Field pea (*Pisum sativum* L.) seed quality responses to fertiliser application

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Abstract

Variability in field emergence is considered to be a major problem for the pea (*Pisum sativum* L.) industry, usually because of variable seed lot vigour. Thirty pea seed lots (from six fertiliser treatments on five sites) were analysed for macronutrient concentration, and tested for germination, vigour (accelerated ageing and electroconductivity) and thousand seed weight (TSW). Fertiliser treatments had a significant effect on TSW at only one site, and on seed concentration of phosphorus, sulphur and potassium at three, four and one site, respectively; there were, however, no consistent effects of treatment. Seed lots did not differ in germination or vigour and no relationship between nutrient concentration and seed vigour was found.

Additional key words: *accelerated ageing, electroconductivity, germination, nutrient concentration, seed vigour*

Introduction

Recent research on yield responses to fertiliser inputs in peas has suggested that soil nutrient status is already adequate for peas on many of the cropping soils on the Canterbury Plains (Wilson *et al.*, 1999), and that additional fertiliser inputs are not required. However, whether this also applies for seed quality, particularly as it relates to field emergence and hence seed vigour (Hampton and Scott, 1982; Castillo *et al.*, 1993), is not known. Maternal plant nutrition has been implicated in changing seed vigour in peas (e.g., Browning and George, 1981; Hadavizadeh and George, 1988; Padrit *et al.*, 1996). However, the experiments performed involved either pot trials or rates of fertiliser much higher than common in production, or both.

The field trials reported in the preceding paper (Wilson *et al.*, 1999) provided an opportunity to examine the effect of nutrient inputs, at commercial rates on commercial properties, on field pea seed quality.

Materials and Methods

Management of the five field trials, and subsequent yield, have been described in Wilson *et al.* (1999). Fertiliser treatments, and hence nutrients applied, at each site are shown in Table 1.

After harvest, samples of each seed lot were stored at 5°C prior to laboratory analysis. Germination and thousand seed weights were determined using internationally agreed methods (ISTA, 1999). Seed vigour was measured by accelerated ageing (42°C for 48h; Hampton *et al.*, unpubl.) and electroconductivity (Hampton and TeKrony, 1995). Macro nutrient analysis was performed by RJ Hill laboratories, Hamilton.

Statistical analyses were performed using Minitab version 10. ANOVA were performed and seed vigour data were related to seed nutrient status using correlation and regression analysis. Duncan's multiple range test at P<0.05 was used to establish significant differences.

Table 1. Fertiliser treatments: amount and nutrients applied (kg/ha).

Fertiliser	Amount	N	P	K	S
Nil	-	0	0	0	0
Cropmaster 15	200	30	20	20	16
Cropmaster 15	400	60	40	40	32
ammonium sulphate	300	63	0	0	72
superphosphate	400	0	40	0	32
potassium sulphate	100	0	0	41	18

Results

The phosphorus (P) concentration in pea seed following fertiliser application varied with both site and treatment (Table 2). At sites 2 and 3, P concentration did not differ from that of the control, at site 1 all fertiliser treatments significantly decreased P concentration, whereas there were significant increases at sites 4 and 5, but not for all treatments. Sulphur (S) concentration responses were also highly variable (Table 3), with increases being recorded at sites 3, 4 and 5, but only superphosphate application increased S at all three sites. Potassium concentration was increased only at site 4 (from 1.10% to 1.27%; data not presented). Thousand seed weight (TSW) was significantly affected by fertiliser treatment at site 5 only, where the superphosphate treatment resulted in a TSW of 286 g *cf.* an average of 357 g for the other treatments; the average TSW for all sites was 341 g (range 286-387 g). There were no significant effects on nitrogen (N) (average 3.6%; range 3.0-3.9%), calcium (average 0.09%; range 0.06-0.16%) or magnesium (average 0.14%; range 0.11-0.15%) concentration at any site.

Laboratory germinations averaged 88% (range 76-95%) and were not significantly affected by fertiliser treatment. Analysis of all sites together showed a trend ($P<0.07$) towards higher germination for the control and Cropmaster 15 at 400 kg/ha treatments (91%) than other treatments (85-87%).

There were no significant effects of fertiliser treatment on seed vigour. Germination after accelerated ageing averaged 91% (range 81-97%). There were no significant differences with time of emergence between seed lots. All conductivity readings were below 14 µs/cm/g seed. Results from all field sites were similar; data from site 4 are presented (Table 4) as an example.

Table 2. Phosphorus concentration (%) in field peas from five commercial sites in Canterbury with six different fertiliser treatments.

	Phosphorus concentration (%)				
Fertiliser	Site 1	Site 2	Site 3	Site 4	Site 5
Nil	0.43c	0.48	0.46	0.39a	0.34a
Cropmaster 15	0.39ab	0.47	0.45	0.38a	0.40b
Cropmaster 15	0.39ab	0.48	0.47	0.41ab	0.42b
Ammonium sulphate	0.40ab	0.47	0.46	0.38a	0.35a
Superphosphate	0.41b	0.49	0.44	0.45b	0.40b
Potassium sulphate	0.38a	0.49	0.44	0.40a	0.39b
LSD $_{P<0.05}$	0.03	ns	ns	0.04	0.04

Table 3. Sulphur concentration (%) in field peas from five commercial sites in Canterbury with six different fertiliser treatments.

	Sulphur concentration (%)				
Fertiliser	Site 1	Site 2	Site 3	Site 4	Site 5
Nil	0.24b	0.22	0.20c	0.15a	0.24b
Cropmaster 15	0.24b	0.20	0.23d	0.17ac	0.25b
Cropmaster 15	0.22a	0.20	0.20c	0.20bc	0.25b
Ammonium sulphate	0.22a	0.21	0.19bc	0.22b	0.23b
Superphosphate	0.22a	0.20	0.18ab	0.19bc	0.20a
Potassium sulphate	0.22a	0.20	0.17a	0.20bc	0.23b
LSD $_{P<0.05}$	0.01	ns	0.02	0.03	0.03

Table 4. Effect of fertiliser on thousand seed weight (g), germination (%), germination after accelerated ageing (%) and conductivity (µs/cm/g seed) of field peas at Site 4.

Fertiliser	TSW[1] (g)	Germ[2] (%)	AA[3] (%)	Conductivity (µs/cm/g seed)
Nil	327.9	91	85	11.12
Cropmaster 15	313.5	89	87	12.13
Cropmaster 15	335.3	88	83	12.74
Ammonium sulphate	338.8	83	85	10.91
Superphosphate	317.0	84	81	11.52
Potassium sulphate	326.3	91	87	13.91
LSD $_{P<0.05}$	ns	ns	ns	ns

[1] Thousand seed weight; [2] Germination; [3] Accelerated ageing

Discussion

Fertiliser treatment of maternal plants had no subsequent effect on seed vigour, despite the fact that P and S concentration in seeds was affected on several sites. This supports data from a survey (Rowarth *et al.*, 1998) of 13 lots of garden peas commercially harvested in 1996 which indicated that macronutrients were not implicated in seed vigour.

Nutrient concentrations were similar to those reported for garden peas (Rowarth *et al.*, 1998), as were TSWs and conductivity readings, all of which were in the top category (i.e., nothing to indicate seed unsuitable for early sowing or for sowing under adverse conditions (Matthews and Powell, 1981)).

Vigour tests such as accelerated ageing are used to distinguish between seed lots of high germination (Hampton and Coolbear, 1990). In New Zealand, high germination is generally considered to be 90% or greater (Hampton, 1994). In this study, only 9 of the 30 seed lots had laboratory germination of 90 % or above. The highest yielding site (Wilson *et al.*, 1999), where there had been no water deficit, had only one treatment with germination over 90%. Overall, a mean of 12 % abnormal seedlings were recorded, indicating possibly that, although the seed lots had been harvested by hand, the high seed moisture content (Wilson *et al.*, 1999) at harvest had resulted in some mechanical damage, such as bruising; bruising has been reported in garden peas harvested at 40 % SMC (Castillo *et al.*, 1992).

Variability in field emergence of field peas is considered to be a major problem for the industry (Knox, pers. comm., 1999); seed vigour differences due to the production environment have been recorded (Castillo *et al.*, 1993; 1994). However, the hypothesis that maternal plant nutrition may affect the vigour of the seed produced cannot be supported or disproved from these results because seed lots either did not differ in macronutrient concentrations, or the differences recorded were only minor, and seed lots did not differ in vigour.

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