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Effects of Different Seed Drying Methods on Moisture Percentage and Seed Quality (Viability and Vigour) of Pea Seeds (*Pisum sativum* L.)

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Abstract: Post harvest management i.e. drying seeds at different drying methods (floors) studies were performed in an unheated glasshouse of the University of Wales, Bangor, United Kingdom. Seeds were air dried on different floors, made of concrete, cowdung and soil. It was observed that concrete drying floor was suitable to maintain seed quality (viability and vigour) for pea seeds (*Pisum sativum* L.).

Key words: Seed, drying floor, viability, vigour

Introduction

Every year large volumes of high quality seeds are lost for planting purposes because of excess moisture. Seed moisture content is one of the factors which determines whether or not seed can be stored safely without loss of germination and vigour. When moisture content is too high the seed may heat and various moulds can grow. Therefore it is absolutely vital to ensure that harvested seed is at a safe moisture content before putting it into store. A seed crop is often harvested when the seed moisture content is higher than desirable for safe storage. Safe seed moisture contents vary with crop species, but generally 14% or less is considered satisfactory for short term storage (Kelly, 1988). Most high moisture seed lots could be saved for seed purposes if properly dried. A farmer wants to dry seed quickly, but high temperature may cause damage seed viability and vigour. The effect of high temperature is most damaging when the moisture content of the seed is high (Almekinders and Louwaars, 1999).

Seed drying depends on the climate at harvest. In a dry climate, seed can go direct from the combine harvester to store. In wet regions, particularly in the tropics, large scale drying plants are necessary. It is a characteristic of agricultural seeds that they can withstand the removal of water and remain viable even if the moisture content is reduced to as low as 5% (Thomson, 1979). Final moisture content for safe storage depends upon the initial moisture content of the seed crop species. Final moisture contents for safe storage of seed of peas is 14% (McLean, 1989). In 1999 three different drying floors and a range of drying periods (days) were tested to dry the seeds. In most developing countries farmers are very poor. They produce their own seed crops for the next years sowing. Sometimes they do not grow any seed crop. They just grow crops for their own need and preserve some grain from that crop for the next years sowing. After harvesting and threshing, traditionally they dry the seeds on either an earthen drying floor or they prepare a floor covering by a very thin layer of liquid cow dung on an earthen floor and after a little bit of drying they use this as a seed drying floor. The objectives of this study were to determine the effects of different seed drying methods (floors) on moisture percentage and seed quality (viability and vigour) of pea seeds.

Materials and Methods

Growing the seed crops

The experimental crops were grown in the field at Henfaes Research Centre of the University of Wales, Bangor, United Kingdom. The crops were harvested as they matured. All normal agronomical procedures were done.

Treatments and experimental designs

The experiments were performed in 1999. Three types of drying floor: earthen floor (mud covered); cowdung covered floor (a thin layer of cowdung covered) and concrete floor were used and as drying time treatments 0, 2, 4, 6, 8, 10, 12, 14 and 16 days were tested. For the earthen and cowdung covered floors drying was continued up to 16 days but for the concrete drying floor it was only up to 12 days. Initial seed moisture content was determined taking four samples of seed (which were randomly collected from the bulk harvest) straight away after harvest and by drying at 105°C in an oven for 48 h. Moisture percentage was calculated following the procedures described by ISTA (1976a,b). A completely randomized design was used.

Preparation of drying floors

The earthen floor was prepared by thoroughly wetting some field soil, compacting it by hand and then allowing it to dry in the glasshouse. The cowdung floor was prepared by preparing an earthen floor as above and then covering it with a thin layer of diluted cowdung. The concrete glasshouse floor was used as concrete drying floor.

Experimental details and sampling procedures

To look at the effects of different drying methods (floors) on moisture percentage and seed quality (viability and vigour), three types of drying floors were artificially prepared as described above. The depth of the bulk seeds on the drying floors was 2.5 cm. In this experiment the seed crops were grown in a field. Plants were harvested at maturity by hand from four replicate field plots, when seed moisture content was around 26% (fresh wet basis). All the pods were threshed gently by hand and the seeds collected. These replicates were maintained throughout the quality tests. Three different drying floors were artificially prepared inside an unheated glasshouse. After preparing the whole floor surfaces four separate plastic rings (15 cm diameter) were fixed randomly on the each floor surface to make four separate replicates. The seeds were then allowed to dry on the different drying floors for different amounts of time according to the experimental design. The seeds were mixed four times a day by hand. The moisture content of the seed was measured at the end of each drying period. After drying seeds were then stored in paper bags in a laboratory at room temperature to allow for dormancy breaking.

Methods for testing seed quality

Seed quality testing started approximately 4 months after harvest. Before starting seed quality measurements seed dormancy was tested periodically by taking a small sample of seed and testing germination. Seed samples from all four individual replicates of the field experiment were kept separate and treated as the replicates of the seed quality tests. To determine the effects of different drying methods on seed viability and vigour, germination, soil emergence and electrical conductivity tests were made on samples of seed. These tests were also repeated on samples of seed that had undergone controlled deterioration. Before starting seed quality testing the amount of ageing required to decrease germination by 50% was determined. To determine the effects of drying methods on seed viability and vigour, germination percentage, emergence percentage and electrical conductivity tests were made on samples of seed. These tests were also repeated on samples of seed that had undergone controlled deterioration.

Method used for controlled deterioration

Before starting the deterioration process seed moisture content was raised by placing the seeds on a perforated tray suspended over water for 24 h at 25°C temperature in a growth chamber of Heanfaes Research Centre, University of Wales, Bangor, UK. The seeds were then placed in small sealable containers of 120 ml volume (Merck Ltd, Merck House, Poole, Dorset BH 15 1TD, UK). Approximately 400 seeds were placed in a container and then sealed. The containers were then placed on the shelf of an incubator, set at 50°C. Samples of seed were removed after 8 days and germination, emergence and electrical conductivity were determined. Moisture percentage of the seeds was measured before and after controlled deterioration as a check on the procedure.

Method for germination test

The seeds were allowed to germinate on sheets of Whatman no. 1 filter paper in plastic petri dishes. The filter paper was kept moist with distilled water. The petri dishes were kept at 20°C in an incubator in the dark. There were 100 seeds per replicate of each treatment. These were split between four petri dishes, each containing 25 seeds. Germination was recorded until no further seeds germinated. The first count was made after 3 days and a seed was considered germinated when its radicle protruded out about 2 mm. The final count was made at 7 days and no further germination occurred after this allocated time.

Method for emergence test

The emergence test took 21 days to complete, from sowing to taking the final recordings. It used 100 seeds per replicate of each treatment and was conducted in soil in pots in an unheated glasshouse at the same time as the germination test. The mean soil temperature during this period was 8.26°C±0.59. The maximum daily air temperature recorded throughout this period was 13.5°C and the minimum daily air temperature recorded was 4.1°C. The first count of emergence was recorded at 7 days and a seed was considered emerged when its first two leaves protruded out about 2.5 cm above the soil. Final emergence was recorded 21 days after sowing. No further emergence occurred after this time.

Method for electrical conductivity

Following the procedures described by PGRO (1981) for measuring electrical conductivity 50 seeds of peas per replicate were used. The base diameter of the container was 80 mm. The seeds were placed in 250 ml de-ionized water and then the containers were covered to prevent evaporation loss and entry of foreign matter. A separate container of de-ionized water was prepared at the beginning of each test. All containers were kept at 20°C for 24 h and then electrical conductivity was determined using an analytical conductivity meter (Model Ch-8603, Schwerzenbach, Switzerland).

Statistical analysis

The results were analysed in two ways using Minitab Statistical Package Version-12. Firstly a two way ANOVA (balanced design) was performed on the data for moisture percentage, including values for 0, 2, 4, 6, 8, 10 and 12 days for all drying floors, but excluding data for times greater than 12 days as the design become unbalanced. A second one way ANOVA was performed to look at the effects of drying method (floors) on moisture percentage at each sampling time. A separate analysis of variance was performed on the seed quality data at each drying floors. The data which were recorded as counts and expressed as percentages (germination percentage and emergence percentage) were transformed, following the procedures described by Gomez and Gomez (1984).

Results

Figure 1 shows the changes in seed moisture content of pea seeds over time in different drying floors. The effects of drying methods, drying periods and the drying methods X drying period interactions were all significant ($P<0.001$). In general as the drying period increased moisture percentage from the seed of every floor decreased. On all floors the moisture loss was greater during the early part of the drying period, when seed moisture content was high, than during the later part of the drying period, when seed moisture content was lower. This decrease was faster on the concrete drying floor and slower on the other two floors. The decrease in moisture content on the earthen and cowdung covered floors were slow and similar, although the cowdung covered floor resulted in slightly faster drying than the earthen floor. Seeds continued to lose moisture throughout the drying period. On the earthen and concrete floors there was no significant further loss of moisture after 10 days. On the cowdung floor there was no significant further loss of moisture after 8 days. The decrease of seed moisture percentage was extremely small from 10 days to 16 days on the earthen and cowdung covered floors and from 10 days to 12 days on the concrete floor. However, all cases, seed moisture content continued to decrease slowly throughout the drying period.

Table 1 shows the effects of different drying floors on viability and vigour of pea seeds. After drying when the seeds were stored for dormancy breaking, their final moisture contents were 20, 19 and 11% for earthen, cow dung and concrete floors, respectively. During the controlled deterioration test the seeds had a moisture content of between 19 and 22% after humidification. This decreased only slightly during the deterioration at high temperature. The unaged seeds

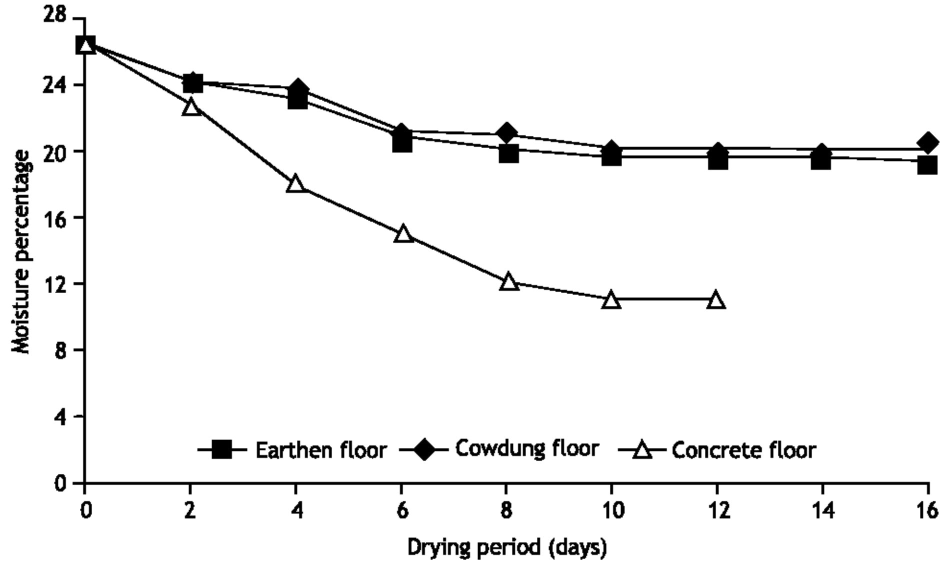

Fig. 1: Effects of different floors and drying periods on the moisture content of pea seeds

germinated rapidly and achieved high germination in three days. By the end of the test, at 7 days, germination ranged from 70 to 90%. Germination was higher in seeds dried on the concrete drying floor than on the other two floors. Raising seed moisture content followed by deterioration at 50°C for 10 days decreased final germination. As in unaged seeds germination percentage was higher in seeds dried on the concrete floor than on the earthen and cowdung floors. The differences between treatments were greater with aged seeds than unaged seeds and the effects of ageing were greater in seeds dried on cowdung and earthen floors than in seeds dried on a concrete floor. For both aged and unaged seeds, the cowdung floor gave higher germination percentage than the earthen floor, although the difference between these two treatments was in each case non significant.

In all the treatments the emergence percentage of unaged seeds were over 60%. In the aged seeds emergence was markedly decreased. The differences in emergence percentage of both aged and unaged seeds were significant and greater for aged than unaged seeds. As with germination, emergence percentage was greater in seeds dried on the concrete floor than on the other two floors. Seeds dried on the cowdung floor had higher emergence than seeds dried on the earthen floor, although the difference was not significant. The effects of ageing were much greater on seeds dried on cowdung and earthen floors than on seeds dried on the concrete floor. The data for electrical conductivity followed a similar trend. The electrical conductivity of unaged seeds was similar and ranged between 19.1 and 20.7 μS/g. However electrical conductivity of aged seeds showed a much wider variation and was lowest in seeds from the concrete drying floor treatment.

Table 1: Effects of different drying floors on seed quality (viability and vigour) of pea

	Drying floors				
	Earthen	Cow dung	Concrete	SED	LSD
Moisture content after storage	20.1	19.3	11.1	0.35	0.80***
Moisture % after humidification	22.2	22.1	19.2	0.28	0.63**
Moisture % after controlled deterioration	20.0	19.3	18.3	0.48	1.10*
First count germination % (after 3 days)					
Unaged seeds	53.0	62.5	80.0	5.28	11.95*
Aged seeds	24.5	32.2	55.5	8.74	19.78*
First count germination % (tran data)					
Unaged seeds	0.56	0.68	0.93	0.072	0.162*
Aged seeds	0.25	0.33	0.59	0.095	0.214*
First count germination % (after 7 days)					
Unaged seeds	70.0	76.5	89.5	6.35	14.36*
Aged seeds	32.2	40.5	69.0	10.46	23.67*
First count germination % (tran data)					
Unaged seeds	0.78	0.90	1.12	0.120	NS
Aged seeds	0.31	0.42	0.77	0.122	0.277*
Emergence %					
Unaged seeds	61.5	67.0	83.0	3.91	8.84***
Aged seeds	8.5	16.0	64.5	6.20	14.04***
Emergence % (transformed data)					
Unaged seeds	0.66	0.74	0.98	0.052	0.117***
Aged seeds	0.09	0.16	0.71	0.069	0.156***
Electrical conductivity (µS/g)					
Unaged	20.7	20.1	19.1	0.75	NS
Aged	35.9	31.6	20.6	2.88	6.51***

Discussion

There are many different methods for drying seed. In dry climates it may be sufficient to spread the seed out in the sun on a clean drying floor, turning it frequently. The seed must not be allowed to become too hot in direct sunlight (Kelly, 1988). In developing countries like Bangladesh, where drying is necessary, traditionally farmers have, on the basis of experience, evolved methods which utilize the sun and wind and which are suitable for small quantities. Threshed seed may be spread out in a thin layer on a smooth earthen floor or on straw matting (Thomson, 1979). In Bangladesh farmers sometimes prepare an artificial drying floor by putting a thin layer of cowdung over the earthen floor. Kelly (1988) also reported that the rate of drying is important; if it is either too rapid or too slow, the seed is liable to be damaged. Rapid drying can harm the seed, either because water is withdrawn too quickly or because of the high temperature. Slow drying may have the effect of maintaining the seed at a high moisture content and a relatively high temperature and so accelerate the deterioration which drying is intended to prevent (Thomson, 1979).

The experiments reported in this paper, efforts were made to look at the effects of different drying methods (floors) on moisture percentage, seed germination and vigour. After threshing seeds were allowed to dry at a range of times on different types of drying floors. After different time interval samples were taken and their seed quality (germination and vigour) tested.

Effects of drying floors on moisture content and seed quality (viability and vigour) of pea seeds

Drying seed on different drying floors influenced seed viability and vigour significantly. The seeds dried on earthen and cowdung floors could not retain high seed viability and vigour, whereas the seeds dried on the concrete floor retained seed viability and vigour. The concrete drying floor method helped to preserve the quality of seed and the seed viability may be prolonged. The quick loss of viability in pea seeds on earthen and cowdung floors was associated with loss of seed membrane integrity as evident from the electrical conductivity values (Table 1). Similar drying effects were also reported earlier (Seyedin ***et al.***, 1984; Nautiyal and Zala, 1991). In the concrete drying floor method the seeds achieved a lower seed moisture content (<12%, Fig. 1) which during the initial storage period may have helped to retain higher seed viability and vigour (Nautiyal and Joshi, 1991). It was observed that pea seeds dried on the concrete floor method retained acceptable seed viability and vigour after storage and had higher germination, emergence and lower electrical conductivity values than other two drying floors under both aged and unaged conditions. Therefore, this technique could be used as a remedy to prolong the seed viability of peas of the small farmers in hot and humid regions.

The low viability and vigour of pea seeds may be due to high moisture content of seeds at the end of the drying period (>14%) in Table 1, which is not a safe moisture content for storage. Kelly (1988) reported that generally 14% or less moisture content is considered satisfactory for short term storage. There are probably many factors such as high initial moisture content of the seed, seed size, ratio of seed volume to surface area, relative attraction of starch and fat for water etc in seed drying that can influence the moisture losing periods of pea seeds. Thomson (1979) reported that large seeds such as peas take long time to lose moisture in drying than small seeds.

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