Seed box survey of field crops in Victoria during 1996 and 1997

Michael R. Moerkerk
Department of Natural Resources and Environment and CRC for Australian Weed Management,
PO Box 260, Horsham, Victoria 3401, Australia

Summary Significant levels of foreign seed contamination were recorded in seed used for sowing dry-land crops in Victoria during 1996 and 1997. In all crops (except vetch (*Vicia sativa* L.)) at least one sample was recorded as being weed free, indicating it is possible to use clean seed for crop establishment. Significant differences in contamination were recorded between some wheat (*Triticum aestivum* L.) and barley (*Hordeum vulgare* L.) varieties as well as some significant regional differences. Ninety nine percent of seed used for crop establishment was farmer saved or purchased 'over the fence'.

There were highly significant differences in weed species recorded between cereal and pulse crops. The five main weed species recorded as contaminants in cereal crops were annual ryegrass (*Lolium rigidum* Gaudin), wild oats (*Avena* spp.), volunteer cereals, great brome (*Bromus diandrus* Roth) and paradoxa grass (*Phalaris paradoxa* L.). Whilst those in pulse crops were volunteer pulses, volunteer cereals, wild oats, wild radish (*Rapahnus raphanistrum* L.) and weedy pulses (*Medicago* spp., *Trifolium* spp. and *Melilotus indicus* (L.) All.).

Keywords Weed seeds, seed quality, seed purity.

INTRODUCTION

The sowing of weed seeds with the crop has been put forward as the most important single agency for the introduction of alien species (Salisbury 1961).

As market demand for quality produce increases the contamination of grain produce with foreign seeds becomes a serious issue in maintaining market share and obtaining a premium price. Mock and Amor (1982) identified that brome grass (*Bromus* spp.) were significant contaminants of barley grain in the Victorian Mallee and resulted in 11.5% of samples being docked in 1980–1981 and 24% in 1985–1986 (Mock 1987).

A limited number of surveys of seed used for crop establishment have been done by collecting seed directly from drills (Tonkin and Phillipson 1973, Girsch *et al.* 1996). These surveys have identified that retained-saved seed has a higher level of weed contamination than certified seed. Tonkin and Phillipson (1973) identified that in England and Wales 28% of seed used for crop establishment was home-saved or came direct from another farm. Girsch *et al.* (1996) reported that in self saved seed in Austria in 1992–1994, 21% of spring barley and 50% of winter rye (*Secale cereale* L.) had less than 98% purity whilst the levels in certified seed for the same crops were 0.4% and 1.2% respectively.

There are a number of factors that constitute seed quality. These include purity and germination capacity of seed lots, species purity, cultivar purity, vigour, seed size, seed lot uniformity, seed health and seed moisture content, all of which have varying degrees of practical importance for agriculture (Scott and Hampton 1985).

There are two important factors in assessing the importance of a species as a contaminant of sowing seed: the frequency of which it occurs in samples and the concentration it occurs at. Factors affecting the frequency and concentration with which a species occurs include the geographical origin of the seed, husbandry methods, relative growth habits of the weed and crop species, time of seed set, method of harvesting, morphology of the weed seed and the difficulty of separating it from the crop seed by cleaning machinery, certification schemes and seed legislation (Tonkin and Phillipson 1973).

An additional factor that determines the frequency and level of contamination by a species in seed is the awareness of the end user of the quality of the seed and their ability to reject the seed prior to its use.

The importance of seed purchases knowing the species contaminating seed lots has been highlighted in recent years in Australia through the introduction of bifora (*Bifora testiculata* (L.) Spreng.) into Victoria in 1994 through certified vetch (*Vicia sativa* L.) seed (Moerkerk, personal observations). And cleavers (*Galium aparine* L.), redshank (*Persicaria maculosa* S.F.Gray) and field madder (*Sherardia arvensis* L.) into southern, Australia in certified canola seed (*Brassica napus* L. cv. Karoo) in 1996.

Casual observations in paddocks, over a number of years, of wheat, with barley heads present at maturity, indicated a number of paddocks where the barley plants were occurring in the drill rows. This is indicative of barley sown as a contaminant with the wheat seed and not as a volunteer from previous crops in the paddock where the pattern of distribution would be expected to show plants establishing between drill rows as well as within. Similar patterns were observed

with volunteer peas (*Pisum sativum* L.) occurring in chickpea (*Cicer arientnium* L.) crops.

These observations prompted a survey of seed used for crop establishment to be conducted in Victoria and southern New South Wales in 1996 and 1997 to identify seed contaminants present in seed for sowing. This paper reports on the frequency of foreign seed contamination between cereal and pulse crops and regional differences observed.

MATERIALS AND METHODS

Samples of sowing seed were either collected at sowing time from seed-boxes or groupers, or submitted by farmers for assessment in 1996 and 1997. Sample weights were in the range of 1–2 kg. Sub samples of approximately 250 g were assessed for foreign seed contamination. If less than 25 foreign seeds were found in the sub sample a full 1 kg sample was assessed for contamination.

Foreign seed species and numbers were recorded for each sample and results expressed as seeds per kilogram. Victorian standards for certified seed were used to divide samples into five quality classes of contamination (Table 1).

No assessment was made on germination percentage or varietal purity of the samples. Observations on whether the seed was pickled or inoculated were also made. In order to assess the differences between foreign species contamination between cereal and pulse crops, contaminant species were assigned to one of 14 weed categories (Table 2).

Samples were assigned to one of four regions from where they originated i.e., Mallee, Wimmera, North Central Victoria or North East Victoria (including southern NSW). Where insufficient information was supplied with the sample they were not assigned to a region and excluded from regional analysis. These samples were however included in the species analysis.

Statistical analysis Sample results from 1996 and 1997 for wheat and barley have been combined for the purpose of statistical analysis between cereal types. Statistical analysis has only been performed on 1997 data set for comparisons between cereals and pulses and regional differences.

Quality categories were assessed with a generalised linear regression on wheat and barley for region and varieties differences. The same model was used to compare between cereals and pulses quality categories.

Contingency table analysis was performed on weed categories between pooled cereals and pulse results.

RESULTS

Ninety nine percent of samples assessed were farmer-retained seed whilst the remaining were certified seed. Approx. 50% of samples were cleaned either professionally or by the farmer. Only 35% of wheat, 34% of barley, 22% of triticale (*Triticosecale*) and 17% of oats (*Avena sativa* L.) seed was treated with pickle.

Cereals and pulse crop comparisons There was a highly significant difference between the contaminant species between cereals and pulse crops (Table 2). The five most frequent weed species present in cereal crops were annual ryegrass, wild oats, volunteer cereals, great brome and paradoxa grass. Whilst those in pulse crops were volunteer pulses, volunteer cereals, wild oats, wild radish and weedy pulses.

Table 1. Quality categories applied to seed samples.

Quality category	Meets certified seed std's	Criteria for a one kg seed sample
1	Y	foreign seed free
2	Y	<15 foreign seeds and <=1 volunteer crop, no wild radish
3	N	<15 foreign seeds >1 volunteer crop, no wild radish
4	N	>15 foreign seeds, no wild radish, if volunteer crop removed <15 foreign seeds
5	N	>15 foreign seeds after removal of volunteer crops and/or wild radish detected

Table 2. Frequency of samples containing particular weed categories for cereal and pulse crops (1997 data).

Weed category	Cereal	Pulse
Annual grasses	15	5
Annual ryegrass	134	18
Wild oats	99	27
Great brome	53	10
Paradoxa grass	41	1
White iron weed (*Buglossoides arvensis* I.M.Johnston)	16	7
Thistles	12	16
Weedy brassicas	8	5
Weedy pulses	13	21
Wild radish	31	25
Hogweeds and docks (*Polygonum* spp.)	27	6
Other broad leaf species	20	16
Volunteer cereals	80	44
Volunteer pulses	25	45

Pearson chi-square value is 128.81 with 13 df.
Pearson chi-square test gives a significant result (P<0.001).

Average seed quality did not meet certification standards with the average cereal and pulse crops falling into quality category 3 (Table 3). For all cereal crops 21% were weed free, 18.1% fell into quality category 2, (i.e., 39.1% met certified seed quality) 10.7% into quality category 3, 6.2% into quality category 4, 44% into quality category 5 (12.8% because of wild radish and 31.3% due to other weeds).

For all pulse crops 24.5% were weed free, 16.3% fell into quality category 2, (i.e., 40.8% met the certified seed standards) 16.3% quality category 3, 6.1% into quality category 4 (i.e., 22.4% failed to meet certified seed quality due to volunteer crops), 36.7% into quality category 5 (21.4% because of wild radish and 15.3% due to other weeds).

For cereals and pulses respectively 16.9% and 24.4% did not meet certification standards due to volunteer crop contamination levels.

Fifty three percent of wheat, 27% of barley, 23% of triticale and 6% of oat seed met certification standards.

Sixty three percent of lentils (*Lens culinaris* Medik.), 54% of beans (*Vicia faba* L.), 38% of peas, 21% of lupins (*Lupinus angustifolius* L.) and 20% of chickpea seed met certification standards.

Wheat An analysis by the method of generalised linear models for regions showed that the quality category estimates for the North Central region were significantly higher ($P<0.05$) than the Mallee, North East and Wimmera (Figure 1). The analysis for wheat varieties showed that the quality category estimate for Swift was significantly higher ($P<0.10$) than Dollabird, Frame, Ouyen and Rosella (Figure 2).

Table 3. Percentage of samples falling into each quality category.

Crop	No. of samples assessed	Quality category				
		1	2	3	4	5
Wheat	129	31	21.7	11.6	3.9	31.8
Triticale	18	16.7	5.6	22.2	11.1	44.4
Barley	78	8.6	19.8	6.2	0	65.4
Oats	18	5.6	0	5.6	0	88.9
Total cereals	243	21	18.1	10.7	6.2	44
Lentils	11	45	18	27	0	9
Beans	13	38.5	15.4	7.7	0	38.5
Lupins	13	21	0	21	7	50
Peas	26	15.4	23.1	19.2	3.9	38.5
Chickpea	29	10.3	10.3	27.6	17.2	34.5
Vetch	6	0	0	0	0	100
Total pulses	98	24.5	16.3	16.3	6.1	36.7

Barley Analysis of barley quality category estimates by region gave non significant results (results not presented). Only three regions were compared due to insufficient data for the North-East. Comparisons were made between four varieties (Arapiles, Chebec, Galleon, Schooner). Arapiles had significantly lower ($P<0.05$) quality category estimate than Galleon indicating cleaner seed.

Regional differences A regional comparison of wheat and barley quality category estimates were conducted over Mallee, Wimmera and North Central. The only significant difference between wheat and barley was in the Wimmera, where wheat had a significantly lower ($P<0.05$) quality category estimate than barley. The differences between barley and wheat quality category estimates in the Mallee were significant at the 90% level ($P=0.07$) (Figure 3).

There was no significant difference in pulse seed quality category estimates across Victoria (results not presented).

DISCUSSION

There is a highly variable quality to seed used for crop establishment between crop types and some regional areas in Victoria.

As indicated by Scott and Hampton (1985) the variation of weed contamination between crop types is a reflection of the management of these crops and the regions they are grown. There are less options

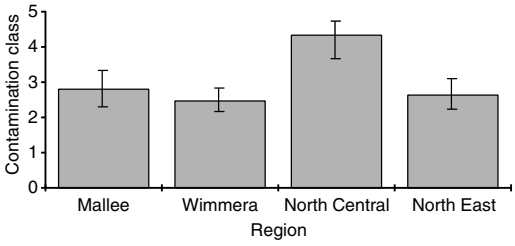

Figure 1. Regional differences in quality category estimates for wheat.

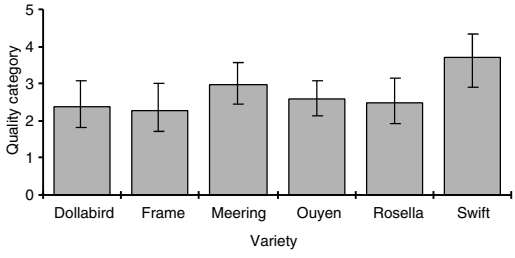

Figure 2. Quality category estimates for wheat varieties.

for grass management in cereals than there are in pulse crops whilst the converse is true for broad-leaf weed management. Volunteer cereals in cereals are difficult to manage, as there are no herbicides for removal of barley from wheat and vice-versa. This type of contamination needs to be managed through rotations and agronomic solutions including the use of clean seed. Broadleaf weed management in pulse crops has limited options and it is often described as the 'weak link in weed management' (pers. comm) in the farming system.

Because of the agronomic similarity between pulse crops and weedy type pulses it is not surprising these form a major contamination of pulse seeds.

The perceived relative importance of the crops to the farmer and its end use may also reflect the differences in contamination of seed between wheat, barley, triticale and oats and pulse crop types. Higher value crops like wheat favour higher management regimes due to better returns than lower value crops like or oats and vetch.

The failure to recognise that weed seeds sown with crop seed, even at low contamination levels, may not have an effect in the crop sown but may have potentially damaging long-term effects in crop choice and weed management options needs to be considered. It is interesting to note that the newer barley variety Arapiles had significantly lower contamination than older varieties of barley. This may indicate a higher value of this variety but may also reflect the shorter period Arapiles has had in the rotations and hence less time for contamination levels in the seed to build up.

In all crops (except vetch) there was at least one weed free sample indicating that it is possible to use weed free seed for crop establishment.

Self-assessment of seed quality before sowing will increase the awareness of weed problems that are being perpetuated through contaminated crop establishment seed. This self-assessment is easily achieved by taking a 1 kg sample of the sowing seed and sorting through this. By separating the foreign seeds from the desired crop seed, the farmer asks themselves the question 'are they happy sowing the level of contamination in the paddock?'. If the answer is no, then the seed needs to be re-cleaned and re-assessed or an alternative source sought.

Growers should be aiming for weed free sowing seed. Indicated by the results of this survey this is achievable in most crops.

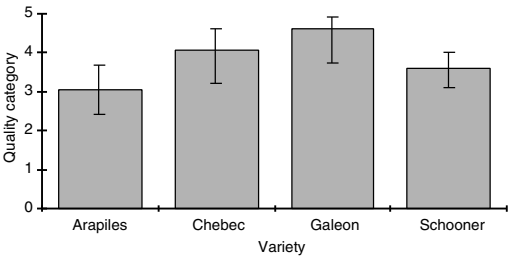

Figure 3. Quality category estimates for barley varieties.

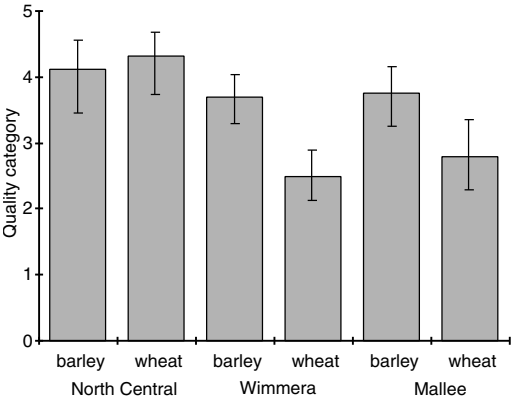

Figure 4. Regional differences between wheat and barley quality category estimates.

ACKNOWLEDGMENTS

Thanks go to the farmers and TopCrop coordinators who contributed and collected seed for this survey. A. Chambers, R. Argall and R. Perris for assistance in assessing samples. DNRE and GRDC for financial support. C. Wright for assistance with statistical analysis.

REFERENCES

Girch, L., Weinhappel, M. and Schwarz, H. (1996). Ecological aspects of the use of certified seed in comparison with saved seed. *Forderungsdienst* 44 (7), 45-52.

Mock, I.T. (1987), Distribution and severity of brome grass in barley crops in the Victorian Mallee. *Plant Protection Quarterly* 2 (3), 135-136.

Mock, I.T. and Amor, R.L. (1982). Brome grass (*Bromus* spp.) as contaminants of barley grain in the Victorian Mallee. *Australian Weeds* 2 (1), 16-17.

Salisbury, E.J. (1961). 'Weeds and aliens'. (Collins).

Scott, D.J. and Hampton, J.G. (1985). Aspects of seed quality, *In* 'Producing herbage seeds'. Grasslands Research and Practice Series No. 2, pp. 43-52, eds M.D. Hare and J.L. Brock. New Zealand Grassland Association, Palmerston North.

Tonkin, J.H.B. and Phillipson, A. (1973). The presence of weed seeds in cereal seed drills in England and Wales during spring 1970. *J. Nant. Inst. Agric. Bot*. 13, 1-8.