HGCA

PROJECT REPORT No. OS29

AN ANALYSIS OF THE POTENTIAL FOR IMPROVING SEED QUALITY IN OILSEED RAPE AS A BASIS FOR OPTIMISING ESTABLISHMENT

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AN ANALYSIS OF THE POTENTIAL FOR IMPROVING SEED QUALITY IN OILSEED RAPE AS A BASIS FOR OPTIMISING ESTABLISHMENT

by

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Contents

Summary

Oilseed rape is the most widely grown combinable crop in the UK; about half a million hectares were drilled in 1997 with about 90% sown in the autumn. The establishment period of rape is crucial. Too few plants will restrict canopy expansion during autumn, reducing growth and the ability of the crop to compete with weeds and pigeons. Patchiness exacerbates the problem by reducing the uniformity of crop growth and development leading to less uniform ripening, often necessitating the greater use of pre-harvest desiccants. In extreme cases, total crop failure requires crops to be re-sown or the cropping sequence to be changed. Crops of winter rape are particularly at risk during a six month period from September to February and in the worst years, establishment can be so poor that up to 30% of rape crops have been abandoned. Plant failure during establishment has often been associated with poor seedbeds because almost three quarters of the oilseed rape grown is drilled into clay soils, and it is on these soils, especially where cereal residues have to be incorporated, that seedbed preparation is difficult and crop failure most likely to occur.

Previous studies by McWilliam *et al.* (1995) and a recent review of establishment (Bullard *et al.*, 1996) have examined the effect of cultivation equipment on seedbed production in the presence of cereals residues and on subsequent seedling survival. Whilst substantial benefit can be derived a better understanding of seedbed structure, better control of cultivation will never be able to provide the whole solution to the establishment problem on heavy soils where cereal residues are incorporated. These investigations indicate that the quality of the seed itself can have significant implications for success or failure. Small seed was extremely sensitive to deep sowing and also when the soil covering them was more compact than 1.2 g of soil cm^{-3}. Furthermore, germination in the field where water was not limiting, but where temperatures were low (5°C), was markedly reduced to less than 70% compared with germination in the laboratory at temperatures closer to the ideal.

The aim of the work reported here was therefore to examine the potential for improving seed quality in oilseed rape and to gauge whether or not this would be sufficiently worthwhile to explore as a viable means of improving establishment.

At the University of Nottingham and at ADAS, experiments in controlled environments have examined patterns of germination and emergence to determine the potential advantages from selecting variety, seedlot (of the same variety), and large and small seed

from within the commercial grades. Often during the germination and emergence phases, the supply of water is marginal and there may be osmotic forces from fertiliser and leachates. To shorten the period between sowing and germination in an attempt to reduce exposure to these forces when the seed/seedling is small and most susceptible, seeds were advanced by priming and drying back. The following key results were found:

Performance of a range of seedlots used by growers in 1996 varied markedly in the speed and uniformity of germination, particularly at temperatures similar to those experienced in the field. Variation between seedlots of the same variety was as large as the difference between varieties, and in some cases, treatment with fungicide and insecticide reduced germination. Seedlots showing more rapid germination emerged better from deeper sowing. From within these commercial seed grades, selecting the half with larger seeds resulted in individual seed weight being increased by 30%. Associated with this increase in size, the seed was able to emerge better from deeper drilling as would be the case in dry conditions when growers tend to place the seed at depth where moisture is more available.

The speed of germination, emergence and early seedling development were all improved by seed advancement. There was no adverse effect of advancement until the radicle emerged when drying back substantially reduced subsequent root growth. Advancement in polyethylene glycol offered no benefit over water. An understanding of variety and seedlot response to temperature was crucial for determining safe durations of advancement.

There was strong evidence that the potential benefit from seed advancement was greatest where seeds were sown 3cm deep or deeper, a zone in which many seeds have been found in growers' fields. Advancement also increased the number of seeds which germinated where osmotic stress was caused by dry soil, fertilizer N or leachate from decomposing straw.

There were indications that the improvements possible from each individual step, i.e. seedlot selection, seed grading and seed advancement, might combine to give a large overall benefit in specific situations. These potential improvements in germination and emergence from seed selection / advancement are being developed under continuing funding from HGCA which will provide first indications of whether the strategic combination of specific treatments will produce more than additive advantages, particularly where stresses are severe.

A crucial finding from this work, with important consequences for growers, is that temperature during germination affects both the pattern and final germination percentage of some varieties / seedlots far more than others. These differences will not only have direct implications for establishment (e.g. suitability to later sowing at more northerly sites where seedbed conditions are likely to be colder), they will also have implications for the benefits likely to follow from seed selection and seed advancement.

Introduction

Oilseed rape is the third largest combinable crop in the UK. In 1996, over half a million hectares were drilled with 85% sown in autumn because of the larger yields from winter rape. Economically viable production of winter oilseed rape for both food and industrial use can only be achieved where plant populations in spring are satisfactorily high and uniformly spaced. Unsatisfactory establishment commonly results from failure during the establishment phase in early autumn, rather than from plant loss over winter although overwintering loss can be important. Patchy crops are characterised by uneven plant competition and inefficient use of water, light and nutrients, uneven plant development and maturity. Furthermore, pigeons are attracted where landing spaces are available and their grazing exacerbates the problem. In poorly established crops, poorer competition with weeds often results in use of more agrochemical during winter and early spring.

Establishment of rape in autumn is difficult. In dry years, incorporation of cereal residues usually results in dry cobbly seedbeds; water supply to the seed is limited but is often not uniform at all seed sites because of local differences in seed /soil contact. Germination may be patchy but importantly, after radicle protrusion, seeds are particularly vulnerable to desiccation if water supply is not maintained before an adequate root system has developed. In wetter, colder years, seeds usually imbibe rapidly but then take longer to reach a size where they are less likely to be killed by waterlogging, toxin production from decaying cereal residues and the activity of slugs. The scale of the establishment problem is such that in some years as much as one third of the autumn sown crop is ploughed up.

The aim must be to the improve the speed and uniformity of the establishment process. HGCA has funded work to examine the effects of cultivation on the complex interactions at the seed / soil interface and progress in this area is presented in Bullard *et al.* (1996). However, developments in cultivation and machinery cannot provide all the answers, and there is the need to look for more strategic areas of improvement. Where rainfall is limited during June and July, the effects of dry soils are often exacerbated by the need to cultivate and incorporate straw. Here moisture conservation and maintenance of supply to the germination / emerging seed is crucial. Where rainfall is excessive, anaerobic conditions and the presence of leachates from decomposing straw place contrasting pressures on small seedlings. In both circumstances, there will be substantial benefit to establishment from reducing the time from sowing to the point where the young seedling is less vulnerable to death from desiccation or excessive water supply. In these conditions, one potential approach is seed advancement. Seed advancement, a treatment in which seeds are hydrated sufficiently to allow preparative events for germination to occur, but are insufficiently hydrated to allow the radicle to emerge, followed by drying back before sowing, can bring forward and sometimes synchronise germination (Gray and Martin, 1995). Seed advancement has been shown to reduce the time to emergence in a range of species for example, sugar beet (Durrant, Jaggard and Scott, 1984); lettuce (Seale, Cantfliffe and Stoffella, 1993); celeriac (Drew and Dearman, 1993); canola (Rao and Philips, 1993). Zheng et al. (1994) further showed preliminary evidence that priming canola seed gave significant benefits to establishment, especially when sowings were made into cold soils. In further studies (McWilliam *et al.*, 1995; and unpublished) small seed was found to be extremely sensitive to both deep sowing and when the soil covering them was more compact than 1.2 g of soil cm^{-3}. Furthermore, germination in the field where water was not limiting, but where temperatures were low (5°C), was markedly reduced to less than 70% compared with germination in the laboratory at temperatures closer to the ideal.

Therefore, the thrust of the work reported here is to examine for potential benefits from reducing the period from sowing to first emergence so that the period when the seed / seedling is most vulnerable is shortened as much as possible. Then to examine for potential benefits from selecting larger seeds from within commercial samples. It is only by undertaking this more fundamental work that the overall benefit to establishment from improving seed quality can be assessed.

Objectives

The objective of this project was to identify the potential benefits to establishment from improving seed quality. This consists of two elements: 1) an analysis of the variation in seed quality found within commercial seedlots, and b) an analysis of the performance of particular selections of seed so that those types most susceptible , and those most tolerant to the stresses operating in the seedbed can be determined.

Materials and Methods

List of Experiments reported

- The effect of advancement on seed performance and effect of duration of advancement
- The effect of aggregate size on the rate of soil drying and the ability of advancement to overcome germination difficulties
- The effect of depth of sowing and seed size on germination and rate of emergence
- The effects of seed advancement on germination and emergence from a range of seed sizes and sowing depths
- The osmotic effects of N on germination and emergence and the interaction with seed advancement
- The osmotic effects of straw leachate on germination and emergence and the interaction with seed advancement
- The effects of seed treatment on germination and emergence
- The response of 16 seedlots to temperature

General :

The seed used in these experiments were taken from 16 lots sampled from batches sown in autumn 1996. These were obtained from a range of sources, mainly ADAS Research Centres and can be taken to be representative of the seed sown commercially. In addition two lots (S1 and S2) were obtained with and without fungicide treatment. Most of the experiments used two seedlots of cv. Bristol (S1 and S13). Both were treated with gamma HCH and fenpropimorph (Lindex + FS). Seeds from other seedlots were used as appropriate. All seedlots were tested in experiments to determine the seedlot response to temperature.

Germination tests of advanced / selected seeds were conducted at either 15 or 20 °C. Twenty five or 30 seeds were placed on 2 sheets of Whatman No. 1 filter paper, 6 ml of water was added and the lid replaced. In a preliminary experiment the volume of water applied was found to have negligible influence on the progress to germination: between 4 and 8 ml, there was no observed effect. There were between 3 and 5 replicates per individual treatment but, as most experiments were factorial combinations, there were as many as 50 replicates per main factor effects in some experiments.

Emergence tests were conducted in horticultural silver sand in 12 cm diameter pots. The required depth of sand was added to the seed so that the surface of the sand was at the same height in each pot regardless of the depth that the seed was sown. In the emergence tests, water was frequently applied to ensure seedlings were not exposed to drought.

Seed advancement (priming) methodology

All seed was advanced by placing in water at 15 °C for the required duration after which seeds were removed, blotted dry and dried until constant weight at between 20 and 25 °C. This usually took approximately 2 hours in a dry room environment but slightly less in forced draft conditions. In a preliminary experiment, the rate of drying of advanced seed was doubled without any detriment to subsequent germination. When compared with water, advancement in 5% and 10% solutions of polyethylene glycol gave no improvement and were therefore discontinued as treatments.

Experiment 1 - Duration of advancement:

In this experiment, seeds from S1 and S13 were advanced for either nil (control), 6, 12, 18, 24, 30, or 36 hours at 15 °C and the number of germinated seeds counted. Following drying back and storage for 2 days, germination tests were conducted at 15 °C. At the end of the experiment, the number of seeds with abnormal radicles (stunted and discoloured, usually with no root hairs) were counted.

Experiment 2 - Soil drying:

This experiment was conducted to identify the effect of soil type and aggregate size on the rate of soil drying and to determine whether or not pre-treatment of seed conferred advantage in rapidly drying soils, typical of those often found in autumn. Seedlot 1 was used for this experiment. Factorial combinations of soil type (Dunnington Heath {sandy loam}, Fladbury {alluvial clay}), aggregates size (2-3.35mm, 3.35-6.75mm, 6.65-11mm) and seed advancement (nil {control}, advanced for 18 hours) were replicated three times in foil trays. Each tray was subdivided into split plots of large and small seed (largest and smallest halves from the original seedlot). Each tray was covered with 1.5cm soil, the seeds placed on top, a further 1.5 cm soil applied, levelled and then misted with water for about 2 hours until drainage occurred through the foil tray. At this point it was assumed that the soil was at field capacity. The trays were placed in a growth room at 20 °C with a 16 / 8 day/ night lighting cycle. No further water was added. Soil drying was measured by weighing the trays daily and then calculating the gravimetric water content expressed as a percentage of dry soil. Emerged plants were counted as soon as their cotyledons could be seen above soil surface and were classed as dead when the cotyledons and hypocotyl had shrivelled.

Experiment 3 - Depth of sowing:

This experiment tested the benefit from advanced seed when sown at differing depth. From previous analyses in the field, it had been found that seed depth was often poorly controlled and a sizeable proportion of seeds could be sown at 6 - 8 cm. Seeds from S1 and S13 were advanced and compared with non-advanced seed sown at either 1, 3 or 6 cm deep into horticultural silver sand. Plant emergence was counted daily .

Experiment 4 - Seedlot, size selection and advancement on response to sowing depth:

Factorial combinations of seedlot (S1, S7, S13); seed size (largest and smallest halves from the original seedlot); advancement (nil {control}, advanced for 18 hours) were tested in 4 replicates of germination tests and 3 replicates of emergence tests in silver sand.

Experiment 5 - Osmotic effect of N:

The aim of this experiment was to determine whether or not choice of seedlot (S1, S7, S13); seed size (largest and smallest halves from the original seedlot) or advancement (nil {control}, advanced for 18 hours) gave any advantage for germination when seed came into contact with a solution of N likely to inhibit germination. In a preliminary experiment, it was found that a concentration of 15g NH4+NO3- in 1l of water produced an osmotic solution which substantially delayed the onset of germination and reduced the final number of seeds which germinated. Germination tests were conducted in petri dishes with either 6 ml of water or 6 ml of this ammonium nitrate solution.

Experiment 6 - Osmotic effect of straw leachate:

Leachate from decomposing wheat straw was produced by incubation with surplus water (about 10 litres per 2kg of straw. 3 samples were incubated for 48 hours after which all the solution was drained from the three samples and mixed. In a preliminary test, it was found that this leachate (without further dilution) reduced both the rate of germination and the final number of seeds to germinate. The effect of leachate was tested against the effects of water on germination of advanced and control seed from seedlot S1.

Experiment 7 - Effect of seed treatment:

It was only possible to obtain untreated samples of 2 seedlots (S1 and S2). Therefore these data must be regarded as provisional. Treated and untreated seeds from S1 and S2 were advanced (18 hours in water at 15 °C) and compared with non-advanced seed in germination tests.

Experiment 8 - Response of seedlot to temperature:

This experiment examined the germination responses of the 16 treated seedlots to temperature (5, 10, 15, 20 °C) to identify whether to progress from initial imbibition to 90% germination and final germination percentage was affected by temperature.

Results and Discussion

Experiment 1 - Duration of advancement

This experiment showed that advancement of seed brought forward the onset of germination and the attainment of final germination score. However, there were subtle differences between seedlots. Firstly, the control treatment in S13 took slightly longer to germinate and, after each advancement duration, more seeds had germinated during the period of advancement (i.e. shown by the number of seeds which had 'germinated' at the start of the germination test (Figure 1). Thus it appears that the time from imbibition to radicle emergence differs between seedlots. This is important because any seed which germinates prior to drying back is very likely to produce abnormal roots (Figure 2). Nevertheless, this experiment demonstrated that substantial hastening of germination can be achieved by advancement with water. The longer the duration of advancement, the more the onset of germination was brought forward.

Not all seeds which germinated prior to drying back produced abnormal roots (about 30%). It is possible that whilst the radicle is very small it may adequately survive desiccation. However, should a large proportion germinate and die during drying back, then the earliest germinating seeds and presumably those with the highest vigour might be lost to the detriment of the seedlot as a whole.

Experiment 2 - Soil drying

The greater available water content of the alluvial clay resulted in substantially more water being available during the period of soil drying (Figure 3). It is important that the smaller aggregates of both soils resulted in faster drying probably because of their larger surface area to mass and hence increased surface evaporation.

The increased water supply from the alluvial clay resulted in substantially more seedlings emerging however, these died as soil water fell below 15%. More plants emerged in the soils composed of larger aggregates, presumable because they supplied water for longer. This finding has important implications for soil cultivation: smaller aggregates will improve seed / soil contact which may increase initial water transfer but, if these soils dry more quickly, the seed will be more vulnerable to desiccation during dry cycles. Seed advancement and selection of larger seeds resulted in 25% and 1% more plants emerging but did not delay the onset of senescence due to soil moisture deficiency (Figure 4).

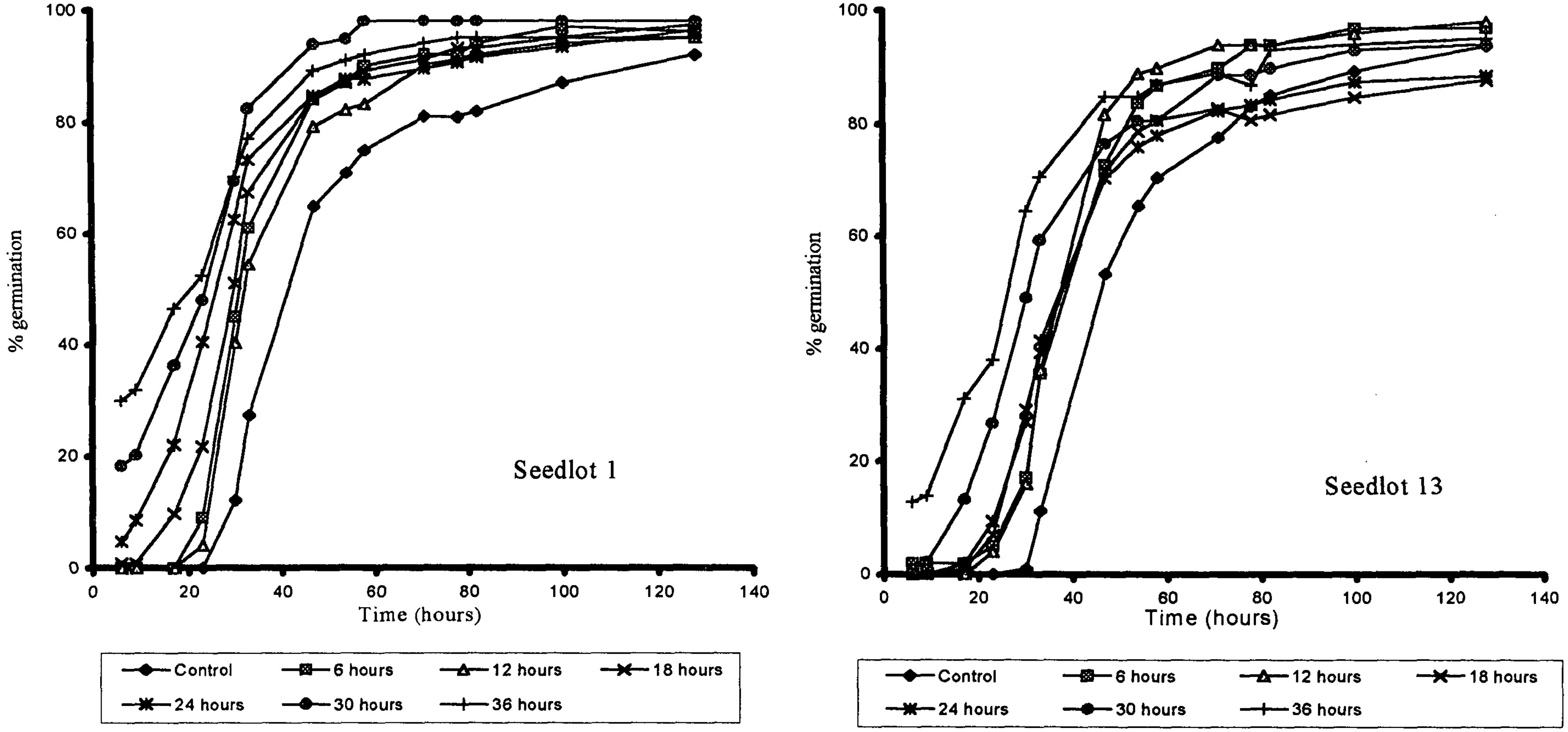

Figure 1 Effect of duration of advancement (hours in water at 15 °C followed by drying back to constant dry weight) on germination on filter paper at 15 °C of seedlots 1 and 13.

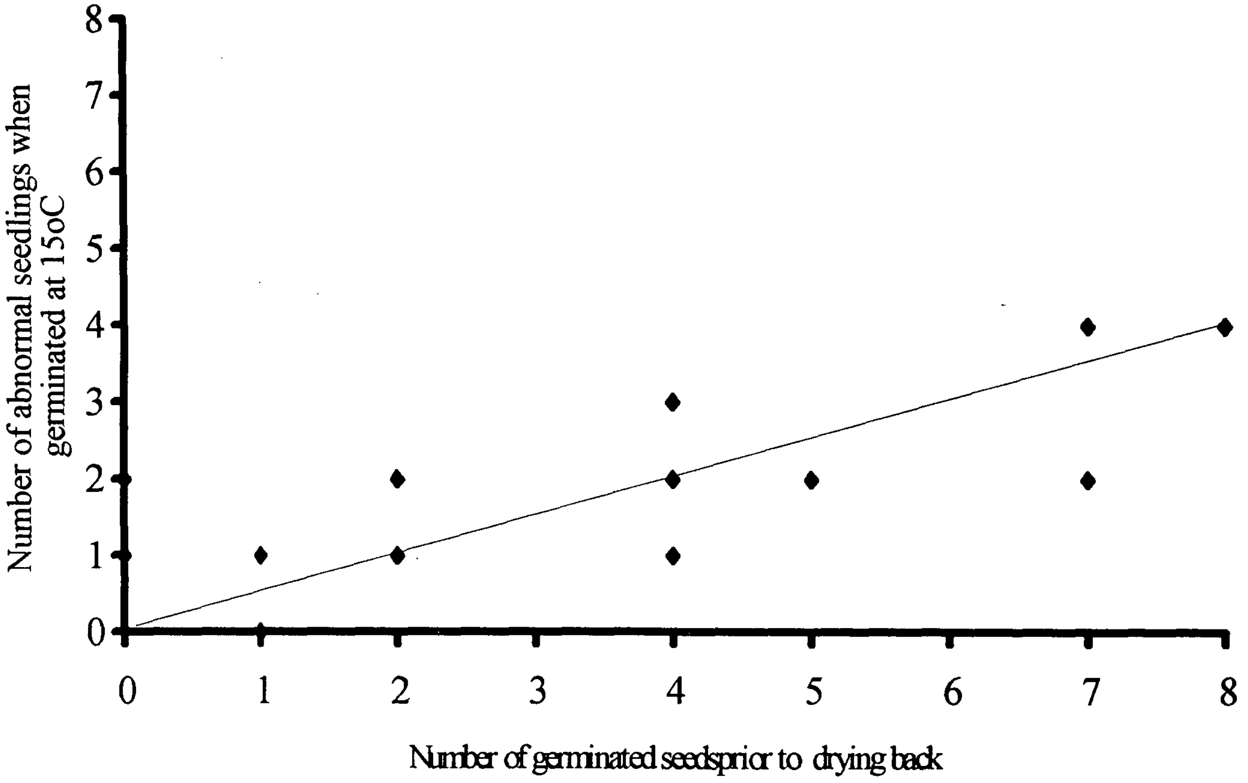

Figure 2 Relation between the number of seeds per petri dish with radicles visible prior to drying back and the number of seedling which subsequently produced abnormal radicle growth when germinated at 15 °C.

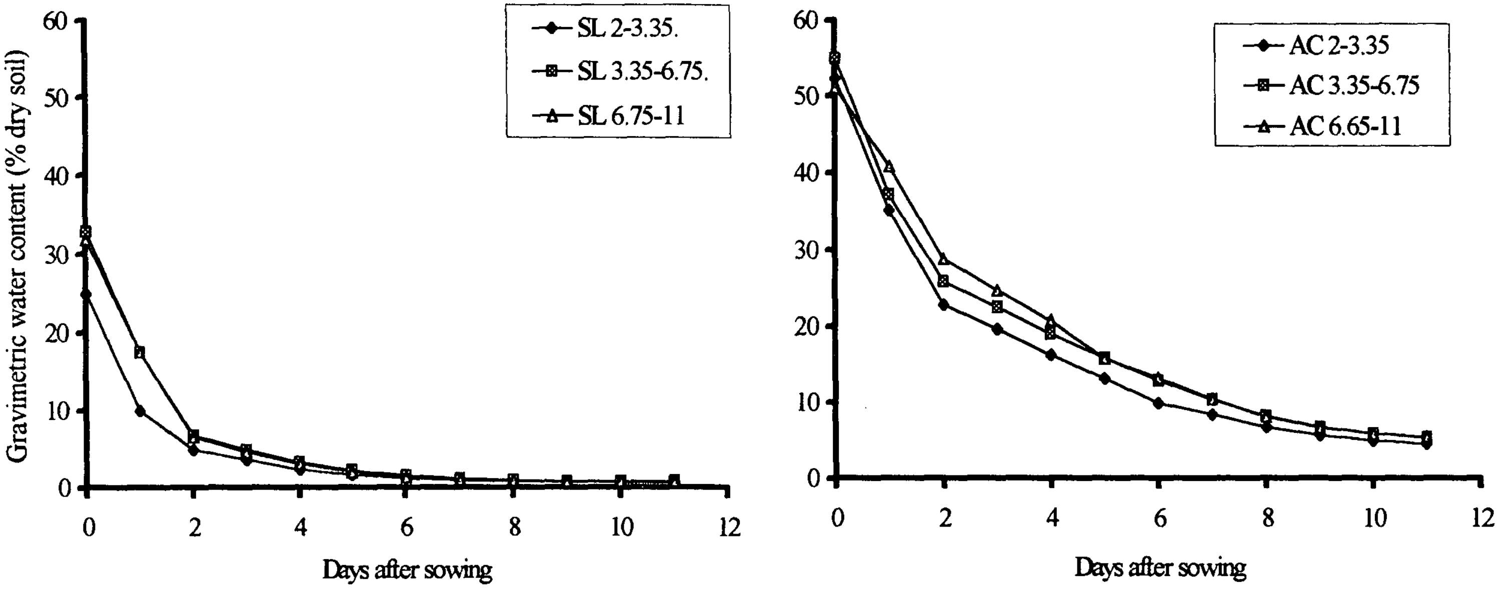

Figure 3 Progress curves for soil drying of different aggregate sizes of the Dunnington Heath sandy loam (SL) and the Fladbury alluvial clay (AC) soils. Field capacity was achieved at sowing and soils were not subsequently watered.

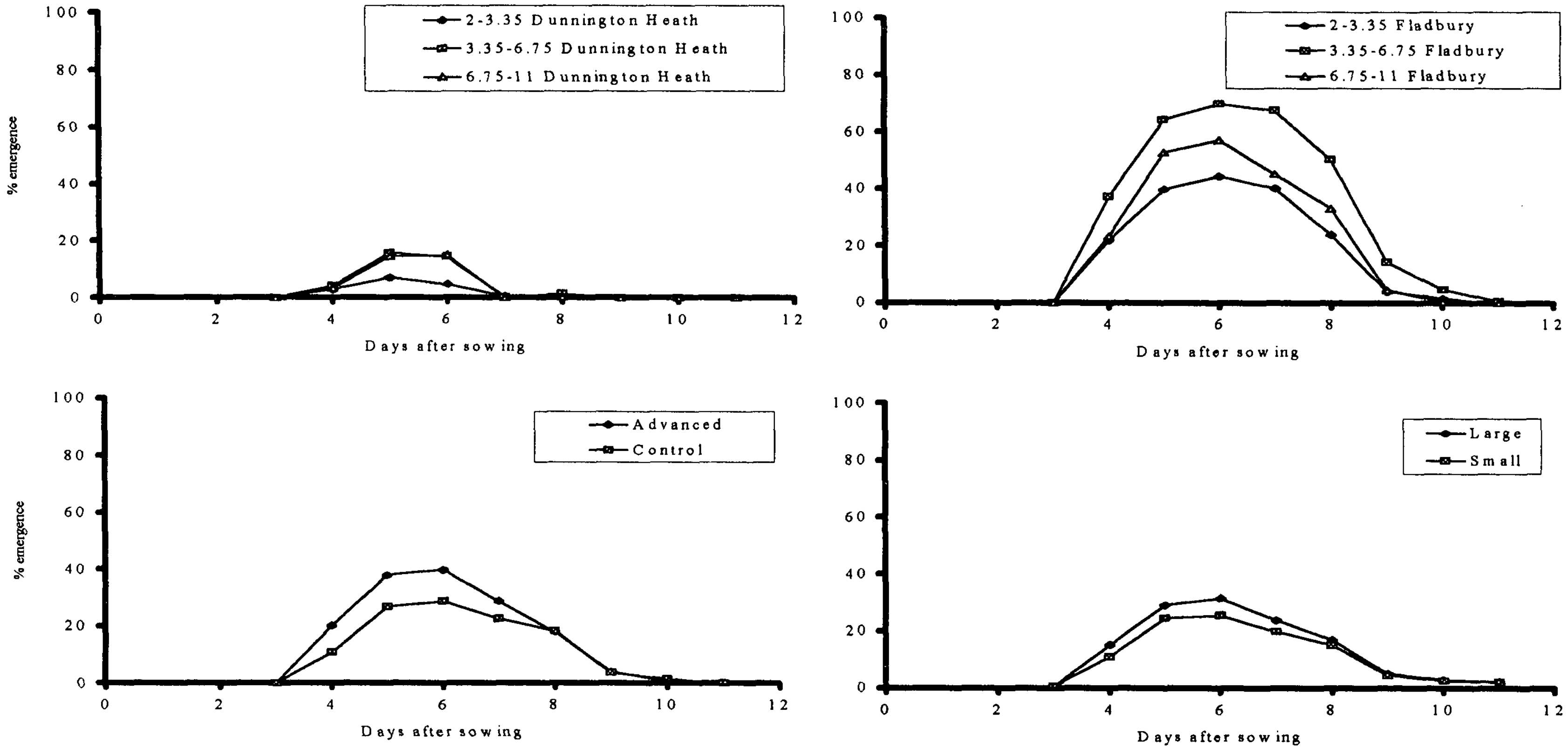

Figure 4 The overall effects of soil type and aggregate size, seed advancement and seed size selection on percentage emergence during soil drying.

Experiment 3 - Depth of sowing

The effect of advancement on emergence in silver sand is shown in Figure 5. Deeper sowing resulted in significant delays in both date of first emergence and the number of plants to emerge after 20 days. Seed advancement had little effect on seeds sown 1 cm deep but produced substantial improvements, doubling and tripling the number of plants to emerge from 3 and 6 cm respectively. The explanation for this response in not clear, however, if deeper sowing results in less available oxygen, then progress from imbibition to germination may be slowed. Thus, if more of the germination process can occur in more ideal conditions (i.e. during advancing) then the negative effects of deeper sowing will have less time to manifest before the seed germinates.

Experiment 4 - Seedlot, size selection and advancement on response to sowing depth

In this experiment, further evidence was found to substantiate the differences in germination pattern between seedlots: seedlot 7 (Synergy), showed the most rapid and most complete germination (Figure 6). Seed advancement reduced the time to 50% emergence by about 20 hours; approximately equivalent to the duration of the advancement treatment. Large and small seed responded similarly to advancement but always germinated more rapidly then larger seed because of their greater surface area to mass ratio and hence more rapid imbibition.

In the emergence tests, Synergy (S7) emerged more rapidly and produced more plants then S1 and S13 especially when sown at 6 cm. Thus the more rapid germination in Synergy may be linked to the better emergence in the same manner that advancing improved emergence in the previous experiment. In this experiment small seed germinated more rapidly than large. However, this did not markedly improve emergence and, when sown 6cm deep, small seed was significantly poorer than large seed. Seed advancement significantly improved emergence particularly at depth; emergence was increased more than five-fold (Figure 7).

Figure 7 Mean effect of seedlot, seed size and seed advancement (18 hours in water at 15 $^{oC)}$ on emergence at 20 ^{oC} when sown in silver sand at 1, 3 and 6 cm deep.

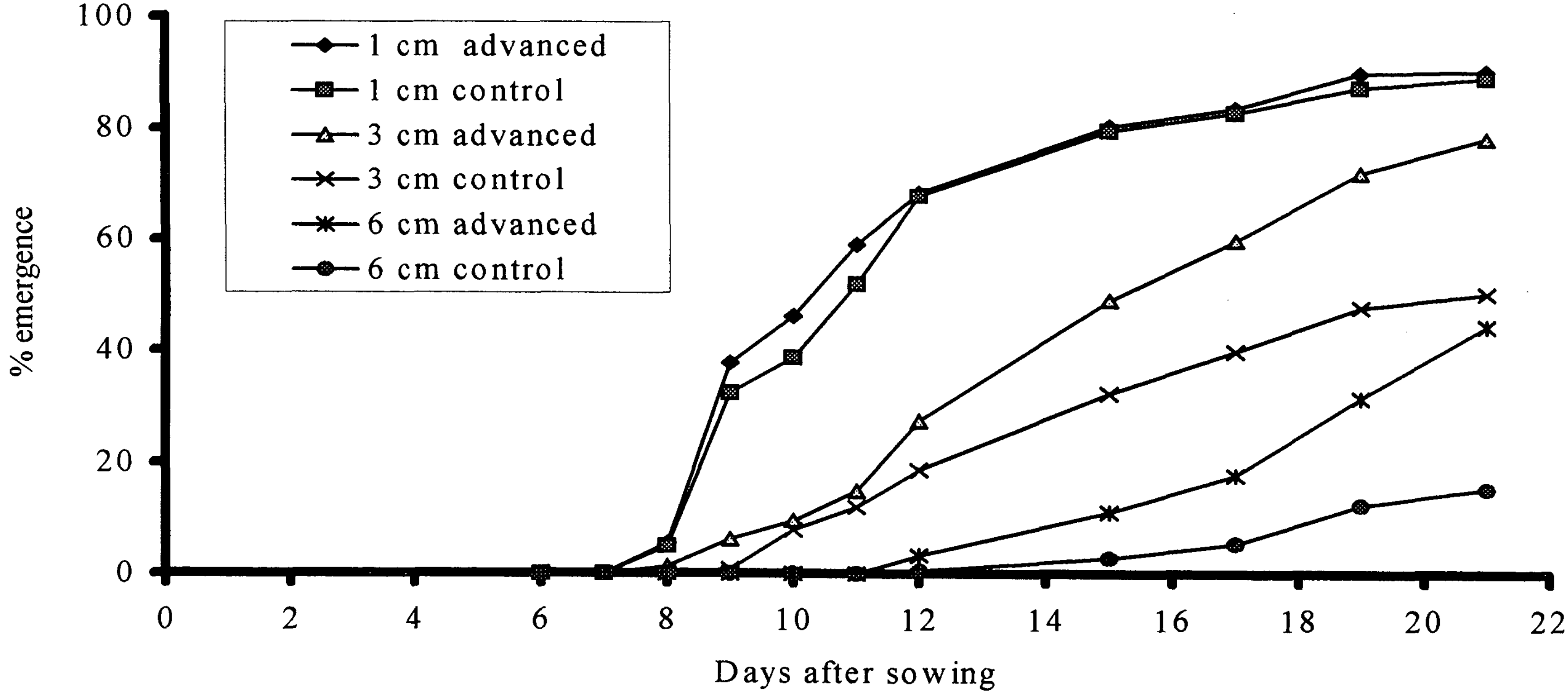

Figure 5 Effect of seed advancement (18 hours in water at 15 °C) on plant emergence at 15 °C after sowing at 1, 3 and 6 cm deep into horticultural silver sand.

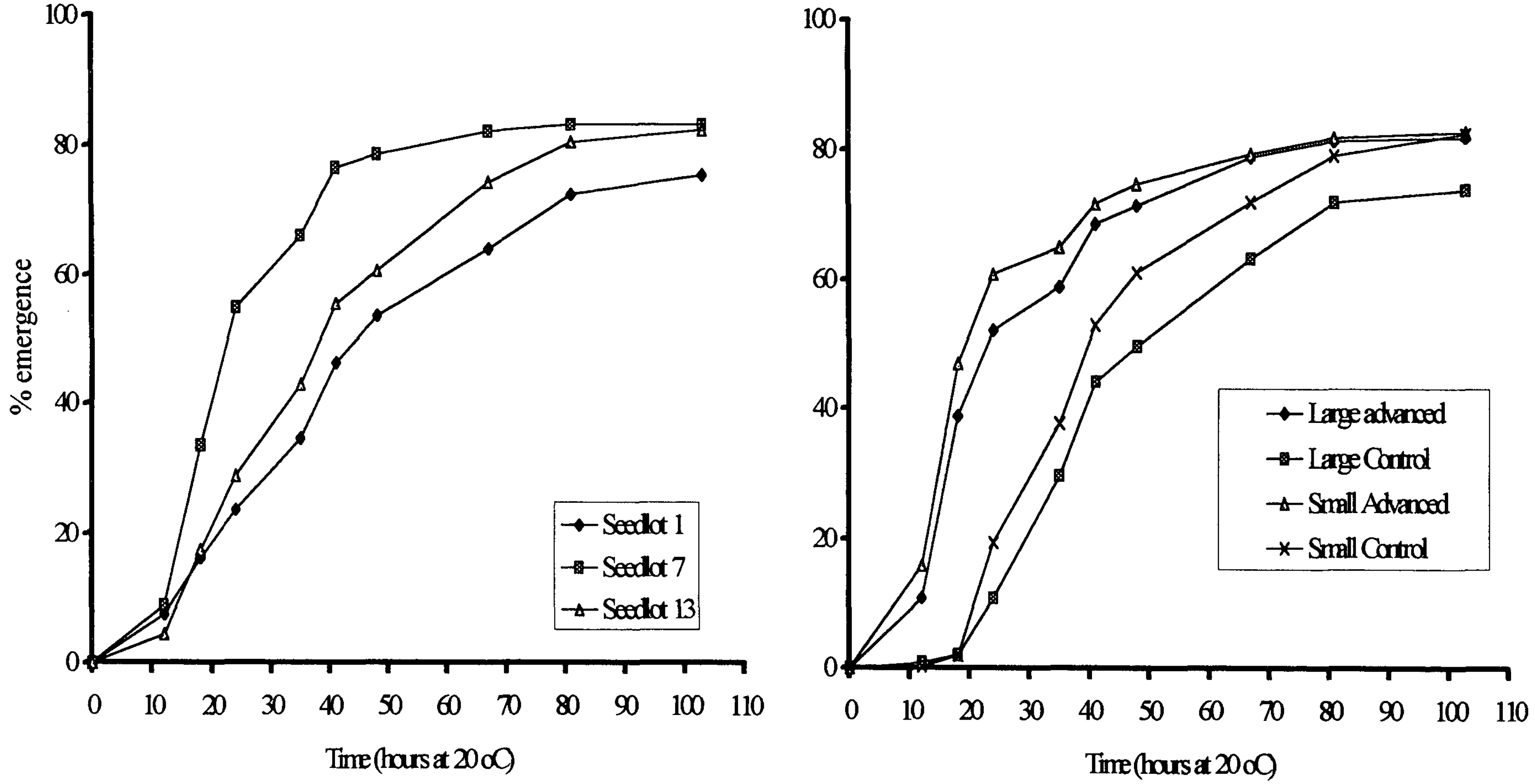

Figure 6 Mean effect of seedlot and advancement (18 hours in water at 15 °C) of large and small seed on germination on filter paper at 20 °C.

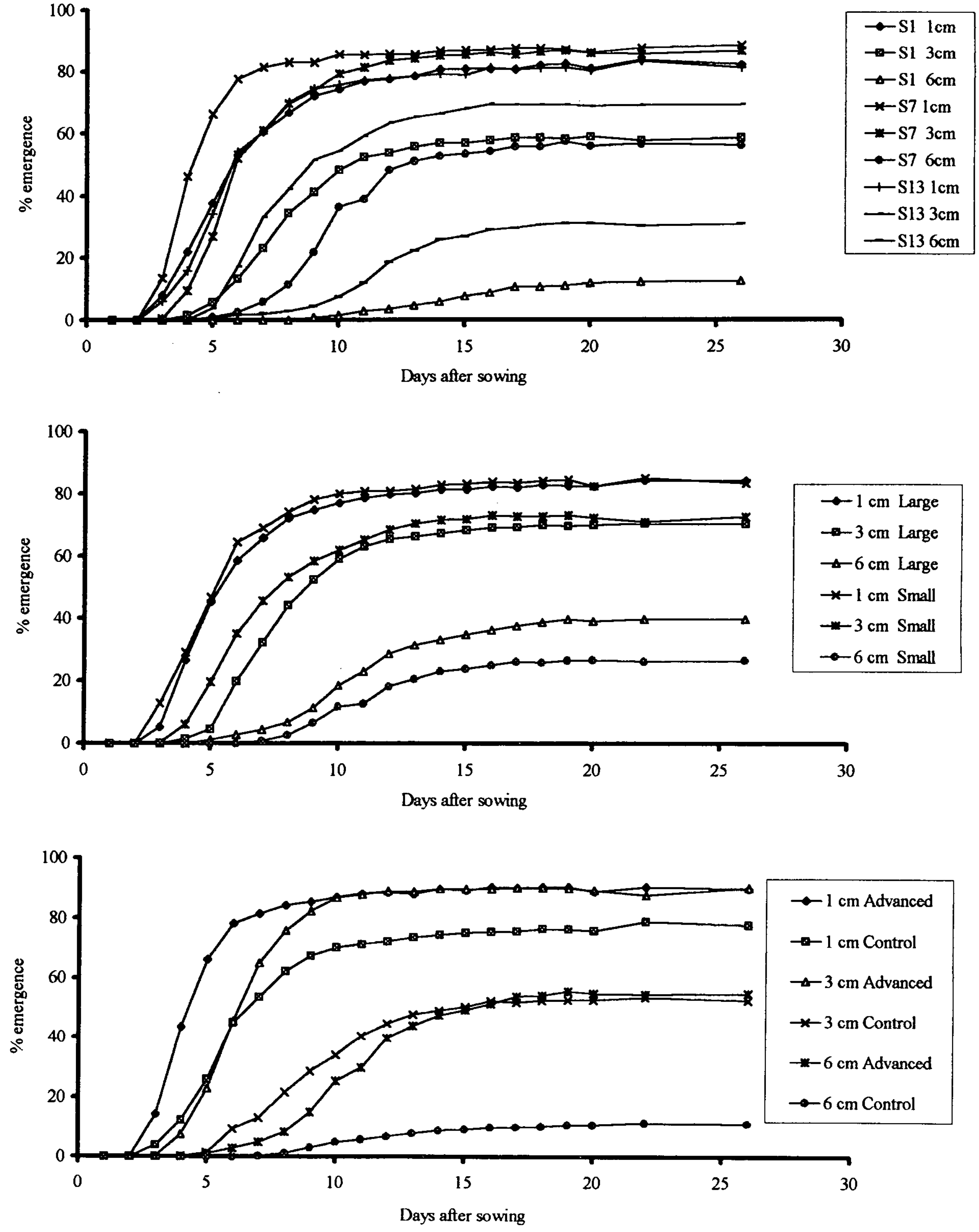

Figure 7 Mean effect of seedlot, seed size and seed advancement (18 hours in water at 15 °C) on emergence at 20 °C when sown in silver sand at 1, 3 and 6 cm deep.

Experiment 5 - Osmotic effect of N

The effect of an ammonium nitrate solution sufficiently concentrated to impair germination on germination seedlots S1, S7 and S13, large and small seed and advanced seed is shown in Figure 8. S7 germinated more rapidly than the other two seedlots when germinated in water. There was little difference in final germination. However, when germinated in the solution of ammonium nitrate, S7 was substantially better, producing twice as many seedlings than S1.

Selection of larger seed improved germination in the solution of ammonium nitrate only, increasing the number of seeds germination by about 20%. In water, seed advancement hastened the onset and rate of germination but not the final number. In contrast, when exposed to osmotic solution, advancement increased the onset, rate and doubled the number of seeds which germinated. The next step with this work is to examine for osmotic damage to the radicle to identify if these promising treatments confer any protection against osmotic scorch after germination.

Experiment 6 - Osmotic effect of straw leachate

In water, significantly more seed germinated within 20 hours following seed advancement (Figure 9). The non-advanced seed germinated more slowly but the final number of seeds to germinate were similar. In the presence of leachate, seed advancement increased six-fold the number of seeds germinated after 30 hours and almost doubled the final number of seeds to germinate.

Experiment 7 - Effect of seed treatment

On S1, seed treatment did not affect the time of onset of germination but reduced the rate of germination and the final number to germinate (Figure 10). Seed advancement improved the rate of germination in both treated and untreated but these data indicate that seed treatment on this seedlot had a negative effect on the pattern of germination which was comparable with the magnitude of the positive benefit from the advancement of the untreated seed. Thus in this case, it appears that seed treatment and seed advancement can have additive effects on the pattern of germination.

In S2, there was no detrimental effect of seed treatment and seed advancement had the same effect of both treated and untreated seed.

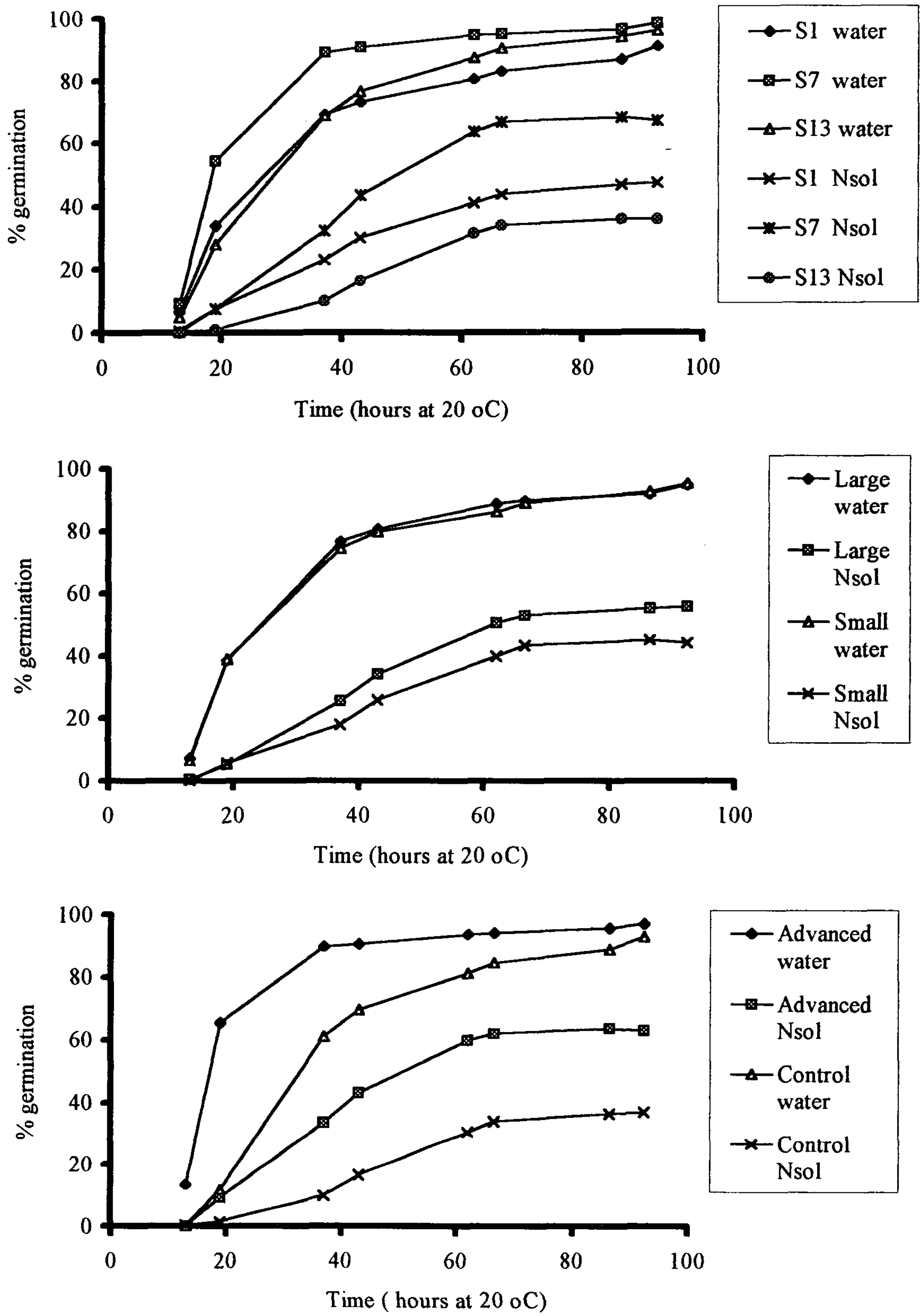

Figure 8 Effect of seed advancement (advanced; control), variety (S1, S7, S13) and seed size (large; small) on germination in the presence of osmotic forces from fertiliser N

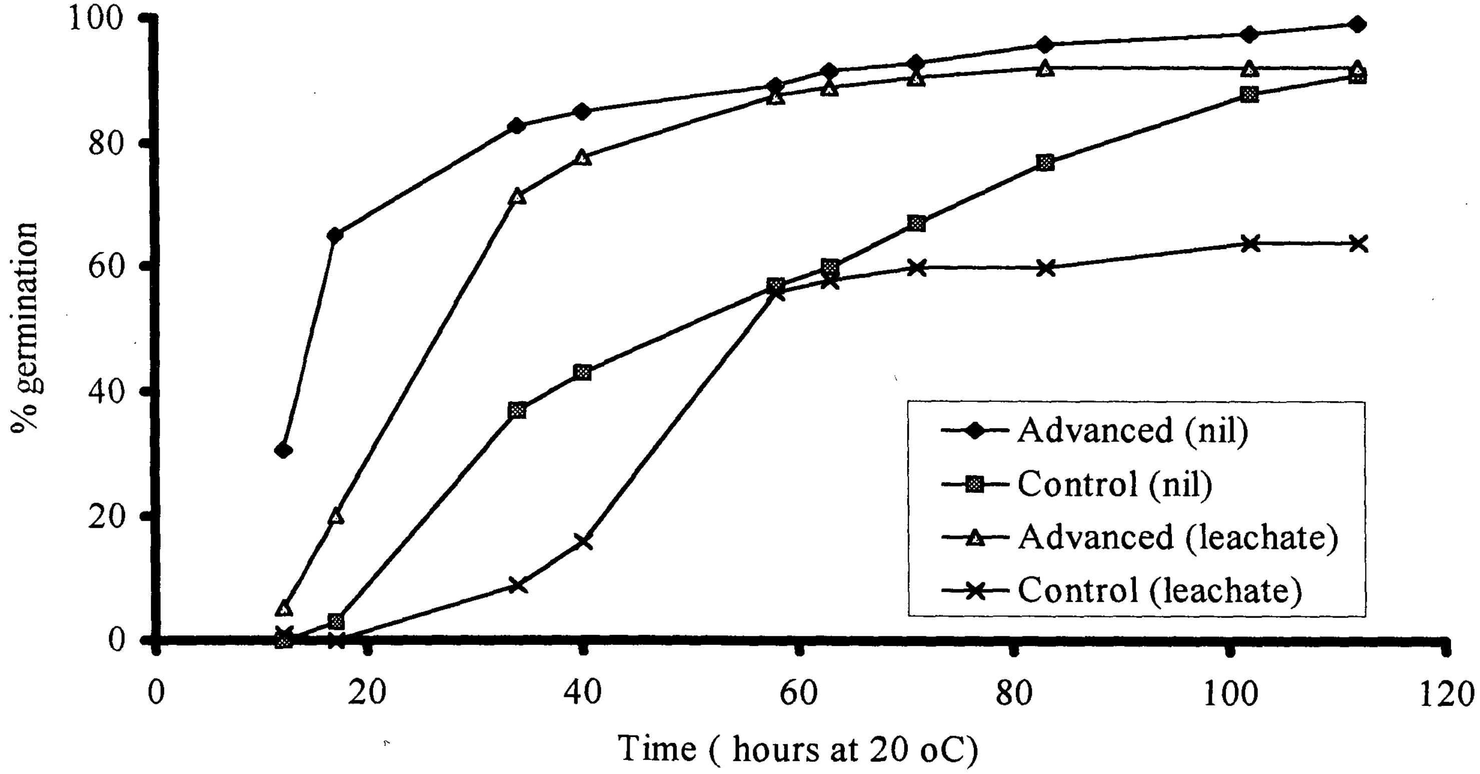

Figure 9 Effect of seed advancement on germination in the presence of straw leachates.

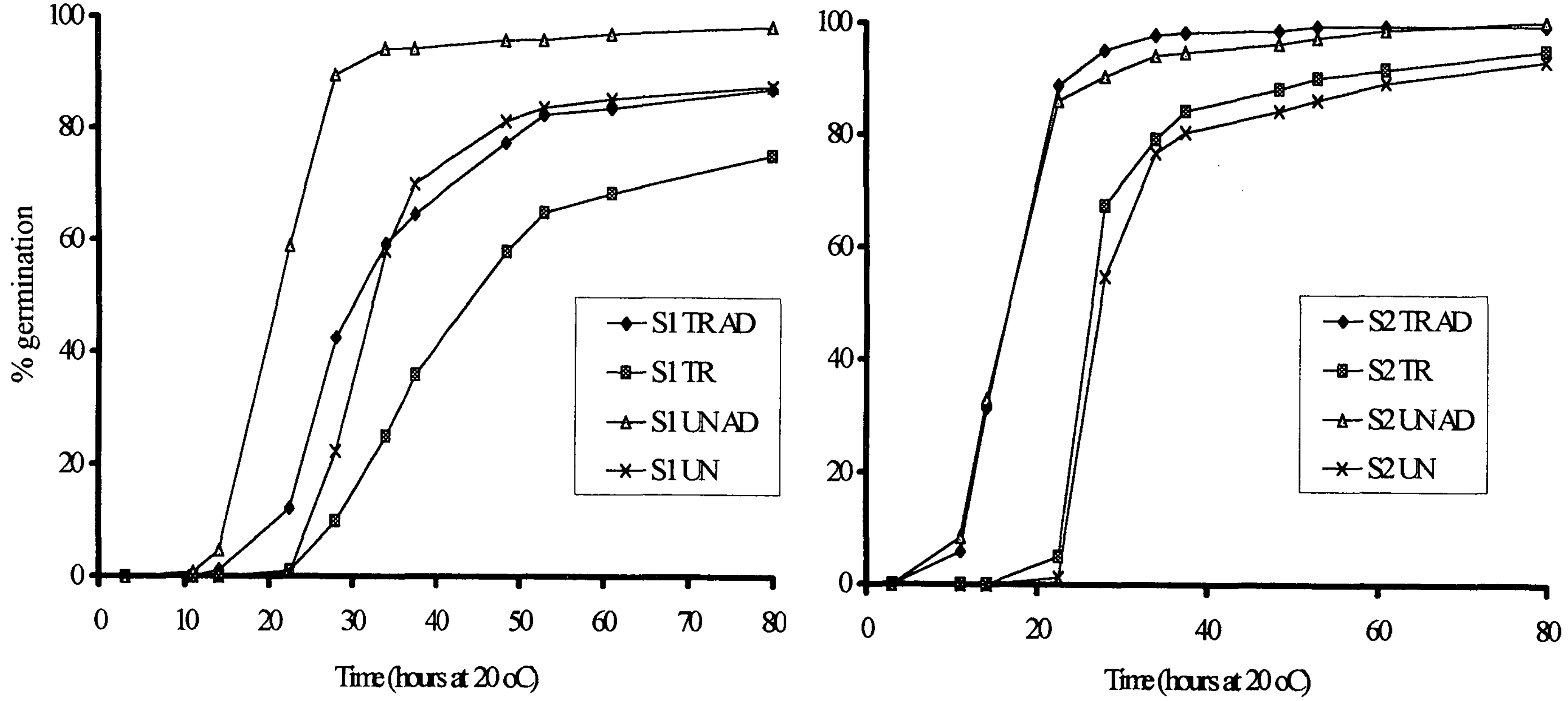

Figure 10 Effects of seed treatment (TR: Gamma HCH plus Fenpropimorph [Lindex FS]) and seed advancement (AD =18 hours in water at 15 oC) on germination on filter paper at 20°C.

Experiment 8 - Response of seedlot to temperature

During the course of these investigations, it became increasingly apparent that there were potentially important differences in the pattern of germination between different seedlots i.e. some seedlots germinated more rapidly than others when held at the same temperature. This not only affects the speed of emergence in the field but may also be important for successful emergence from deeper sowings. Furthermore, the time from imbibtion to onset of germination is crucial for any imbibition strategy if damage to early germinating seeds is to be avoided. Thus any successful advancement technique must be based on the physiological response of the seed to temperature during the germination phase (eg. Bradford and Haigh, 1994). The following experiment set out to determine whether or not the seeds in these commercially used seedlots responded differently to temperature.

The effect of germination temperature on the final germination is shown in Table 1. At 20 °C, the temperature that most germination tests are conducted, there was little difference between seedlots; all had over 90% germination except cv. Rocket (77%). At 25 °C there was again little difference but, S1 Bristol had fewest seeds germinate (72%). At 15 °C (close to the highest temperatures experienced in seedbeds during September) there was generally little difference between seedlots, overall germination was 94%. However, at 10 °C, commonly the temperature of most seedbeds during September (especially at night), the overall germination fell to 80%. Whilst this seemed to be a varietal trait (e.g. average for cv. Bristol (55%) and cv. Apex (88%), there was substantial variation between seedlots (e.g. cv. Bristol with 76%, 57%, 32% germination in seedlots S1, S6 and S13 respectively). At 5 °C the differences were greater, cv. Bristol averaged only 35% with some seedlots showing less than 10% germination.

These variations in germination with change in temperature are crucial. Not only are they high around the temperatures likely to be experienced in the field in September, but if a significant proportion of seeds fail, this may have implications for the ability of the remainder to germinate.

In order to further investigate the possible reasons for this effect of temperature on germination, the relationship between temperature and the rate of progress (1/t) from first imbibition to 90 % of final germination is presented in Figure 11. Whilst the mean rate of germination was strongly and significantly related to germination temperature, there was considerable (almost two-fold) variation between seedlots. Some of this appeared to be related to variety with cv. Apex having a faster rate than cv. Bristol although the means for cv. Bristol conceal marked variations between seedlots.

Having identified that seed treatment can have effects on the pattern of germination, it is possible that these data could be partly influenced because all seed was treated. However, if there was any influence of seed treatment , its effects must have been specific to individual seedlots because the three seedlots of cv. Bristol had the same seed treatment.

There is an urgent need to examine the relationship between seed germination and temperature to clearly separate in fully balanced experiments the effects of genotype, batch and seed treatment as any changes to the fundamental nature of seed response to temperature will have major implications for seed advancement which the potential benefit to growers.

Table 1 Effect of temperature on final germination % of 16 seedlots

			Germination temp					
Lot	***Variety***	***Seed treatment***	**5**	**10**	**15**	**20**	**25**	***Mean***
S1	Bristol	Lindex + FS	55	76	94	93	72	***78***
S2	Apex	Lindex + FS	73	88	99	98	100	***92***
S3	Nickel	Rovral FS+hydraguard	55	74	95	90	90	***81***
S4	Rocket	Lindex + FS	92	74	97	91	80	***87***
S5	Capitol	Lindex + FS	58	92	92	98	95	***87***
S6	Bristol	Lindex + FS	41	57	94	100	92	***77***
S7	Synergy	Lindex + FS	63	96	93	98	100	***90***
S8	Apex	Rovral FS+hydraguard	99	95	99	100	97	***98***
S9	Alpine	Vitavax RS	9	49	89	92	98	***67***
S10	Falcon	Lindex + FS	88	96	97	99	99	***96***
S11	Synergy	Lindex + FS	57	97	88	99	95	***87***
S12	Apex	Vitavax RS	72	86	94	100	100	***90***
S13	Bristol	Lindex + FS	8	32	87	98	98	***65***
S14	Gazalle	Lindex + FS	97	98	100	96	95	***97***
S15	Rocket	Lindex + FS	83	79	98	77	82	***84***
S16	Apex	Vitavax RS	77	83	94	99	91	***89***
		Mean	***64***	***80***	***94***	***96***	***93***	***85***
Mean	*Bristol*		35	55	92	97	87	
	Apex		80	88	97	99	97	

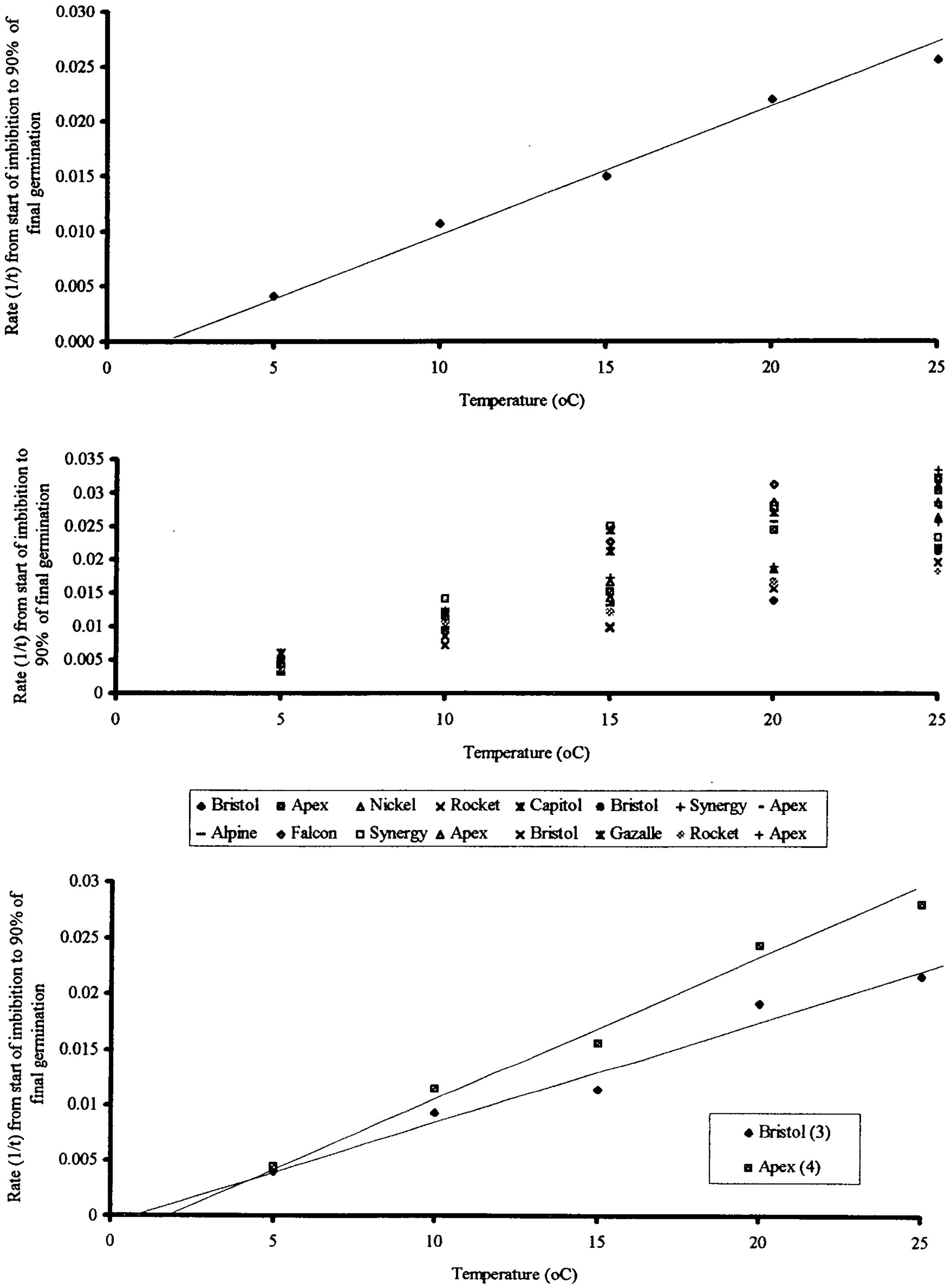

Figure 11 Analysis of the effect of temperature on the rate of germination from start of imbibition to 90% of final germination.

Conclusions

In the experiments reported here, an examination was made of the patterns of germination and emergence to determine the potential advantages from selecting variety, seedlot (of the same variety), and large and small seed from within the commercial seed grades. To investigate whether these approaches could be further improved to give more rapid emergence, particularly where osmotic and drying stresses are exerted on the seed / seedling, seeds were advanced by priming and drying back so as to shorten the period between sowing and germination.

The following key results were found:

- The performance of a range of seedlots used by growers in 1996 varied markedly in the speed and uniformity of germination, particularly at temperatures similar to those experienced in the field where low temperatures restricted germination to less than 10% of the seeds and resulted in excessively long duration between first imbibition and 90% germination. Variation between seedlots of the same variety was as large as the difference between varieties. There appeared to be negative influences of fungicide and insecticide treatment. These delayed the onset of germination, reduced the rate of germination and reduced the proportion of seeds which finally germinated. These effects appeared to be more severe on some seedlots than others. When representative seedlots were tested for seedling emergence in sand, the seedlots showing rapid and more synchronous germination emerged faster from deeper sowings.

- From within these commercial seed grades, selecting the half with larger seeds resulted in individual seed weight being increased by on average 30%. The speed of germination and emergence from very shallow sowings was improved by selecting the fraction of smaller seed, because the seed imbibed more quickly. However, in deeper sowings, more common of the field situation, a greater proportion of the larger seed emerged because it had larger seed reserves.

- The speed of germination, emergence and early seedling development were all improved by seed advancement in water at 15 °C for 18 hours. Advancement in polyethylene glycol offered no benefit over water and rapeseed did not exhibit adverse effects unless the radicle emerged prior to drying back. An understanding of variety and seedlot response to temperature was found to be crucial for determining safe durations of advancement because the nature of the response of different seedlots to temperature means that some seed lots will be further advanced for any given duration of treatment.

- There was strong evidence that the potential benefit from seed advancement was greatest where seeds were sown 3cm deep or deeper. Advancement also increased the number of seed which germinated in the presence of osmotic stress caused by dry soil, fertiliser N and leachate from decomposing straw.
- There were indications that the improvements possible from each individual step, i.e. seedlot selection, seed grading and seed advancement, might combine to give a larger overall benefit in specific situations. For example, significantly more of the large seed emerged from the deeper sowings. In addition, seed advancement doubled the emergence from deeper sowings. Therefore it seems probable that there is every chance of combining selection of large seed and seed advancement to improve emergence from deeper sowings. This approach may for example, be of particular benefit where soil surface conditions are dry and sowing more deeply may place the seed where moisture may be more available.

Overall, this preliminary work has confirmed that there is sufficient variation in the quality of commercially available seedlots such that selection can make significant improvements to performance in those conditions likely to be experienced in the field.

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