Retention of aphid resistance during the commercialization of lucerne (*Medicago sativa* L.) cv. Nova

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Summary
An experiment was undertaken to determine if any changes in aphid susceptibility and agronomic characteristics occurred during the commercialization of lucerne cv. Nova. There were no significant changes between generations. Aphid attack reduced plant dry matter but not stem length. This response is discussed in relation to results obtained from other lucerne cultivars.

Introduction
There are currently three species of lucerne aphid present in Australia: *Therioaphis trifolii* (Monell) f. *maculata*, spotted alfalfa aphid (SAA), *Acyrthosiphon kondoi* Shinji, bluegreen aphid (BGA) and *A. pisum* (Harris), pea aphid (PA). SAA and BGA were accidentally introduced in 1977 (Passlow 1977a, 1977b) and PA arrived in 1980 (Walters and Brownlee 1980). Prior to the introduction of these three aphid species the Australian lucerne industry was reliant on one cultivar (Hunter River) of lucerne (*Medicago sativa* L.), which was highly adapted to Australian growing conditions but had no aphid resistance. In response to these introductions resistant cultivars were imported from the USA and also bred locally.

The first cultivar with SAA resistance to be developed and commercialized in Australia was cv. Nova (Reg. No. B-8a-8) which was bred jointly by the N.S.W. Department of Agriculture and CSIRO (Mackay 1982).

Commercialization of lucerne cultivars normally follows a strict procedure. The original breeders' seed, on which extensive pest and disease resistance and agronomic data are obtained, is released to selected commercial growers for the production of basic seed. Normally little or no data is obtained on basic seed which is used by registered lucerne seed growers to produce certified seed, the usual grade sold to farmers. Some data, often qualitative, is obtained from certified seed in field trials. However, there is often little attempt to relate the original registered data on breeders seed to that subsequently obtained on certified seed.

This experiment was undertaken to determine whether there was any change in aphid resistance or agronomic characteristics between the various generations of cv. Nova.

Materials and methods
The lucerne cv. Nova was grown with flood irrigation at the Agricultural Research Centre, Trangie, New South Wales (32º02'S,147º59'E). The generations were the original breeders' seed (produced in 1978), basic seed (produced 1981/82, NSW Agriculture and Fisheries, Seed Testing Laboratory Reference No. 2LDNPK49), basic seed (produced 1983, Reference No. 3LDNPK10) and certified seed (Reference No. 4LDNPK10). Soil type was a red-brown earth Dr 2.23 (Northcote 1971). Seed was hand sown at 0.75 kg ha^{-1} in spring 1983 into an irrigation bay which contained 32 plots arranged in four rows, suitable for a randomized complete block design. Each plot was four rows wide (50 cm row spacing) by 5 m long.

In October, 1984 there was major flight activity of the three aphid species. One block of lucerne was left unsprayed throughout the three week period of aphid activity, until the lucerne was cut for hay. The other block was sprayed weekly with demeton-S-methyl (37.5 g a.i. ha^{-1}) to prevent aphid attack. Mean maximum and minimum temperatures during this period were 24.2ºC and 9.8ºC respectively.

Ten stems were taken randomly from each of the plots at weekly intervals over the three weeks, immediately prior to spray application. These were placed in plastic bags and taken to the laboratory where aphids were washed from the stems with 70% ethanol and sorted into nymphs, apterae and alatae for each of the three species, using a binocular microscope. Stem lengths were measured and recorded. Plant dry matter was determined immediately prior to cutting the lucerne for hay. Two cuts each of one metre of row per plot were taken and the cut lucerne was dried for 48 hours at 80ºC prior to weighing.

Dry weights were initially analysed using the original duplicate measurements from each plot, using a randomized complete block analysis of variance (RCB). Duncans Multiple Range (DMR) test was used to determine the significance of differences between the spray treatments and generations of lucerne. Stem lengths at each sampling date were analyzed as plot means obtained from the ten individual measurements using the same RCB analysis. The aphid nymphs plus apterae counts for each species at each sampling date were combined to give an estimate of progeny. Logarithmic transformation of the counts of progeny and alates was used to stabilize the variance prior to the RCB analysis.

Results and discussion
There were no consistent generation effects on dry weights ($F_{3,53}$= 1.44, p>0.2) (Table 1). Spray effect was significant ($F_{1,53}$= 5.35, p<0.05). There were no significant effects of generation ($F_{3,24}$= 0.27, p>0.5) or spray for stem length ($F_{1,24}$= 2.64, p>0.1) during the experiment. Mean stem length at Week 1 was 19.4 ± 0.35 cm, and at Week 3, 24.6 ± 0.35 cm.

Table 1. Mean plant dry matter (g m^{-1} row) for four generations of sprayed and unsprayed lucerne cv. Nova.

Generation	Sprayed	Unsprayed
Breeders	80.88a	80.25a
Basic 81/82	90.50ab	79.00a
Basic 83	94.00b	84.00ab
Certified	88.75ab	83.75ab
Overall mean[+]	88.53	81.35

[+] $F_{1,53}$= 5.35, p<0.05

Numbers not followed by the same letter are significantly different at p = 0.05 using Duncans Multiple Range test

In Week 1 there was a mean of 13.5 ± 1.34 SAA, 32.5 ± 2.67 PA and 17.0 ± 3.02 BGA per 10 stems, with some nymphs being produced. Retransformed means of aphid alates and progeny for week three are presented as Table 2. Alate aphids were present throughout the experiment and progeny numbers had built up to considerable numbers by the third week. There were no consistent effects of spray treatment or lucerne generation on numbers of alates throughout the experiment (Table 2). Spray effects were predominant in the counts for aphid progeny; PA ($F_{1,21}$= 337, p<0.001), BGA ($F_{1,21}$= 712, p<0.001) and SAA ($F_{1,21}$= 5.44, p<0.05). The spray effect was clearly less for SAA than the other two species. Only PA showed significant generation effects (Table 2) ($F_{3,21}$= 4.51, p<0.02).

Previous work in Australia on effects of BGA infestation (Bishop *et al.* 1982) indicated shortening of internodal length and reduction of stem dry weight. Our results, using a newer cultivar, confirm the dry weight reduction, but shortening of inter-

Table 2. Retransformed means of aphid alates and progeny per 10 stems at week 3 in sprayed and unsprayed plants from each of the four generations of lucerne cv. Nova.

Generation	S[+]	US	S	US	S	US
	SAA Alates		PA Alates		BGA Alates	
Breeders	14.75ab	18.50a	49.50a	39.25ab	16.00bc	39.25a
Basic 81/82	21.25a	16.75ab	54.75a	34.75ab	13.00bc	36.00a
Basic 83	21.00a	17.50ab	32.50bc	34.50bc	7.00bc	21.00b
Certified	20.00a	11.50b	44.00ab	30.50c	10.75bc	11.50bc
	SAA Progeny		PA Progeny		BGA Progeny	
Breeders	15.25ab	30.0ab	11.50c	297.00a	24.25c	831.5a
Basic 81/82	13.50ab	52.5a	36.25b	293.50a	33.50b	770.0a
Basic 83	10.50b	26.0ab	5.75d	273.00a	21.50d	707.0a
Certified	15.75ab	26.5ab	17.50b	285.75a	27.75c	736.0a

[+]S – sprayed blocks, US – unsprayed blocks
Numbers for each stage of each species not followed by the same letter are significantly different at p = 0.05 using Duncans Multiple Range test

nodal length did not occur. The infestation may have occurred too late in the growth cycle to affect internodal length (Bishop, personal communication 1990). The cultivar Nova was selected from cv. Falkiner, which has different germplasm sources to the cultivars used by Bishop *et al* (1982).

There are three mechanisms of plant resistance to aphid attack as defined by Painter (1951). These are: antibiosis (population buildup, development, survival, progeny per female); tolerance (yield, damage, ability to survive aphid attack); non-preference (settling and larviposition preference) redefined as antixenosis by Kogan and Ortman (1978).

Cv. Nova is considered highly resistant to SAA, but susceptible to BGA and PA (Anon 1988). The results given in Table 2 are consistent with these ratings: the SAA counts in unsprayed lucerne are considerably less than for the other two aphid species. Of the three mechanisms of aphid resistance in lucerne, the numbers of SAA progeny produced in unsprayed lucerne (Table 2) suggests that antibiosis is operating against this species. Aphid counts for BGA and PA on unsprayed lucerne were as expected for a susceptible cultivar.

Aphid attack caused a mean dry matter reduction of 8% (Table 1), depending on the lucerne generation, although there was no consistent trend. This is close to the economic threshold of 10% proposed by Bishop *et al* (1982). However, because there was no reduction in stem length, this loss would not be apparent upon visual inspection (the usual method used by farmers to check for aphid infestation and damage).

There was no significant difference in aphid resistance or stem length and stem dry weight response between different generations of cv. Nova. This indicates that there was no loss of these characteristics between development and commercialization and that the qualities originally registered by the plant breeders on the basis of breeders seed can be relied upon in certified seed.

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