Three new pulse cultivars for New Zealand's arable industry

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Abstract

New field pea (*Pisum sativum* L.) and lentil (*Lens culinaris* Medik.) cultivars have been released by the New Zealand Institute for Crop & Food Research Ltd. during 1994 for New Zealand domestic and export markets. Cv. Hadlee, bred by Crop & Food Research, is a small, blue field pea with resistance to pea seed-borne mosaic virus (PSbMV). In spring-sown regional evaluation trials conducted in Canterbury from 1990 to 1994, cv. Hadlee produced a significantly ($P<0.01$) higher dry seed yield than the current commercial cultivar cv. PV12. Cv. Allure is a white field pea of French origin, released for the higher rainfall cropping regions in the lower half of the South Island of New Zealand. Cv. Allure is a semi-leafless type with improved resistance to lodging. The dry seed of cv. Allure is suitable for human consumption or compounding for feed. Cv. Rajah is a new, red cotyledoned lentil bred by Crop & Food Research. The dry seeds of cv. Rajah are larger than the current commercial cultivar cv. Titore. Cv. Rajah has improved resistance to Ascochyta blight caused by *Ascochyta fabae* f.s. *lentis*.

The Crop & Food Research field pea breeding programme is continuing to breed field pea cultivars with resistance to PSbMV and top yellows virus, downy mildew, powdery mildew and Ascochyta blight with improved agronomic characteristics. The emphasis on lentil improvement continues to be the development of lentil cultivars with improved resistance to Ascochyta blight.

Additional Key words: *Field peas, lentils, disease resistance, breeding*

Introduction

Field peas (*Pisum sativum* L.) are an important grain legume crop grown in New Zealand and represent the largest volume of peas exported from New Zealand. Department of Statistics figures indicate that in 1992 75,000 t of peas were produced from 23,000 ha, which equates to an average yield of 3.3 t/ha. The majority of field peas are produced in Canterbury (77%) followed by Southland (8%), Otago (5%) and Hawke's Bay (3%).

The Crop & Food Research field pea breeding programme commenced crossing programmes in 1932 (Jermyn, 1987) in response to problems associated with blue peas grown in New Zealand at that time. The breeding programme currently concentrates on the five major classes of field peas grown in New Zealand. These are blue peas (small seeded 'Prussian' types and larger seeded 'Rhondo' types), white peas (for human consumption and animal feed), marrowfat, maple and forage peas. Market requirements differ significantly for each type, depending on the end use, and breeding strategies differ accordingly.

The main criteria targeted for field pea improvement in the Crop & Food Research breeding programme are marketability, disease resistance, seed yield and the seed quality parameters of size and colour uniformity. Morphological characteristic that is important in the selection process is stiff straw, to allow easier harvesting. Other important characteristics for improvement are the components of yield, such as peas/pod and pods/plant. The characteristics of two new field pea cultivars released by Crop & Food Research during 1994 are described along with potential benefits for the New Zealand arable industry.

Lentil production commenced in New Zealand in 1982 after a decade of agronomic research and cultivar selection. The first lentil cultivar to be released by Crop & Food Research was cv. Titore', which until recently was the only red lentil cultivar grown in New Zealand. The Crop & Food Research lentil selection programme has relied heavily on evaluating imported germplasm, initially obtained from the USA and Canada and more recently from the International Centre for Agricultural Research in the Dry Areas (ICARDA) in Syria.

The main aims of the lentil selection and breeding programme at Lincoln is to breed and select red and yellow lentil cultivars with improved marketability, higher seed yields, improved resistance to Ascochyta blight (caused by *Ascochyta fabae* f.s. *lentis*) and lodging resistance. The characteristics of a new red lentil cultivar, named cv. Rajah', released by Crop & Food Research during 1994 are described.

Results

cv. Hadlee field pea

Hadlee is a new, small blue pea with resistance to PSbMV. This is the first locally bred pea cultivar to be released in New Zealand with resistance to this virus. Pea seed-borne mosaic virus (PSbMV) was first detected in New Zealand in 1978 in a number of commercial seed-lines (Fry and Young 1980). Ovenden and Ashby, 1981 described the properties of one common isolate, PSbMV-Pam.

During the pea-growing season of 1984-85, problems arose when field pea seed was down-graded on export markets because seeds had symptoms described as tennis ball mark and there was a high percentage of small seed. Isolation, host range studies, serology and electron microscopy confirmed the presence of the Standard (ST) strain of PSbMV. The continuing incidence of PSbMV in many seed lines and the increase in the incidence of the seed symptoms, especially in field peas during the 1986 and 1987 seasons, led to the re-initiation of a programme to incorporate the 'sbm' resistance gene into DSIR-bred pea cultivars. Early attempts to incorporate resistance to PSbMV into the DSIR pea breeding programmes were unsuccessful due to the lack of a reliable assay to detect PSbMV. Adoption and adaption of screening techniques used by USDA researchers (Kraft and Mink, 1987) and the use of a reliable PSbMV antiseria allowed the programme to proceed.

Crosses were made in 1986 using OSU442-15 (an accession obtained from Oregon State University) as the resistant parent, crossed with Crop & Food Research blue pea breeding lines. Preliminary yield trials were conducted in 1989/90 followed by 14 regional evaluation trials in Canterbury from 1990/91 to 1993/94. From these trials, a blue prussian type field pea with resistance to PSbMV, and a significantly ($P<0.01$) higher dry seed yield than the standard cultivar cv. PV12 was selected for release in 1994 and named Hadlee (Russell and Jermyn, 1994).

Hadlee has a medium plant height with first flowers occurring at the 14th to 16th node. Hadlee produces short blunt pods, which are predominantly set as doubles (two pods per inflorescence). An average of 4.7 peas are set per pod. Hadlee has light green foliage and stipules. Seed is smooth and round with a mean seed weight of 214 g per 1000 seeds. The testa is light blue/green and the cotyledon colour is green.

Resistance to the standard strain of PSbMV was confirmed by mechanical inoculation of Hadlee with PSbMV obtained from ground tissue from infected plants, followed by visual assessment and ELISA assay for the presence of the virus. Resistance to bean yellow mosaic virus (BYMV) was also confirmed by mechanical inoculation with BYMV followed by visual assessment of symptom development. However, Hadlee is susceptible to powdery mildew (*Erysiphe pisi* DC.).

Hadlee is most like cv. PV12 in appearance, but is slightly taller with shorter internodes and pods. The seed of Hadlee is larger and more spherical than cv. PV12. Hadlee has a plant type that is more erect than cv. PV12, and, under normal circumstances, a crop of Hadlee will remain more upright at maturity allowing the crop to be harvested more easily. A summary of results from 14 spring-sown regional trials conducted in Canterbury between 1990/91 and 1993/94 is presented in Table 1.

Hadlee is suitable for export as whole seed for human consumption but tests conducted by Crop & Food Research indicate that it is unsuitable for canning (Harvey, W., pers. comm.). The significantly ($P<0.01$) higher dry seed yield combined with resistance to PSbMV is seen as an advantage over existing small blue field pea cultivars currently grown commercially in New Zealand. Peter Cates Ltd. (Ashburton) has been appointed Head Licensee for cv. Hadlee peas in New Zealand.

cv. Allure field pea

Allure is a new white-flowered, field pea cultivar of French origin, released by Crop & Food Research in 1994 for growing in the southern cropping regions of New Zealand (Armstrong *et al.*, 1994). This cultivar was bred by the Nickersons NRPB company in Chartainvilliers, France, where it was intended for use by the animal feed industry. Allure was imported to New Zealand in 1990 by Crop & Food Research and has been included in regional evaluation trials in Southland from 1991 to 1994.

Table 1. Summary of the performance of cv. Hadlee field pea in 14 regional evaluation trials conducted in Canterbury from 1990/91 to 1993/94.

Cultivar	Seed yield (t/ha)	Seed yield (%PV12)	Plant habit [1]	1000 Seed Wt. (g)
Hadlee	3.65 a	116	2	214
PV12	3.15 b	100	3	175
LSD (1%)	0.31			
CV (%)	9.1			

[1] Plant habit scored prior to harvest: 1 (erect) to 4 (prostrate)

Allure is a semi-leafless cultivar in which leaflets are replaced by tendrils. This characteristic allows the plants to remain more upright throughout the season and, most importantly, allows a larger percentage of pods to remain off the ground. A more upright plant type is important in the wetter Southern cropping regions where significant seed staining can occur in field pea crops that lodge (Saunders, *pers. comm.*). Staining is normally due to infection of the pods, and, subsequently, infection of the seeds within the pods by Ascochyta blight. Crops that lodge can also be difficult to harvest mechanically.

The dry seed of Allure is smooth and round with a white testa and a yellow cotyledon.

The mean thousand seed weight of Allure dry seed in trials was 288 g, slightly larger than that of the cultivar Bohatyr. A summary of the performance of Allure in four replicated field trials conducted in Southland between 1991 and 1994 is presented in Table 2.

Allure is suitable for use as a compounding pea for the animal feed industry, or for export as whole or split seed for human consumption. The Head Licensee for Allure in New Zealand is Southern Grain and Produce Ltd., Winton.

cv. Rajah lentil

Rajah is a new red lentil cultivar developed for the New Zealand lentil export industry which was released by Crop & Food Research in 1994 (Russell, 1994). Rajah originates from a single plant selection made at Crop & Food Research at Lincoln in 1987/88 from an accession originating from ICARDA, Syria. Rajah was selected for resistance to Ascochyta blight combined with early maturity and a larger seed size than Titore, the only other red lentil currently grown commercially in New Zealand.

The resultant seeds from this selection were multiplied in a glasshouse for two generations during 1988 and concurrently screened for resistance to Ascochyta blight in a glasshouse environment by inoculating seedlings with Ascochyta blight isolated from locally grown lentil seed. From 1988/89 to 1992/93, Rajah was included in spring-sown, on-farm regional trials in Canterbury where its agronomic performance was assessed against commercial standards.

The dry seed of Rajah has a mean 1000 seed weight of 50 g (approximately 30% larger than Titore). The larger seed size is a significant advantage over Titore as some export markets consider a larger seed size desirable. The cotyledon colour of Rajah is orange and the testa colour brown, with one to three seeds produced per inflorescence. Seedling emergence is slower than Titore occurring approximately five days later. The leaflets of Rajah are slightly smaller than Titore and are a darker green colour. Rajah normally produces five main branches above ground level compared with Titore's three, and reaches a similar height to Titore when sown in late spring in Canterbury.

A characteristic purple pod pigmentation is present at the green, flat pod stage of development but is absent on dry pods. Rajah seed pods are larger than those produced by Titore and have a blunt pod end. Under spring-sown conditions in Canterbury, Rajah flowers, on average, eight days earlier than Titore (71 days after planting). In regional evaluations, dry seed harvest has occurred up to two weeks earlier than Titore.

In glasshouse inoculation experiments and spring-sown field evaluations, Rajah exhibited a higher level of resistance to Ascochyta blight than Titore (Table 3). It is hoped that a higher level of resistance to Ascochyta blight will result in significant improvements in seed quality, and, subsequently, enhance the marketability of

Table 2. Summary of the performance of Allure field pea in four replicated field trials conducted in Southland between 1991 and 1994.

Cultivar	Seed yield (t/ha)	Seed yield (% of Birte)	1000 seed weight (g)	Plot lodging[1]
Allure	5.13	109	288	2
Bohatyr	4.74	101	284	3
Birte	4.70	100	270	4
LSD	0.94			
CV%	11.86			

[1] Plot lodging prior to harvest: 1 (erect) to 4 (prostrate).

Table 3. Mean performance of cv. Rajah and cv. Titore lentil in 12 regional evaluation trials conducted in Canterbury from 1990/91 to 1992/93.

Cultivar	Days from planting to full flower	Plot lodging[1]	Seed yield (t/ha)	Resistance to Ascochyta blight[2]	1000 seed weight (g)
Rajah	71	3	2.70 a	4	50
Titore	79	2	1.96 b	7	38
LSD			0.65		
CV%			13.9		

[1] Plot lodging prior to harvest: 1 (erect) to 4 (prostrate).
[2] Resistance to Ascochyta blight was scored visually on a scale of 1 (highly resistant) to 9 (highly susceptible).

lentil seed produced in New Zealand.

Rajah has been evaluated in 12 spring-sown, regional evaluation trials in Canterbury between 1990/91 and 1992/93, where its performance was compared with the commercial standard cultivar Titore. Statistical analysis indicates that seed yields from Rajah were significantly higher than Titore (Table 3). While Rajah received a lodging score that indicated that this cultivar is less erect at harvest than Titore, mechanical harvesting is still possible. Peter Cates Ltd. (Ashburton) has been appointed Head Licensee for Hadlee peas in New Zealand.

Breeding for disease resistance

Incorporating genetic resistance to economically significant diseases affecting field peas and lentils in New Zealand is the most economical and environmentally sound method of disease control. Disease resistance is likely to result in significant improvements in dry seed yields and seed quality. This is particularly important for the field peas exported form New Zealand to human consumption markets which are quality conscious. The diseases considered to be the most important biotic constraints to the production of field peas in New Zealand, for which sources of resistance or acceptable field tolerance have been identified are the fungal diseases of downy mildew (caused by *Peronospora pisi*), and powdery mildew (caused by *Eryisyphi pisi*). Other fungal diseases for which sources of resistance are being sought are Ascochyta blight and aphanomyces root rot. Virus diseases considered important for which sources of resistance have been identified are pea seed-borne mosaic virus and top yellows virus. Where sources of resistance have been identified, they are being used to develop resistant cultivars within the major classes of field peas grown in New Zealand.

Sources of resistance to New Zealand strains of lentil Ascochyta blight have been identified from germplasm obtained from ICARDA and methods have been developed to screen segregating populations for resistance (Russell, unpublished data). This germplasm is being used in a crossing programme to incorporate resistance into commercially acceptable lentil cultivars.

Acknowledgements

I wish to acknowledge Dr. Bill Jermyn for his role in developing cv. Hadlee; Mr. John Fletcher for conducting serological tests to confirm virus resistance; Dr. Mathew Cromey for assistance in screening lentils for resistance to Ascochyta blight; Mr. Stewart Armstrong for conducting regional evaluation trials with cv. Allure in Southland; Mr. Ross Hanson for conducting regional evaluation trials in Canterbury; Mr. Gerry Ovenden for sourcing cv. Allure from France; Peter Cates Ltd. for providing financial support and marketing expertise that has assisted in developing cv. Rajah and cv. Hadlee; Southern Grain & Produce Ltd. for supplying land for regional evaluation trials in Southland and providing marketing expertise for cv. Allure; and finally all of the pea and lentil growers who provided assistance and trial sites which helped to develop the new cultivars.

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