EFFECT OF P, K AND S FERTILISERS ON THE AMINO ACID COMPOSITION OF LUPINUS ANGUSTIFOLIUS CV. UNIHARVEST SEED

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ABSTRACT

Amino acid composition and nitrogen content of field grown **Lupinus angustifolius** cv. Uniharvest kernel was unaffected by addition of P, K and S up to 30, 50 and 100 kg/ha respectively. Seed nitrogen content was very uniform but there was considerable variation in amino acid composition. No casual relationship for this variation was found.

INTRODUCTION

Grain legumes in recent years have been receiving considerable attention as a source of high quality protein (Farrington, 1975; Leslie and Sutton, 1975). The value of legume seed protein, however, is generally restricted because of the low content of the sulphur-containing amino acids, methionine and cystine (Nelson, 1969; Arora and Luthra, 1971; Eppendorfer, 1971). Several workers usings, **Phaseolus aureus, Vicia faba, Glycine max** and **Lupinus angustifolius** (Arora and Luthra, 1971; Eppendorfer, 1971; Sharma and Bradford, 1973; Blagrove et al., 1976) have shown that fertilisers can be used to influence amino acid composition of legume seed. Most experiments have been carried out in controlled environments with plants grown in pots. The relevance of these experiments and the high levels of fertiliser applied (Eppendorfer, 1971, applied up to the equivalent of 1600, 800 and 800 kg/ha of P, N and S, respectively), to field practice and economic sense may be debated. The purpose of this study was to determine, under field conditions, the effect of different rates of P, K and S fertilisers on the amino acid composition of **Lupinus angustifolius** cv Uniharvest seed.

MATERIALS AND METHODS

A 3^3 design with a single replicate, and with partial confounding of the P, K and S interaction was used. The remaining degrees of freedom from this interaction were used as the estimator of error.

Seed inoculated with a commercial lupin inoculant was sown at a depth of 4 cm with a Stanhay precision seeder. Rows were 25 cm apart and the distance within the row was 8 cm (50 seeds m^{-2}). Each plot was 2.5 m wide and 10 m long. The trial was sown on a Wakanui silt loam at the Lincoln College Research Farm and grown during the spring and summer of 1974 - 75. A soil test taken in 1974 prior to planting this trial gave the following Quick Test analysis.

pH	5.9	Ca	9	
		K	13	
		P	16	(Olsen)

Fertiliser treatments of P, K and S as triple superphosphate, potassium chloride and gypsum, respectively, were applied at 0, 15, 30 kg ha $^{-1}$ of P; 0, 25, 50 kg ha $^{-1}$ of K, and 0, 50, 100 kg ha $^{-1}$ of S. The previous fertiliser history of the trial area is given in Table 1.

TABLE 1: Crop and fertiliser history of trial site

YEAR	CROP	FERTILISER
1965	Ryegrass trials	2 tonnes lime/ha
1966-68	Ryegrass trials	
1969-73	Pasture	125 kg super/ha/yr
1973-74	Wheat (winter)	225 kg super/ha
1974-75	Lupin trial (after winter fallow)	

At maturity seed from the centre six rows was harvested. Samples of the seed were taken and the testa removed. The kernel was ground to pass through a 0.5 mm screen. Two 300 mg samples for each treatment were taken for total nitrogen determination by the micro - kjeldahl digestion method.

Amino acids were determined by column chromatography in a Technicon TSM amino acid analyser on 100 mg air dry samples hydrolysed for 24 hr in 100 ml 6N-HC1-Formic acid.

RESULTS AND DISCUSSION

TOTAL SEED NITROGEN

Kernels from field grown **L. angustifolius** cv. Uniharvest at three levels of the three different nutrients had similar nitrogen levels (Table 2). The mean nitrogen content was 5.70% + 0.03 ($S\bar{x}$ t, 0.05). Blagrove et al. (1976) found similar amounts of nitrogren in Uniharvest grown in pots with low and high levels of sulphur.

TABLE 2: Response of kernel nitrogen content to the application of P, K and S fertilisers

FERTILISER RATE (kg/ha)	NITROGEN CONTENT (%)
Phosphorus:	
0	5.67
15	5.69
30	5.73
Potassium:	
0	5.69
25	5.72
50	5.69
Sulphur:	
0	5.73
50	5.71
100	5.65
L.S.D. 5%	0.11

TABLE 3: Effect of P, K and S fertilisers on kernel content of cystine, methionine, essential and total amino acids (g/16 g N)

Fertiliser Rate (kg/ha)	Cystine†	Methionine	EAA	TAA
FAO Std*	4.2		30.0	
Phosphorus:				
0	0.7	0.5	28.4	78.8
15	1.1	0.6	32.9	93.5
30	1.0	0.6	33.1	89.3
Potassium:				
0	0.8	0.6	32.2	87.2
25	0.9	0.5	27.8	80.0
50	1.0	0.7	34.4	94.4
Sulphur:				
0	0.8	0.6	31.1	87.0
50	0.8	0.5	28.7	76.5
100	1.2	0.6	34.5	98.1
L.S.D. 5%	0.6	0.3	10.7	22.1

+ 70% recovery

* FAO Standard for cystine plus methionine and essential amino acids excluding tryptophan

In a late sown preliminary fertiliser trial with superphosphate on the same soil, Hill (unpublished data) obtained no yield response when rates of up to 500 kg/ha were applied. In a field experiment on a virgin lateritic soil, Rahman and Gladstones (1974) obtained a seed yield response, but found no consistent effect of superphosphate application on seed nitrogen concentration in four lupin species.

With Uniharvest, Trinick **et al.** (1976) found a rapid increase in nitrogen fixation, measured by acetylene reduction, in the first seven weeks after sowing. This was followed by a period of little change in fixation rate during flowering and pod filling with a rapid decline at senescence. Sulphur and phosphorus are important elements involved in nitrogen fixation (Andrew, 1962; Bergersen, 1971), potassium being of lesser importance (Andrew, 1962). Since kernel nitrogen content was the same for all treatments we suggest levels of the three elements in the soil at the start of this experiment were sufficient for the incorporation of nitrogen, from the soil and fixation, into seed protein. Reserves of soil nitrogen were unlikely to be great (Table 1) (Scott **et al.**, 1976).

AMINO ACID COMPOSITION

Fertiliser rate had no effect on methionine and cystine contents. A similar result was obtained for the summations of essential and all other amino acids (Table 3).

In pot experiments, Arora and Luthra (1971) with **Phaseolus aureus**, and Sharma and Bradford (1973) with **Glycine max**, showed sulphur amino acid content of seed to increase to a maximum followed by a decline when further sulphur was applied. In our field experiment no such response was obtained.

The comparison of amino acid values (Table 4) for **L. angustifolius** cv. Uniharvest with those reported by Hove (1974) for **L. angustifolius** cv. Uniwhite, show a similar pattern. Some values reported by Hove (1974) are higher, notably lysine and cystine. Such differences are unlikely to be of genetic origin since both cultivars are genetically similar except for the **lentus** (reduced pod shattering) gene (Gladstones, 1970).

The effect of differing climatic conditions on amino acid composition has not been investigated or lupins, but may be important. Several workers (Ali-Khan and Youngs, 1973; Dawson and McIntosh, 1973; Young and Hammons, 1973; Caviness, 1974; Gottschalk and Muller, 1974) have shown significant differences in protein and amino acid contents for soybean, pea and peanut seed when grown in different seasons and (or) locations.

Significant between and within-laboratory variation for amino acid determination has been found (Cavins **et al.**, 1972). Such variation could be important in explaining differences to those reported by Hove (1974). In our experiment we estimated that only 70% recovery of cystine was obtained.

CONCLUSIONS

As seed amino acid composition was not affected by fertiliser treatment, it is probably more economic to change protein quality through the addition of cheaper synthetic sources of methionine (Ottenheym and Jenneskens, 1970). However, the causes of variability in amino acid content found in the present experiment probably require further investigation.

ACKNOWLEDGEMENTS

G. Meijer and A. V. Jones for technical assistance in planting and harvesting the crop. Dr. S. Davies and Miss T. L. Williams for help with amino acid determinations, and Miss P. Johnson with nitrogen determinations.

This work was funded from a D.S.I.R. Lupin Research Contract and utilised equipment provided by the University Grants Committee.

TABLE 4: Mean amino acid contents of lupin kernel

Amino Acid	mg/g lupin (± $s_{\bar{x}}$)	g/ 16 g N (± $s_{\bar{x}}$)
Cystine†	3.3 ± 0.3	0.9 ± 0.1
Methionine	2.1 ± 0.1	0.6 ± 0.03
Lysine	13.9 ± 1.0	3.9 ± 0.3
Histidine	10.5 ± 0.8	3.0 ± 0.2
Arginine	31.4 ± 2.1	8.8 ± 0.6
Aspartic acid	38.4 ± 3.1	10.8 ± 0.9
Threonine	10.6 ± 0.6	3.0 ± 0.2
Serine	15.6 ± 0.8	4.4 ± 0.2
Glutamic acid	70.0 ± 3.3	19.7 ± 0.9
Proline	14.7 ± 0.6	4.1 ± 0.2
Glycine	13.5 ± 0.7	3.8 ± 0.2
Alanine	4.4 ± 0.2	1.2 ± 0.1
Valine	11.5 ± 0.6	3.2 ± 0.2
Isoleucine	13.8 ± 0.7	3.9 ± 0.2
Leucine	30.0 ± 1.4	8.4 ± 0.4
Tyrosine	11.8 ± 0.5	3.3 ± 0.1
Phenylalanine	14.9 ± 1.1	4.2 ± 0.3

† 70% recovery

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