The effect seed source, size and frost damage on emergence and grain yield in field pea (*Pisum sativum*) cv. Kaspa

Jason Brand and Tony Leonforte

PIRVic, DPI – Horsham PB 260 Horsham Vic 3401 www.dpi.vic.gov.au Email jason.brand@dpi.vic.gov.au

Abstract

Field trials were sown in 2003 to investigate the effect of seed source, seed size and frost damage on emergence and grain yield. Only the frost damaged seed source resulted in a significant reduction in emergence and grain yield. However, if seeding rates for this treatment were increased so that plant emergence was optimum for Kaspa it could be expected that grain yields would be similar to other treatments. This research also confirmed previous studies that seed size has little effect on grain yield and highlighted that provided optimum plant densities are reached grain yield will be unaffected.

Media summary

Seed source and quality had little effect on the grain yield of the field pea cv. Kaspa in 2003 despite significant differences in emergence.

Key Words

Seed weight, Seed discolouration, Plant density.

Introduction

There have been conflicting reports on the effect of seed source and size on growth and grain yield in various crops (Burnett et al. 1997; Perin et al. 2002; Stelling et al. 1994; Tapscott and Cowling 1995). Stelling et al. (1994) showed that the grain yield of faba beans, but not field pea were significantly affected by seed source. The seed source of faba beans with highest grain yields also tended to have higher seed weights. Conversely in lupins, Tapscott and Cowling (1995) showed that although seed source significantly affected grain yield, there was no relationship with seed size. Turk and Tawaha (2002) and Perin et al. (2002) indicated similar findings, that seed size had no effect on grain yield for faba bean and common bean, respectively.

Frost during flowering and podding can significantly reduce grain yield, but also can cause seed discolouration, particularly when frost events occur later in the podding period (Brand et al. 2003). The effect of seed discolouration on emergence and grain yield are unknown.

Field pea (*Pisum sativum* L.) is widely cultivated throughout southern Australia (>800,000 ha sown in 2003). Growers have been generally encouraged to select their best quality seed (eg. harvested from the most fertile area of the paddock), screen it to remove small and damaged seed and use this for sowing in following crops. This research investigated the effect of seed source, seed size and frost damage on emergence and grain yield.

Methods

Experimental Design

Seed of the field pea cv. Kaspa was collected from five trial sites and one farmer paddock (Lub02) across 2000, 2001 and 2002 in the southern Mallee and Wimmera of Victoria (Table 1). The sites represented a range of soil types and resulted in grain of various seed weight (15.4 – 22.4 g/100 seed). At the Beulah site in 2001 there was a frost event that resulted in discolouration and a reduction in size of the grain (Brand et al. 2003). The grain was sorted into three additional treatments: frost damaged seed – seed displayed discolouration attributable to the frost, unfrosted seed – seed that had no visual damage from frost, and graded seed (>5 mm) – seed was screened on a 5 mm round sieve and all seed less than 5 mm diameter discarded. At the Curyo site in 2002 visual assessment of grain indicated a wide range of sizes within the sample. Seed was passed through 7 mm, 6 mm and 5 mm round sieves to provide 3 further treatments (Table 1). Weight of seed and germination percentage for each site x treatment was determined (Table 1).

In 2003, a field trial was repeated at 3 sites in Victoria: Horsham in the Wimmera and Warne and Beulah in the southern Mallee. Seed was sown in small plots (5 m long with 6 rows at 19.5 cm spacing) to achieve a plant density of 50 plants/m^2, except the Hor02 treatment which was sown at 70 plants/m^2 (i.e. sowing rates were varied for each treatment dependant on seed weight and germination percentage). This resulted in seeding rates between 80 and 150 kg/ha. Eighty kilograms per hectare of 'grain legume super + 2.5% Zn'(0:15:7) was drilled with the seed. Weeds, insects and fungal diseases were controlled by the relevant application of appropriate herbicides, insecticides and fungicides. A completely randomised block design with 3 replicates was used.

Table 1. Site details of seed sources, and seed weight and germination percentage of each seed treatment used for field trials in 2003.

Seed Source				Treatment	Treatment code	Seed weight	Germination
Site	Year	**GPS**	Soil Type[1]			(g/100 seed)	(%)
Southern Mallee							
Warne	2000	S 35^{O}47'56"E 143^{O}01'34"	Calcareous loam over a sodic, calcareous medium clay	Untreated	War00	20.3	92
Beulah	2001	S 35^{O}56’93”E 142^{O}15’69”	Calcareous sandy loam over a calcareous heavy clay	Untreated[2]	Beu01	22.0	97
				Frost damaged seed	Beu01-Fro	17.7	82
				Unfrosted seed	Beu01-Unfro	24.7	94
				Graded +5mm	Beu01-5mm	22.2	91

Curyo	2002	S 35°52’08”E 142°44’05”	Calcareous sandy loam over a calcareous clay	Untreated[3]	Cur02	22.5	96
				Graded (>7mm)	Cur02-7mm	25.4	98
				Graded (6-7mm)	Cur02-6mm	21.9	97
				Graded (5-6mm)	Cur02-5mm	18.7	97
			Wimmera				
Longrenong	2001	n.r.[4]	Alkaline black cracking clay	Untreated	Lon01	20.0	98
Lubeck	2002	n.r.	Alkaline red clay	Untreated	Lub02	15.4	97
Horsham	2002	n.r.	Alkaline black cracking clay	Untreated	Hor02	21.5	96

1. Detailed soil analysis not shown; 2. Includes both frost damaged and unfrosted seed; 3. Includes all seed sizes outlined in the following 3 treatments; 4. GPS reading for these sites not recorded.

Measurements and statistical analysis

Seedling emergence was determined by counting 4 x 1m lengths of randomly selected drill row per plot. Grain yield was determined from machine harvest of the whole plot. Data was analysed by analysis of variance to test for significant differences between seed source and sites. The correlation between seed weight and germination percentage of the sown seed, and emergence and grain yield was calculated.

Results

Weather in the 2003 growing season across the Wimmera and southern Mallee was characterised by average to above average rainfall in winter after below average falls in May. Spring temperatures were generally warmer than average and rainfall lower than average which resulted in terminal drought.

For both emergence and grain yield there was no significant ($P>0.05$) interaction between seed source and site. However the main effect of seed source was significant ($P<0.05$) for both measurements and the main effect of site was significant for emergence. Seedling emergence was generally highest at Beulah and lowest at Horsham (Table 2). It was less than the targeted plant densities for all treatments except Hor02 (Table 3). Seed from Beu01-Fro and Beu-5mm resulted in significantly fewer plants emerging than all other treatments (Table 3).

Plant growth throughout the season appeared normal for all treatments. Grain yields were between 2 and 2.5 t/ha for all treatments at all sites (Table 2 and 3). Seed from Beu01-Fro resulted in significantly lower grain yields (Table 3).

There were significant correlations between initial seed weight and grain yield, and germination percentage of seed prior to sowing and emergence (Table 4).

Table 2. Average emergence and grain yield across all treatments at each trial site in 2003.

Site	Emergence (plants/m^2)	Grain yield (t/ha)
Beulah	45	2.32
Horsham	40	2.36
Warne	42	2.23
LSD (P=0.05)	2	NS[1]

1. Not significant

Table 3. Average emergence and grain yield across all sites at each trial site in 2003.

Treatment code	Emergence (plants/m^2)	Grain yield (t/ha)
War00	43	2.28
Beu01	38	2.39
Beu01-Fro	18	2.04
Beu01-Unfro	44	2.30
Beu01-5mm	33	2.46
Cur02	46	2.26
Cur02-7mm	44	2.43
Cur02-6mm	44	2.46
Cur02-5mm	43	2.26

Lon01	43	2.28
Lub02	40	2.22
Hor02	73	2.28
LSD (P=0.05)	4	0.24

Table 4. Correlation coefficients between emergence and grain yield of trials in 2003 and the initial seed weight and germination percentage of grain used for the trials.

	Emergence	Grain yield	Seed weight
Grain yield	0.28		
Seed weight	0.29	0.65*	
Germination	0.62*	0.56	0.26

* $P<0.05$

Conclusion

This research shows that seed source did not affect the final grain yield in 2003 unless the seed displayed discolouration due to frost. However the lower grain yield in this treatment probably resulted from lower plant emergence, suggesting that if higher seeding rate was used to increase final plant density, grain yields would be similar to other treatments. Previous research has found the optimum of plant density range for Kaspa to be 35-55 plants/m^2 (Brand unpubl.).

Similar to previous research (Perin et al. 2002; Tapscott and Cowling 1995; Turk and Tawaha 2002) there was no significant effect of seed size on grain yield in these trials. If smaller seed is found to be suitable for sowing, this could have a significant benefit for growers, in that, the actual quantity of seed (kg/ha) required to achieve optimum plant densities is less, thus reducing the cost of sowing the crop. In addition, the seed from Lub02 was small as it was harvested from a crop grown under rainfall deficient conditions. This research could alleviate grower concerns that small seed harvested from a drought affected crop is less viable and likely to produce poorer grain yields in the following season. It also highlights the importance for growers of calculating seed weight and germination percentage of the grain that is to be used for sowing, as 9 of the 12 treatments achieved plant densities between 38-46 plants/m^2, when we targeted 50 plants/m^2. These plant densities are within the optimum range for Kaspa (Brand unpubl.) and in this research all these treatments resulted in similar grain yields.

Acknowledgments

The authors wish to thank the plant breeding team at DPI – Horsham for management of trials.

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