 kg/ha and Lentils 79 kg/ha
Seeding date: 13/5/1987
Basal: 300 kg/ha 3:2 super and potash topdressed IBS
200 kg/ha superphosphate at seeding
Herbicide: Spraysseed at 2 L and Bladex at 2 L/ha IBS
Insecticide: Endosulfan at 1.0 L/ha
Plot size: 4 rows x 10 metres, 3 replicates
Sampling: Plant count 25/6/1987. All plots except lentils machine harvested
Rainfall: May–October 305 mm

Number: 87KA37
Location: Katanning
Co-operator: Mr Marty Ladyman (Farmer) and Katanning District Office
Soil type: Gravelly sandy loam. pH (H₂O) 6.4–7.3 50 cm depth
History: Wheat 1986
Crop: Seeds inoculated and sown at; Peas 160 kg/ha, faba bean 260 kg/ha, Narbon bean 140 kg/ha, Kiev Mutant 200 kg/ha, Danja lupin 90 kg/ha, Chickpeas 110 kg/ha and Lentils 79 kg/ha
Seeding date: 27/5/1987
Basal: 265 kg/ha 3:2 super and potash topdressed IBS
140 kg/ha superphosphate at seeding
Herbicide: Bladex at 2 L/ha IBS
Insecticide: Roxian at 85 ml/ha 7/7/1987, Decis at 200 ml/ha 16/7/1987 and Endosulfan at 1.0 L/ha 9/9/1987
Fungicide: Benlate at 500 g/ha 20/7/1987 and 8/8/1987
Plot size: 4 rows (0.7 m) x 10 metres, 3 replicates
Sampling: Plant count 8/7/1987. The lentil plots quadrat sampled (1.33 m²) for yield. Rest machine harvested
Rainfall: May-October 212 mm

Number: 87M09
Location: Nugadong
Co-operator: Mr Charles Hyde (Farmer) and Moora District Office
Soil type: 40 cm red/brown clay loam over orange loam. pH (H₂O) 6.4-8.5 50 cm depth
History: Wheat 1986
Crop: Seeds inoculated and sown at; Peas 160 kg/ha, faba bean 260 kg/ha, Narbon bean 140 kg/ha, Kiev Mutant 200 kg/ha, Danja lupin 90 kg/ha, Chickpeas 110 kg/ha and Lentils 79 kg/ha
Seeding date: 14/5/1987
Basal: 200 kg/ha super copper, zinc and molybdenum No. 1 mix topdressed IBS. 200 kg/ha superphosphate at seeding
Herbicide: Bladex at 2 L/ha IBS
Insecticide: Fusilade 212 at 600 ml/ha on 30/6/1987
Fungi: Thiadan at 1.0 L/ha and metasystox at 150 ml/ha on 2/9/1987
Plot size: 4 rows (0.7 m) x 10 metres, 3 replicates
Sampling: Plant count 24/6/1987. Lentil plots quadrant sampled (1.33 m²) for yield. Others machine harvested
Rainfall: May-October 283 mm

Number: 87MA1
Location: Manjimup Horticultural Research Station
Co-operator: Mr Dick Pearce (Manager) and Manjimup District Office
Soil type: Orange/brown loam. pH (H₂O) 6.3 throughout profile
History: Pasture 1985, cereal variety trial 1986
Crop: Seeds inoculated and sown at; Peas 160 kg/ha, faba bean 260 kg/ha, Narbon bean 140 kg/ha, Kiev Mutant 200 kg/ha, Danja lupin 90 kg/ha, Chickpeas 110 kg/ha and Lentils 79 kg/ha
Seeding date: 29/5/1987
Basal: 140 kg/ha 3:2 super and potash IBS
Herbicide: Roundup at 2.0 L/ha prior to seeding
Bladex at 2.0 L/ha IBS
Fungi: Benlate at 300 g/ha 15/8/1987
Plot size: 4 rows (0.7 m) x 10 metres, 3 replicates
Sampling: Plant count 15/7/1987. All plots machine harvested
Rainfall: May-October 499 mm

Number: 87NA15
Location: Quindanning
Co-operator: Lynford Farm and Narrogin District Office
Soil type: Red/brown sandy loam. pH (H₂O) 7.7-7.0 at 50 cm depth
History: Wheat 1986
Crop: Seeds inoculated and sown at; Peas 160 kg/ha, faba bean 260 kg/ha, Narbon bean 140 kg/ha, Kiev Mutant 200 kg/ha, Danja lupin 90 kg/ha, Chickpeas 110 kg/ha and Lentils 79 kg/ha
Seeding date: 26/5/1987
Basal: 206 kg/ha 3:2 super and potash topdressed IBS 206 kg/ha superphosphate at seeding
Herbicide: Bladex at 2.0 L/ha IBS
Insecticide: Endosulfan at 1.0 L/ha
Plot size: 4 rows (0.7 m) x 10 metres, 3 replicates
Sampling: Plant count 7/7/1987. Lentil plots quadrat sampled (1.33 m²) for yield. Other plots machine harvested
Rainfall: May-October 251 mm

Number: 87SG9
Location: Salmon Gums Research Station
Co-operator: Mr Dave Collins (Manager)
Soil type: Red/brown clay loam. pH (H₂O) 7.8-9.3 at 50 cm depth
History: Wheat 1984, pasture 1985, spraytopped 1986
Crop: Seeds inoculated and sown at; Peas 160 kg/ha, faba bean 260 kg/ha, Narbon bean 140 kg/ha, Kiev Mutant 200 kg/ha, Danja lupin 90 kg/ha, Chickpeas 110 kg/ha and Lentils 79 kg/ha
Seeding date: 21/5/1987
Basal: 104 kg/ha superphosphate at seeding
Herbicide: Bladex at 2 L/ha 26/5/1987
Fusilade at 500 ml/ha 4/8/1987
Insecticide: Lorsban at 140 ml/ha 22/6/1987
Cymbush at 200 ml/ha 25/9/1987
Pirimar at 10 g/15 ml on faba bean plot only September 7 and 9
Plot size: 8 rows (1.4 m) x 12 metres, 3 replicates
Sampling: Plant count 9/7/1987. Some lentil plots quadrat sampled (1.33 m²) for yield. Other plots machine harvested
Rainfall: May-October 194 mm
Results: Grain legume species trial

Mean seed yields (kg/ha) for seven sites 1987

<table>
<thead>
<tr>
<th>Treatments</th>
<th>A2</th>
<th>C2</th>
<th>KA37</th>
<th>MA1</th>
<th>MO9</th>
<th>NA15</th>
<th>SG9</th>
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<tbody>
<tr>
<td>Dundale</td>
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<td>2,457</td>
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<tr>
<td>Wirrega</td>
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<td>3,869</td>
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<td>2,578</td>
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<tr>
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<td>1,774</td>
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<td>x</td>
<td>890</td>
<td>808</td>
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Table continued ...

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<tr>
<th>Treatments</th>
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<th>KA37</th>
<th>MA1</th>
<th>MO9</th>
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<td>651</td>
<td>x</td>
<td>633</td>
<td>983</td>
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<td>685</td>
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<td>36.9</td>
<td>17.6</td>
<td>11.7</td>
<td>32.7</td>
<td>24.1</td>
<td>21.8</td>
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</table>

* Low seed germination.
* Not harvested because of heavy seed loss through Heliotthis damage.

Grain legume species trials 1987

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Flowering dates 87A2</th>
<th>Flowering dates 87SG9</th>
<th>Crop ht (cm) 87MO9</th>
<th>Crop ht (cm) 87C2</th>
<th>% Pods damaged by budworm 87C2</th>
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<td>19/8</td>
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<td>5/8</td>
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<td>2/9</td>
<td></td>
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<td>25</td>
</tr>
<tr>
<td>Doen</td>
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<td>4/9</td>
<td></td>
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<td>11/9</td>
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<td>50</td>
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<td>11/9</td>
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<td></td>
<td>90</td>
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<tr>
<td>ILL 5728</td>
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<td>2/9</td>
<td></td>
<td></td>
<td>90</td>
</tr>
<tr>
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<td>90</td>
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<td>31/8</td>
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<td>90</td>
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<td>31/8</td>
<td>20-25</td>
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</tr>
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<td>SA 14697</td>
<td>10/9</td>
<td>26/8</td>
<td>20</td>
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<td>25</td>
</tr>
<tr>
<td>Titore</td>
<td>29/9</td>
<td>-</td>
<td>15-20</td>
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<tr>
<td>Cicer 61</td>
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<td>-</td>
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</table>

* Pods shattering.
### Crop Density

**File:** 3250 EX  
**Title:** Crop densities for grain legume species  
**Aim:** To examine the seed yield response to crop density in various grain legume species.

**Number:** 87A21  
**Location:** Avondale Research Station, paddock 1C  
**Co-operator:** Ken Burchell (Manager)  
**Soil type:** Red loam  
**History:** Lupin crop 1985, cereal variety trial 1986  
**Crop:** Seeds inoculated with Fiord faba bean also lime pelleted  
**Seeding date:** 10/6/1987  
**Basal:** 80 kg/ha superphosphate drilled prior to seeding and 50 kg/ha super applied with seed.  
**Herbicide:** Diuron at 1.5 L/ha applied 4 weeks prior to seeding  
**Fusilade 600 mL/ha on 30/6/1987**  
**Insecticide:** Le Mat 30/6/1987, Lorsban in July  
**Plot size:**  
**Sampling:** Plant count 2/7/87.  
**Rainfall:** May-July 183 mm; August 38 mm; September 32 mm and October 8 mm. Total M-O 261 mm.

**Results:** Seeding rate (kg/ha) and density (m$^{-2}$)

<table>
<thead>
<tr>
<th>Desired density</th>
<th>Dundale Rate</th>
<th>Tyson Rate</th>
<th>Amethyst Rate</th>
<th>Laird lentil Rate</th>
<th>Fiord bean Rate</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>47 D. 24</td>
<td>23 D. 20</td>
<td>34 D. 18</td>
<td>17 D. 23</td>
<td>86 D. 19</td>
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<tr>
<td>30</td>
<td>95 D. 49</td>
<td>47 D. 30</td>
<td>69 D. 35</td>
<td>34 D. 39</td>
<td>172 D. 34</td>
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<tr>
<td>45</td>
<td>141 D. 59</td>
<td>70 D. 46</td>
<td>102 D. 47</td>
<td>51 D. 62</td>
<td>256 D. 51</td>
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<tr>
<td>60</td>
<td>190 D. 85</td>
<td>95 D. 60</td>
<td>138 D. 64</td>
<td>69 D. 77</td>
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<td>75</td>
<td>235 D. 101</td>
<td>117 D. 71</td>
<td>171 D. 76</td>
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<td>45</td>
<td>48</td>
<td>60</td>
<td>49</td>
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</tbody>
</table>

A.O.V. seedling density: Achieved density LSD 5% = 5.8  
Crop mean density LSD 5% = 5.8  
CV = 14.3%

**Seed yield (kg/ha) and density (m$^{-2}$)**

<table>
<thead>
<tr>
<th>Crop</th>
<th>Dens.</th>
<th>Yield</th>
<th>Crop mean</th>
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<tr>
<th>Crop</th>
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<th>Yield</th>
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<tbody>
<tr>
<td>Tyson chickpea</td>
<td>20</td>
<td>995</td>
</tr>
<tr>
<td>Amethyst chickpea</td>
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<td>794</td>
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<tr>
<td>Laird lentil</td>
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<tr>
<td>Fiord bean</td>
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<td>887</td>
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<tr>
<td>Density mean</td>
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</tbody>
</table>

LSD 5% Variety x Density interaction = 624 kg/ha
CV = 24.5%.

10.2.2 Time of Planting

Number: 87A22
Location: Avondale Research Station, paddock 1C
Co-operator: Mr Ken Burchell (Manager)
Soil type: Red loam
History: Lupin crop 1985, Cereal variety trial 1986
Crop: Seeds inoculated, with Fiord faba bean also lime pelleted, and sown at: Dundale pea 120 kg/ha, Tyson chickpea at 80 kg/ha, Amethyst chickpea 100 kg/ha, Laird lentil 40 kg/ha and Fiord at 200 kg/ha
Basal: 80 kg/ha superphosphate drilled prior to seeding and 50 kg/ha super applied with seed
Herbicide: Sprays as 1.5 L/ha and Diuron at 1.5 L/ha 20/5/1987. Fusilade applied at 600 ml/ha 30/6/1987
Insecticide: Le Mat on 30/6/1987, Lorsban in July, Cymbush at 160 mg/ha on 10/9/1987
Fungicide: Benlate at 500 g/ha 16/7/1987
Plot size: 8 rows (1.4 m) x 10 metres, 3 replicates
Sampling: Plant count 1/7/1987
Rainfall: May–July 183 mm; August 38 mm; September 32 mm and October 8 mm. Total M-O 261 mm
Results:

Seedling density (m\(^{-2}\)), seed yield (kg/ha), date of flowering and cumulative day degrees (°C)

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>Date sown</th>
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<th>Cultivar mean</th>
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<td></td>
<td>May 20</td>
<td>June 5</td>
<td>June 17</td>
<td>June 25</td>
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<td>Dundale pea</td>
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<td>25/8</td>
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Date mean dens. 34.5 38.3 43.6 42.7
Date mean y. 1,848 1,524 1,355 1,014

LSD 5% Cultivar mean yield = 285 kg/ha
LSD 5% Date sown mean yield = 255 kg/ha
CV = 24%

LSD 5% Date mean density = 3.8 plants/m\(^2\); CV = 13.1%

10.2.3 Faba bean screening nursery

Number: 87MC35
Location: Manjimup Horticultural Research Centre
Co-operator: Mr D. Pearce (Manager)
Soil type: Red/brown loam
History: Pasture 1986, Faba bean variety trial 1987
Crop: Seeds inoculated and lime pelleted and Fiord sown at 240 kg/ha, Servilliana Local at 470 kg/ha and the H.B. accessions at 375 kg/ha
Seeding date: 29/5/1987

-30-
Basal: 140 kg/ha 3:2 super and potash topdressed IBS. 100 kg/ha double superphosphate at seeding.
Herbicide: Roundup at 2.0 L/ha before seeding
Simazine at 1.5 L/ha IBS
Plot size: 8 rows (1.4 m) x 10 metres; 3 replicates
Sampling: Plant count and disease rating 15/10/1987 = percentage of leaf area affected. A leaf selected approximately one-quarter of the way up the stem of ten plants per plot
Rainfall: May-October 499 mm

Results:

87MC35. Seed yield (kg/ha) and leaf disease score

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LSD 5% 794 0.294
CV 36.2% 30%

(1) Double superphosphate with the addition of Sumisclex® drilled with the seed.
(2) Sumisclex® applied to plants on two occasions, at 2 kg/ha on 16/7/1987 and at 4 kg/ha on 5/8/1987.
(3) The predominant disease was estimated to be Ascochyta fabae although Botrytis fabae was also present. A logarithm transformed value of 0.7 equates with 5% leaf area affected, a score of 0.28 equates with 1% leaf area affected.
APPENDIX 10.3

10.3.1 Pea variety evaluation 1986

Number: 86C2
Location: Chapman Valley Research Station, paddock 19A.
Co-operator: B. Murray (Manager).
Soil type: Red silty loam.
Crop: Field peas inoculated with Group E, 150 kg/ha.
Seeding date: 21/5/86.
Basal: Superphosphate 70 kg/ha.
Herbicide: Diuron 1.5 L/ha, 21/5/86.
Plot size: 4 rows (18 cm) x 5.5 metres, 3 replications.
Sampling:
Rainfall: May–August = 430.4 mm, September and October = 31.4 mm.

Comments:
Temporary waterlogging during winter.

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Yield, LSP (P < 0.05) = 603 g.

Number: 86E2
Location: Esperance Downs Research Station
Co-operator: T. Fox (Manager).
Soil type: Grey sand over clay at 30 cm.
History: Oat 1985.
Crop: Field peas inoculated with Group E, 150 kg/ha.
Seeding date: 5/6/86
Basal: Superphosphate 100 kg/ha.
Herbicide: Roundup.
Plot size: 4 rows (18 cm) x 5.5 metres, 3 replications.
Rainfall: May-October = 410.6 mm.

Comments:

Part of the site was waterlogged over winter resulting in loss of established plants, poor growth particularly in the replicate 1 block. The worst affected plots have been discarded in calculating the mean yields. Downy mildew was present on the lower leaves 7/10/86.

86E2

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Yield, LSD (P < 0.05) = 279 g.

Number: 86KA9
Location: Nyabing
Officer: I. Pritchard (Katanning D.O.)
Co-operator: Goodchild (Farmer)
Soil type: Grey clay 0-10 cm, pH (water) = 5.8-6.5
Brown clay 10-40 cm, pH (water) = 6.0-6.3
Orange mottled clay 40 cm
Crop: Field peas inoculated with Group E, 150 kg/ha.
Seeding date: 11/6/86
Basal: Superphosphate Cu, Zn, Mo, No, No. 1 mix 150 kg/ha.
Herbicide: Treflan® 2.0 L/ha + Diuron 1.0 L/ha 11/6/86.
Fusilade 212® 0.5 L/ha post-emergence.
Plot size: 4 rows (18 cm) x 5.5 m, 3 replicates
Sampling: Pod dehiscence rating 2/12/86.
0 = No pods shattered
1 = 1-10% estimated pod shattered
2 = 11-20% estimated pod shattered
10 = 91-100% estimated pod shattered
Rainfall: May-August = 179 mm, September and October = 36 mm.

Comments:
Heavy crop establishment problems through low rainfall, hard-setting clay soil and root and stem rot diseases.

86KA9

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Yield, LSD (P < 0.05) = 284 g.
Number: 86M12
Location: Merredin Research Station, paddock 941
Officer: Dr R. French (Merredin D.L.R.I.)
Co-operator: Mr W. Booth (Manager)
Soil type: Red sandy loam, pH (water) = 6.0
Crop: Field pea inoculated with Group E, 150 kg/ha.
Seeding date: 27/5/86
Basal: Superphosphate 73 kg/ha.
Herbicide: Diuron 1.5 L/ha and Sprayseed® 1.0 L/ha before seeding.
Plot size: 4 rows (18 cm) x 5.5 mm, 3 replicates
Sampling: 6/11/86.
Lodging: 0 = all stem erect
1 = stems inclined
2 = > 50% of stem erect
3 = > 50% of stem flat
4 = all stem flat
Pod dehiscence: 0 to 10 (as per 86KA9)
Rainfall: May-August = 211 mm, September and October = 31 mm.
Comments:

Some annual ryegrass throughout site.

86M12

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Yield LSD (P < 0.05) = 537 g.

Number: 86N2
Location: Newdegate Research Station, paddock 1 W.A.
Co-operator: A. Meldrum (Technical Officer)
Soil type: Grey - yellow sand over gravel.
History: Cereal stubble
Crop: Field pea inoculated with Group E, 150 kg/ha.
Seeding date: 4/6/86
Basal: Superphosphate 70 kg/ha.
Herbicide: Diuron 1.5 L/ha post seeding, pre emergence.
Plot size: 4 rows (18 cm) x 5.5 mm, 3 replicates
Rainfall: May-August = 186 mm, September and October = 34 mm.
Comments:

Good weed control.

86N2

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Yield LSD (P < 0.05) = 247.5 g.

Number: 86NO9
Location: Goomalling
Officer: T. Sweeney (Northam D.O.)
Co-operator: R. Clarke (Farmer)
Soil type: 0-15 cm sandy clay over grey clay.
\[ \frac{\text{EC}}{\text{water}} = 5.8 \ (0-10 \ \text{cm}) \]
\[ 7.0 \ (30 \ \text{cm}) \]

History: Cereal stubble
Crop: Field pea inoculated with Group E, 150 kg/ha.
Seeding date: 26/5/86
Basal: Superphosphate Cu, Zn, Mo No.1, 100 kg/ha.
Herbicide: Diuron 1.25 L/ha + Treflan®, 1.0 L/ha and Sprayseed®, 1.0 L/ha, 26/5/86. Fusilade® 0.5 L/ha, 8/9/86.
Insecticide: Sumicidin® 0.25 L/ha 26/9/86.
Plot size: 4 rows (18 cm) x 5.5 m, 3 replicates
Sampling: 6/11/86
   Lodging 0 = all stem erect
   1 = stems inclined
   2 = > 50% of stem erect
   3 = > 50% of stem flat
   4 = all stem flat
Pod dehiscence: 0 (nil) to 10 (91-100% pod shatter.
Rainfall: May-August = 230 mm. September and October = 28 mm.

Comments:
Some patches of waterlogging throughout the site. Good weed control.

86N09

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PEA VARIETY EVALUATION, 1987

Number: 87C59
Location: Chapman Valley Research Station, paddock 16B
Co-operator: Mr B. Murray (Manager)
Soil type: 30 cm yellow/orange loamy sand over ironstone gravel sandy clay
History: Wheat stubble 1986
Crop: Field peas, inoculated and sown at 150 kg/ha
Seeding date: 13/5/1987
Basal: 200 kg/ha superphosphate at seeding
Herbicide: Tank mix of diuron at 1.5 L and Sprayseed at 2 L/ha immediately before seeding (IBS)
Insecticide: Endosulfan at 1.0 L/ha
Plot size: 8 rows (1.4 m) x 10 metres, 3 replicates
Sampling: Plant count 24/7/1987; Plant lodging rating 8/10/1987
Rainfall: May-October 305 mm

Number: 87M08
Location: Nugadong
Co-operator: C. Hyde (Farmer) and Moora District Office
Soil type: 30 cm red/brown clay loam over orange loam
History: Wheat 1986
Crop: Peas inoculated and sown at 150 kg/ha
Seeding date: 14/5/1987
Basal: 208 kg/ha superphosphate at seeding
Herbicide: Tank mix of diuron and Sprayseed IBS
Fusilade 212 at 600 ml/ha 30/6/1987
Insecticide: Thiodan at 1.0 L/ha; Metasystox at 150 ml/ha on 2/9/1987
Plot size: 8 rows (1.4 m) x 10 metres, 3 replicates
Sampling: Plant count 23/8/1987; Plant lodging rating 7/10/1987
Rainfall: May-October 283 mm

Number: 87ME1
Location: Merredin Research Station, paddock 8DE
Co-operator: Mr W. Booth (Manager), Dr R. French (D.R.I.)
Soil type: Red/brown loam
History: Pasture 1986, deep ripped and ploughed
Seeding date: 9/6/1987
Basal: 107 kg/ha superphosphate at seeding

-46-
<table>
<thead>
<tr>
<th>Herbicide:</th>
<th>Tank mix of diuron at 1.5 L and trifluralin at 1.5 L/ha IBS; Fusilade 212 at 250 ml/ha on 6/7/1987</th>
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| Number: | 87NO12 |
| Location: | Meckering |
| Co-operator: | M. Fulwood (Farmer); G. Cooper (Northam District Office) |
| Soil type: | 15 cm brown quartz sand/loam; 15-30 cm red/brown clay/loam over white clay |
| History: | Wheat 1986, stubble burnt |
| Seeding date: | 20/5/1987 |
| Basal: | 97 kg/ha superphosphate at seeding |
| Herbicide: | Tank mix of diuron at 1.5 L, Sprayseed at 1.5 L and trifluralin at 1.5 L/ha, IBS. Fusilade at 350 ml/ha on 25/6/1987 |
| Insecticide: | Decis at 300 ml/ha and Lemat at 70 ml/ha, 24/6/1987 |
| Fungicide: | Malathion ULV at 550 ml/ha |
| Plot size: | 8 rows (1.4 m) x 10 metres, 3 replicates |
| Sampling: | Plant count 1/7/1987; Plant lodging rating 4/11/1987 |
| Rainfall: | May-October 211 mm |

| Number: | 87SG8 |
| Location: | Salmon Gums Research Station |
| Co-operator: | Mr Dave Collins (Manager) |
| Soil type: | Red/brown clay loam |
| History: | Wheat 1984, pasture 1985, spray topped 1986, site scarified |
| Seeding date: | 21/5/1987 |
| Basal: | 104 kg/ha superphosphate at seeding |
| Herbicide: | Tank mix of diuron at 1.5 L and trifluralin at 1.5 L IBS; Fusilade at 500 ml/ha on 4/8/1987 |
| Insecticide: | Lorsban at 140 ml/ha on 22/6/1987; Cymbush at 200 ml/ha on 25/9/1987 |
| Plot size: | 8 rows (1.4 m) x 10 metres, 3 replicates |
| Sampling: | Plant count 9/7/1987; Plant lodging rating 11/11/1987 |
| Rainfall: | May-October 194 mm |

| Number: | 87KA7 |
| Location: | East Broomehill |
| Co-operator: | D. Holmes (Farmer), Katanning District Office |
| Soil type: | Grey/brown loamy clay. A soil type difference across half the site with the better growth occurring on the soil with gravel at the surface |
| History: | Wheat 1986 |
| Crop: | Pea inoculated and sown at 150 kg/ha |
| Seeding date: | 18/6/1987 |
| Basal: | 73 kg/ha super Copper, Zinc and Molybdenum at seeding |
| Herbicide: | Fusilade at 500 ml/ha on 7/8/87 |
| Insecticide: | Roxian at 85 ml/ha on 16/7/1987 and Thiodan at 1.0 L/ha on 18/9/1987 |
| Fungicide: | Benlate at 500 ml/ha twice |
| Plot size: | 8 rows (1.4 m) x 10 metres, 3 replicates |
Sampling: Plant count 8/7/1987  
Rainfall: May–October 170 mm

Number: 87N2  
Location: Newdegate Research Station  
Co-operator: Mr H. Jellicoe (Manager)  
History: Wheat 1986  
Crop: Peas inoculated and sown at 150 kg/ha  
Seeding date: 17/6/1987  
Basal: 100 kg/ha superphosphate at seeding  
Herbicide: Diuron at 1.5 L/ha IBS  
Plot size: 8 rows (1.4 m) x 10 metres

Results:

Pea variety mean seed yields (kg/ha) for six sites, 1987

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<tr>
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Pea variety flowering dates, lodging scores

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<td>10/8</td>
</tr>
<tr>
<td>Filler</td>
<td>-</td>
<td>17/8</td>
</tr>
<tr>
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<td>5/8</td>
</tr>
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<td>5/8</td>
</tr>
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<td>5/8</td>
</tr>
<tr>
<td>Maitland</td>
<td>11/9</td>
<td>26/8</td>
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</tbody>
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* Averaged over the trials: 87C59
† Lodging rating:
  87ME1 1 = All stem erect.
  87MO8 2 = More than half of stem erect.
  87NO12 3 = More than half of stem flat on ground.
  87SG8 4 = All stem flat.

10.3.2 Interstate pea variety trial, 1986

Number: 86KA73
Location: Nyabing
Officer: I. Pritchard (Katanning D.O.)
Co-operator: Goodchild (Farmer)
Soil type: 0-10 cm; Grey clay, pH (water) 6.0
          10-40 cm; Grey/brown clay, pH (water) 6.3
          40 cm; Orange mottled clay.
Crop: Field peas inoculated with Gروup E, 150 kg/ha.
Seeding date: 11/6/86
Basal: Superphosphate Cu, Zn, Mo No. 1, 150 kg/ha
Herbicide: Flurfuralin 2 L/ha + Diuron 1 L/ha, 11/6/86
          Fusilade 0.5 L/ha, post emergence.
Plot size: 8 rows (18 cm) x 5.5 m, 3 replicates
Sampling: Flower colour and plant type, 8/10/86
          Lodging and pod dehiscence, 2/12/86
Rainfall: May-August = 179 mm, September and October = 36 mm.
<table>
<thead>
<tr>
<th>Accessions</th>
<th>Density</th>
<th>Yield</th>
<th>Lodging</th>
<th>Dehiscence</th>
<th>Flower colour</th>
<th>Plant type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buckley</td>
<td>59</td>
<td>997</td>
<td>4</td>
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<td>C,T</td>
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<tr>
<td>NZ2-80P7</td>
<td>41</td>
<td>763</td>
<td>2</td>
<td>1</td>
<td>P</td>
<td>SL,D(mix)</td>
</tr>
<tr>
<td>Dundale</td>
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<td>C,T</td>
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<td>PB616-9</td>
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<td>M</td>
<td>SL,S</td>
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<td>2</td>
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<td>SL,M</td>
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<td>SL,S(Mix)</td>
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<tr>
<td>Dun</td>
<td>30</td>
<td>340</td>
<td>4</td>
<td>0</td>
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<td>C,S</td>
</tr>
<tr>
<td>82-001P5-3</td>
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<td>SL,S</td>
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<tr>
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<td>SL,D</td>
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<td>4</td>
<td>2</td>
<td>W</td>
<td>SL,D</td>
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<tr>
<td>82-010P5-1 (PSB5)</td>
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<td>W</td>
<td>SL,D</td>
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<tr>
<td>SA018-82P9-012</td>
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<td>151</td>
<td>3</td>
<td>8</td>
<td>W</td>
<td>SL,D</td>
</tr>
<tr>
<td>82-019P5-3</td>
<td>20</td>
<td>47</td>
<td>4</td>
<td>9</td>
<td>W</td>
<td>SL,M</td>
</tr>
<tr>
<td>AA87-128-1</td>
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<td>955</td>
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<td>0</td>
<td>P</td>
<td>C,T</td>
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<td>953</td>
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<td>1</td>
<td>P</td>
<td>C,T</td>
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<td>PP251-1</td>
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<td>932</td>
<td>3</td>
<td>1</td>
<td>W</td>
<td>C,M</td>
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<td>PP292</td>
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<td>853</td>
<td>3</td>
<td>1</td>
<td>P</td>
<td>C,T</td>
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<td>PP178-1</td>
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<td>813</td>
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<td>1.5</td>
<td>W</td>
<td>C,M</td>
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<tr>
<td>PP8</td>
<td>39</td>
<td>682</td>
<td>3.5</td>
<td>1.5</td>
<td>W+P</td>
<td>C,T</td>
</tr>
<tr>
<td>PP4</td>
<td>52</td>
<td>552</td>
<td>4</td>
<td>1</td>
<td>W+P</td>
<td>C,M</td>
</tr>
<tr>
<td>PP262-1</td>
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<td>523</td>
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<td>P</td>
<td>C,M</td>
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<td>PP133</td>
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<td>396</td>
<td>4</td>
<td>1</td>
<td>W</td>
<td>C,T</td>
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</tbody>
</table>

Accessions 1-24 from Victorian Crop Research Institute, Horsham.  
25-33 from South Australian Department of Agriculture.

Density = plants established (July) per m²  
Yield = g seed/plot (harvested by hand)  
Lodging = 0 = all stem erect  
1 = stems inclined  
2 = > 50% stem erect  
3 = > 50% stem flat  
4 = all stem flat  
Pod dehiscence = 0 = no pod shatter  
1 = 1-10% pods shattered  
2 = 11-20% pods shattered  
9 = 81-90% pods shattered  
Flower colour = W = white, P = purple standard  
Plant type = C = normal  
SL = semi leafless

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T = tall crop height (55-70 cm)
M = medium (45-55 cm)
S = short (35-45 cm)
D = dwarf (25-35 cm)
Mix = mixture of plant types

Comments:

Heavy plant establishment losses in patches from root and stem diseases. The season and soil type combined to restrict crop growth and yield.

The material from Victoria generally had lower seed germinability than the South Australian material. Considerable variation available among the Victorian accessions for crop lodging and pod dehiscence. The South Australian accessions mostly lodged at maturity and had little pod shatter.

**Interstate pea variety trials, 1987**

**Number:** 87HN096  
**Location:** York  
**Co-operator:** Peter Boyle (Farmer), Mr G. Cooper (Northam District Office)

**Soil type:** 40 cm brown clay loam over gravelly clay loam  
**History:** Wheat 1986, stubble burnt  
**Crop:** Peas inoculated and sown at 120-150 kg/ha  
**Seeding date:** 21/5/1987  
**Basal:** 97 kg/ha superphosphate at seeding  
**Herbicide:** Tank mix of diuron at 1.5 L, Sprayseed at 1.56 L and trifluralin at 1.5 L/ha IBS. Fusilade at 550 ml/ha on 26/6/1987

**Insecticide:** Decis at 150 ml/ha on 11/6 and 26/6/1987. Lemat at 75 ml/ha 11/6/1987  
**Malathion ULV at 550 ml/ha**

**Fungicide:** Benlate at 500 g/ha on 22/7/1987  
**Plot size:** 4 rows (0.7 m) x 7.5 metres, 3 replicates  
**Sampling:** Plant count 1/7/1987; Disease rating 23/9/1987, plant lodging and pod shatter 4/11/1987  
**Rainfall:** May-October 272 mm

**Results:**

<table>
<thead>
<tr>
<th>Victorian accessions</th>
<th>Seed yield (kg/ha)</th>
<th>Disease rating*</th>
<th>Lodging rating**</th>
<th>Pod shatter†</th>
<th>Date flowered</th>
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<tbody>
<tr>
<td>Dun</td>
<td>4.403</td>
<td>1.0</td>
<td>3.3</td>
<td>27/8</td>
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<tr>
<td>Dundale</td>
<td>4.246</td>
<td>3.0</td>
<td>3.17</td>
<td>24/8</td>
<td></td>
</tr>
<tr>
<td>Buckley</td>
<td>4.583</td>
<td>2.5</td>
<td>3.0</td>
<td>10/8</td>
<td></td>
</tr>
<tr>
<td>Maitland</td>
<td>3.356</td>
<td>1.5</td>
<td>2.83</td>
<td>1/9</td>
<td></td>
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<tr>
<td>Alma</td>
<td>3.919</td>
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<td>27/8</td>
<td></td>
</tr>
<tr>
<td>Wirrega</td>
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<td>3.17</td>
<td>24/8</td>
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<tr>
<td>Derrimut</td>
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<td>3.0</td>
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<tr>
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<td>2.67</td>
<td>+</td>
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<tr>
<td>PSA 3</td>
<td>3.672</td>
<td>2.5</td>
<td>3.17</td>
<td>++</td>
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</table>

-52-
Table continued ...

<table>
<thead>
<tr>
<th>Victorian accessions</th>
<th>Seed yield (kg/ha)</th>
<th>Disease rating*</th>
<th>Lodging rating**</th>
<th>Pod shatter†</th>
<th>Date flowered</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSA 4</td>
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<td>++</td>
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<tr>
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<td>2.83</td>
<td>++</td>
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<td>3.0</td>
<td>++</td>
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</tr>
<tr>
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<td>2.5</td>
<td>3.17</td>
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<td>3.17</td>
<td>+++</td>
<td>10/8</td>
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<tr>
<td>LSD 5%</td>
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<td>CV</td>
<td>17.3%</td>
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* Disease (Ascochyta pinodes) rating:
  0 = no leaf or stem lesions
  1 = lesions on lower 25% of plant leaves and stem
  2 = lesions on lower 50% of plant leaves and stem
  3 = lesions on lower 75% of plant leaves and stem
  4 = lesions on lower leaves and stem to top of plant.

** Lodging rating:
  0 = stem erect
  1 = stem on incline
  2 = more than 50% of stem erect
  3 = more than 50% of stem flat
  4 = all stem flat

† Pod shatter rating:
  - = Nil
  + = 5-10 seeds on ground
  ++ = 10-20 seeds on ground
  +++ = more than 20 seeds on ground
  ++++ = more and heavy pod shatter.

$ The lower 5-6 reproductive nodes aborted from Septoria pisi disease.

Number: 87N099
Location: York
Co-operator: Peter Boyle (Farmer), Mr G. Cooper (Northam District Office)
Soil type: 40 cm brown clay loam over gravelly clay loam
History:  Wheat 1986, stubble burnt  
Crop:  Peas inoculated and sown at 120-150 kg/ha  
Seeding date:  21/5/1987  
Basal:  97 kg/ha superphosphate at seeding  
Herbicide:  Tank mix of diuron at 1.5 L, Sprayseed at 1.56 L and trifluralin at 1.5 L/ha IBS. Fusilade at 550 ml/ha on 26/6/1987  
Insecticide:  Decis at 150 ml/ha on 11/6 and 26/6/1987. Lemat at 75 ml/ha 11/6/1987  
Malathion ULV at 550 ml/ha  
Fungicide:  Benlate at 500 g/ha on 22/7/1987  
Plot size:  8 rows (1.4 m) x 10 metres  
Rainfall:  May-October 272 mm  

Results:  

<table>
<thead>
<tr>
<th>South Australian accessions</th>
<th>Seed yield (kg/ha)</th>
<th>Disease rating*</th>
<th>Lodging rating**</th>
<th>Date flowered</th>
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<tbody>
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<td>P94-1</td>
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APPENDIX 10.4  FABA BEAN VARIETY TRIALS

Number:  86MN3  
Location:  Manjimup Research Station  
Officer:  D. Bicknell (Manjimup D.O.)  
Co-operator:  D. Pierce (Manager)  

<table>
<thead>
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<th>Accession</th>
<th>Density/m²</th>
<th>Yield (g)</th>
<th>Pod#/plant</th>
<th>Chocolate spot (%)</th>
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<td>8.0</td>
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<tr>
<td>383A</td>
<td>36</td>
<td>856</td>
<td>8.7</td>
<td>64</td>
</tr>
<tr>
<td>Fiord</td>
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<td>743</td>
<td>9.6</td>
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</tr>
<tr>
<td>100151</td>
<td>34</td>
<td>508</td>
<td>7.1</td>
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<td>Lunas</td>
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</tr>
<tr>
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<td>0.1</td>
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</tr>
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<td>1.8</td>
<td>63</td>
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Table continued ...

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<th>Accession</th>
<th>Density/m²</th>
<th>Yield (g)</th>
<th>Pod#/plant</th>
<th>Chocolate spot (%)</th>
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<td>5.1</td>
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<td>797</td>
<td>11.1</td>
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<td>362</td>
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* one plot only.
Yield: g seed per plot. LSD (P < 0.05) = 483.
Chocolate spot infection (%) = No. nodes subtending heavily necrotic leaf
Total No. nodes on stem

Soil type: Red/brown sandy loam over orange gravel at 25 cm.
History: Subclover, grass pasture.
Crop: Faba beans inoculated with Group E and lime pelleted.
Tick beans at 190 kg/ha. Horse beans at 350 kg/ha. Broad beans at 470 kg/ha.
Seeding date: 19/6/86
Basal: Superphosphate Cu, Zn, No. A 200 kg/ha
Herbicide: Roundup 3.0 L/ha before seeding
Simazine 1.5 L/ha 16/6/86.
Insecticide: Fungicide: Plot size: 8 rows (18 cm) x 6 metres, 3 replicates
Sampling: Pod number and disease assessment 11/11/86.
Rainfall: May–October 534 mm
Comments: Heavy annual ryegrass population.

Number: 86KAI2
Location: Katanning
Officer: I. Pritchard (Katanning D.O.)
Co-operator: Ladyman (Farmer)

<table>
<thead>
<tr>
<th>Accession</th>
<th>Density (per m²)</th>
<th>Yield (g)</th>
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<td>INIA-04</td>
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<table>
<thead>
<tr>
<th>Accession</th>
<th>Density (per m²)</th>
<th>Yield (g)</th>
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<td>Fiord</td>
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<td>100151</td>
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<td>Danas</td>
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<td>Kristall</td>
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<td>Russkie Chernye</td>
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<tr>
<td>TF-AF-4</td>
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Yield LSD (P < 0.05) = 174 g/plot

Soil type: 0-15 cm, dark brown loam, pH (water) = 5.6
15-40 cm, orange gravelly loam, pH (water) = 6.2
40 cm, gravel

History: Faba beans inoculated with Group E and lime pelleted.
Tick, Horse and Broad beans sown at 190, 350 and 470 kg/ha.
Seeding date: 12/6/86
Basal: Superphosphate Cu, Zn, No. 1 160 kg/ha
Herbicide: Sprayseed® 2.0 L/ha, immediately before seeding.
Plot size: 8 rows (18 cm) x 6 metres, 3 replicates
Rainfall: May–October 278 mm
Comments:
Poor plant growth due to dry season.

Number: 87MC34
Location: Manjimup Horticultural Research Centre
Co-operator: Mr D. Pearce (Manager) and Manjimup District Office
Soil type: Orange/brown loam. pH (H₂O) 6.3
Crop: Seeds inoculated and lime pelleted and sown at:
Tickbeans (TB) 270 kg/ha
Horsebeans (HB) 440 kg/ha
Broadbeans (BB) 530 kg/ha
Seeding date: 29/5/1987
Basal: 140 kg/ha 3:2 super and potash topdressed IBS. 188 kg/ha superphosphate, copper, zinc and molybdenum at seeding.
Herbicide: Roundup at 2 L/ha prior to seeding  
Fungicide: Simazine at 1.5 L/ha IBS  
Fungicide: Benlate at 300 g/ha 15/8/1987  
Plot size: 4 rows (0.7 m) x 6 metres, 2 replicates  
Sampling: Plant count  
Rainfall: May-October 499 mm

Results:

Seed yields (kg/ha)

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<tr>
<th>Accession*</th>
<th>Yield</th>
<th>Accession</th>
<th>Yield</th>
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<td>5,699</td>
<td>BB-13</td>
<td>4,131</td>
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<td>5,528</td>
<td>HB-37</td>
<td>4,115</td>
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<td>BB-12</td>
<td>5,263</td>
<td>BB-33</td>
<td>4,071</td>
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<td>5,257</td>
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<td>4,060</td>
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<td>3,967</td>
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<td>5,133</td>
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<td>3,930</td>
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<td>5,055</td>
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<td>3,870</td>
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<td>3,856</td>
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<td>LSD &gt; 0.05% = 1,644</td>
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<td>BB-16</td>
<td>4,167</td>
<td>CV = 21.3%</td>
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* The accessions have been labelled according to seed size. (HB = Horse bean, BB = Broad bean, TB = Tick bean) and trait (A = Ascochyta resistant, B = Botrytis resistant, R = Rust resistant, D = determinate flowering, AF = Autofertile) as indicated by ICARDA. The accessions INIA and Servilliana Local are local bean populations introduced from Spain.

Number: 87KA8  
Location: Katanning  
Co-operator: Mr Marty Ladyman (Farmer) and Katanning District Office
Soil type: Marked soil type change in a diagonal direction to the site with a brown loam over clay one side and a sandy loam gravel over clay on the other

History: Wheat 1986
Crop: Seeds inoculated and limepelleted and sown at:
Tickbeans (TB) 270 kg/ha
Horsebeans (HB) 440 kg/ha
Broadbeans (BB) 530 kg/ha

Seeding date: 27/5/1987
Basal: 265 kg/ha 3:2 super and potash IBS
140 kg/ha superphosphate, copper, zinc and molybdenum at seeding

Herbicide: Simazine at 1.5 L/ha IBS
Insecticide: Roxian at 80 ml/ha 7/7/1987, Decis at 200 ml/ha 16/7/1987 and Thiodan at 1.0 L/ha on 9/9/1987
Fungicide: Benlate at 500 g/ha on 20/7/1987 and 8/8/1987
Plot size: 4 rows (0.7 m) x 6 metres, 2 replicates
Sampling: Plant count
Rainfall: May-October 212 mm

Results:

87KA8 flowering dates and seed yield (kg/ha)

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<th>Accession*</th>
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<th>Yield</th>
<th>Accession</th>
<th>Flowering date</th>
<th>Yield</th>
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</table>

LSD
CV

*N.S.*

23.9%

*A* = Ascochyta resistance
*R* = Rust resistance
*B* = Botrytis resistance
*AF* = Autofertility.
<table>
<thead>
<tr>
<th>TITLE</th>
<th>AUTHOR</th>
<th>PUBLICATION DATE</th>
</tr>
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<tbody>
<tr>
<td>1. Nitrogen fertiliser use for cereal</td>
<td>M.G. Mason</td>
<td>July 1986</td>
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<tr>
<td>hay production.</td>
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<tr>
<td>2. Correction of pastures deficient in zinc for sheep</td>
<td>R.J. Brennan and J.W. Gartrell</td>
<td>August 1986</td>
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<tr>
<td>3. A review of deep tillage research in Western Australia</td>
<td>M.W. Perry (Ed.)</td>
<td>November 1986</td>
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<td>5. Late nitrogen for wheat crops</td>
<td>M.G. Mason</td>
<td>December 1986</td>
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<tr>
<td>6. Factors affecting frost damage to wheat in Western Australia</td>
<td>S.P. Loss</td>
<td>April 1987</td>
</tr>
<tr>
<td>7. The effect of nitrogen fertilizer sprays on wheat yield and grain</td>
<td>M.G. Mason and I.C. Rowland</td>
<td>April 1987</td>
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<td>quality</td>
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<td>8. The Esperance rotation trial</td>
<td>I.C. Rowland</td>
<td>October 1987</td>
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<td>9. Climate of the Ord River Irrigation Area, Western Australia</td>
<td>R.J. Delane</td>
<td>August 1987</td>
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<td>10. Effectiveness of phosphatic fertilizers and an evaluation of</td>
<td>M.D.A. Bolland</td>
<td>September 1987</td>
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<td>three soil tests for phosphate in Western Australia</td>
<td>M.J. Baker</td>
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<td>D.G. Allen</td>
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<td>R.J. Gilkes</td>
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<td>M.F. D'Antuono</td>
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<tr>
<td>11. Disease and insect resistance screening of the National</td>
<td>D.J. Gillespie</td>
<td>December 1987</td>
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<td>Subterranean Clober collection</td>
<td>M.J. Barbetti</td>
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<td>13. The effect of rate and time of application of nitrogen</td>
<td>M.G. Mason</td>
<td>October 1988</td>
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<td>fertilizers on the quality of two row barley for malting or feed</td>
<td>G.B. Crosbie</td>
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<td>manual</td>
<td>G.A. Elliott</td>
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<td>15. Agronomy and adaptation of field peas in the Western Australian</td>
<td>R.F. French</td>
<td>December 1988</td>
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<td>16. Effect of sowing rate and time of application of nitrogen fertilizer on grain yield components of wheat</td>
<td>M.G. Mason</td>
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<td>17. Nitrogen fertilizer requirement of crops in direct-drill or conventional cultivation planting systems</td>
<td>M.G. Mason</td>
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