EFFECTS OF METHOD OF HARVESTING, STORAGE CONTAINER TYPE AND DURATION ON SEED GERMINATION OF FOUR RANGELAND GRASSES

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Abstract
The study tested 2 techniques of harvesting pasture grass seed (hand stripping and cutting with stalks), 4 storage containers (Aluminium tins, Polythene, Cotton cloth and brown paper bags), and 10 post harvest periods of storage (0-72 weeks) of four species seed lots harvested in two different seasons during 2001-2002 at Kiboko, Kenya. The species were *C. roxburghiana, C. ciliaris, E. superba* and *E. macrostachyus* and seeds were stored from 0 to 72 weeks post harvest. The Germination (%) test using caryopses extracted with sandpaper and placed in covered Petri dishes lined with moist filter paper was used for duration of 14 days. The overall mean daily germination (%) was 3.61± 0.060, ranging from 2.5% for *C. ciliaris* to 6.4% for *E. macrostachyus*. Harvesting by cutting with stalks resulted in superior seeds than by stripping them. Seeds stored in aluminium tins germinated better than those in plastic, cloth or brown paper bags. Seeds stored for less than eight weeks had lower germination percentage which then increased with storage.

Introduction

Pasture seed is not readily available in developing countries, especially in the arid and semi-arid lands, thus limits increased food production in the tropics (Hanson, 1994). In Kenya, seed in the market comprise of those species considered to be of commercial value, mostly the type that does well in the humid and sub-humid areas. Thus it is difficult to obtain seeds of pasture species adapted to semi-arid and arid rangeland, for example *Chloris roxburghiana (*Shult.*), Cenchrus ciliaris (*L*), Eragrostis superba (*Peyr.) and *Enteropogon macrostachyus* (A. Rich) (Boonman 1993, Herlocker 1999). Various stakeholders have had concerted efforts to sensitise communities in parts of Makueni, Kajiado and Taita-Taveta Districts in southern Kenya on natural pasture improvement and the demand for pasture seed has increased. This has resulted in promoting community based seed multiplication to meet local demands.

However seed quality is normally low due to lack of well documented and disseminated information on seed technology for smallholder farmers (Hanson 1994; ISTA, 1999). Therefore, the main aim of this study was to recommend appropriate grass seed harvesting and storage techniques for farmers that would result in superior seeds for 4 commonly preferred semi-arid rangeland grasses, namely *C. roxburghiana, C. ciliaris, E. superba* and *E. macrostachyus*.

Materials and Methods

Study site description

Kiboko Research Centre (KRC) is situated at 02.25°S, 037.73°E, in Makueni District. It falls within Zone V, which is semi-arid and mostly bushland (Sombriek *et al*., 1982). The land comprises a mosaic of soil types and it is rich in plant species whose distribution and associations have been described (Michieka and van der Pouw, 1977).

Seeds were harvested during the short rainy season in 2000 using 2 methods stripping (milking) the seeds by hand from the panicles when dry or cutting the stalk at the last node bearing the panicle with mature seeds together with the flag leaf. The harvested material was spread on a canvass under shade and away from wind to air dry for 5 days, before threshing. Seeds were cleaned by hand to remove leaves and stalks and other chuff. Clean seed of each species was heaped together and 5 handful grabs were taken from the outer and the inner parts of the heap for immediate germination testing. The rest of the seed lot was put in 4 well-labeled different types of containers namely brown paper bags, white cotton cloth bags, woven polythene sacks and aluminium metal open-top tins with lids. This was repeated for each of the four species. A traditional crib similar to those used by agro-pastoral communities in southern Kenya for food grain storage was used to store the grass seeds. Periodically, post-harvest germination tests were conducted from 0 to 72 weeks of storage resulting in a total of 10 germination tests.

The seed was rubbed using a sandpaper to extract caryopses (HSU 1994). One hundred caryopses were then placed on standard laboratory Petri dishes with filter paper No. 91 and kept under room conditions. A small amount of water was added regularly to moisten the paper. Daily count of germinated seed (signified by an emergent radicle) was done for a period of 14 days (HSU 1994; Koning, 2004).

Data analysis

All data on seed germination were converted into percentages and analysed using Statistical Analysis Systems (SAS 1990) procedures. Results of descriptive analysis of the germination rates were plotted against the number of days. Multivariate analysis was done using method of harvesting, container type, period of storage, and seed lot as the main factors affecting germination and the interactions between them. To test for within subject effects on germination univariate tests were done. Tukeys-b test of significance was used with p-value set at <0.05.

Results and Discussion

Mean daily percent seed germination was 3.61± 0.060 (Figure 1) and the difference between days was highly significant (p<0.001), particularly during the first week of the trial when most seeds germinated. The germination was low, which is characteristic of freshly harvested seeds of most grasses, often less than 10%. This is due to seed dormancy which, is released after 6-12 months of storage (HSTA 2001). Dormancy in some cases is chemically built into the embryo (Koning, 2004) and time wears these chemicals out but some species require a longer period of imbibition before germination occurs since the chemicals are mostly water-soluble (Keya 1997, HSTA 2001).

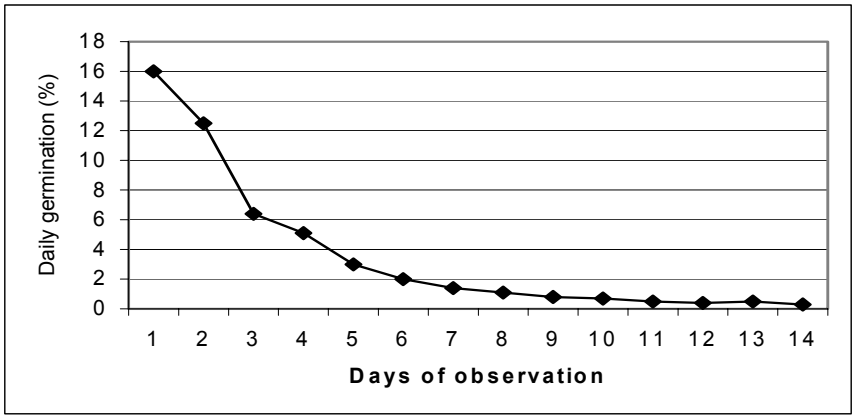

Fig. 1: Overall mean daily seed germination (%) for the entire study comprising 2 seasonal seed lots of 4 grass species harvested using2 methods, stored in 4 container types for 10 periods (0-72 weeks) at KARI Kiboko during 2001-02

Methods used in harvesting the seeds had a significant (p<0.05) effect on the subsequent total percent germination. The trend of daily rate of seed germination was similar but significantly different for the first 2 days. Mean percent germinations were 3.51 ± 0.077 and 3.67 ± 0.084 for the stripping and cutting with stalks methods, respectively. Generally, with most other forage species it does not matter whether the dry seeds are stripped from the panicles or mature ones are cut with the stalks (HSU 1994). The stripping method is not only faster but also less laborious (personal experience of the author at Kiboko), which the communities will probably take up much more easily. However, it merits harvesting by cutting with stalks when evaluating these methods at species level for gene banks and where a premium is placed on the seed quality (Loch and de Souza 1999). In addition, most soils in dry environments tend to lose moisture rapidly especially at the onset of the rains. Therefore, seeds that are quick to germinate may take advantage of the available soil moisture to develop a root system early before the moisture limits its growth. Such seedlings are likely to establish better than those from seeds with a delayed germination. Keya (1998) observed such phenomenon with *Leptothrium senegalense* and *C. roxburghiana* in the arid environments of northern Kenya and it is an important adaptation mechanism.

Container type had significant (p<0.05) effect on the overall percent seed germination. Seeds stored in aluminium tins had higher germination than that stored in brown paper bag and cotton cloth bag, but had similar germination (Fig 2?) to those stored in plastic sacks. Ideal storage containers should be waterproof, to which in this case the aluminium tins and plastic sacks somewhat conform although both were not closed air-tightly. Therefore, the seeds may have absorbed some moisture in the air and reach moisture levels above those recommended for proper storage (8-12%) thereby lowering their germination potential (HSU 1994).

Percent daily seed germination was significantly (p<0.001) affected by period of storage Fig. 2). Seeds stored for a shorter period had lower germination percentage which increased with storage. However, after the 12th week there was no clear pattern possibly due to change in temperature and humidity. Grass seeds can maintain high viability and germination for along time while in storage; five years have been possible with low temperature (20^{o}C) and low moisture content for a number of tropical species (HSU 1994, Chin and Hanson 1999). The four grasses in this study

are therefore in conformity with previous observations although it is uncertain how much longer they will retain this germination potential under the prevailing storage conditions.

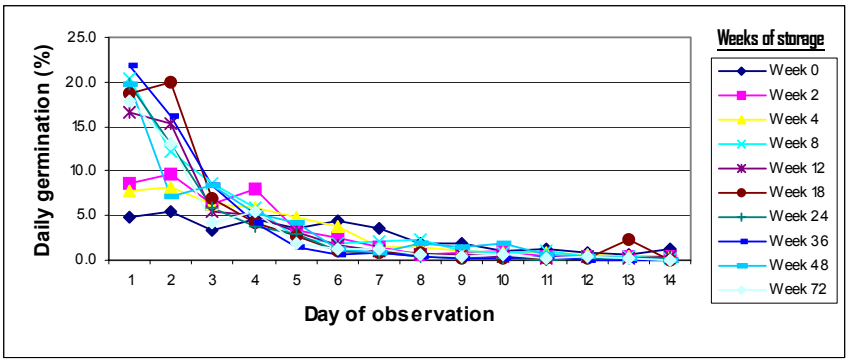

Fig. 2: Daily seed germination rate as affected by period of storage for 4 rangeland grasses At KARI Kiboko during 2001-02

There was highly significant ($p<0.0001$) difference between mean daily seed germination for the four grass species. Whereas *E. macrostachyus* begun with a peak on day one followed by a rapid decline, the other three species started low, peaked quickly and had a slower rate of decline in daily seed percent germination. Similarly, there was a significant ($p<0.001$) difference between the four grass species in their overall germination. Seeds of *E. macrostachyus* had the highest percent germination while *C. ciliaris* and *E. superba* had the lowest but similar germination. It is likely that *E. macrostachyus*'s dormancy mechanism involves only the integument while the other three species may have both the embryo and/or the integument related dormancy (Keya, 1998). Species with delayed germination much later in the season would be at a disadvantage since the rains would end while the seedlings are still too young. In which case, faster germination is desirable since it will give the seedlings a head start in the normal plant competition (Kadman and Shmida, 1990).

Method of harvesting was an important factor among species since seeds of *E. superba* harvested by cutting with the stalks had significantly ($p<0.01$) higher percent germination than those harvested by stripping. So, while it is not advantageous to harvest all four grasses by stripping, better quality seed of *E. superba* are obtained with this method. Seeds of *C. roxburghiana* and *C. ciliaris* had a significantly ($p<0.05$) higher germination percentage when stored in aluminium tins than in both paper and cloth bags. The other two species were unaffected by container type. The two affected species have relatively smaller seed sizes and thus are probably affected more by the high temperature and high relative humidity existing in the store (Chin and Hanson 1999). There was a significant ($p<0.001$) species by storage period interaction effect, implying that different species attained peak germination after different periods of storage. Both *C. roxburghiana* and *E. macrostachyus* peaked after 8 weeks, *C. ciliaris* after 18 weeks and *E. superba* after 36 weeks. The results also agree with earlier reports that seeds require an after-ripening period before they attain optimal germination potential due to dormancy which varies with species (Boonman, 1993; Chin and Hanson, 1999).

Conclusions

Grass seed harvested by stripping was superior to those by cutting with stalks, particularly for *E. superba.* Of the four types of containers metal, and to lesser extent polythene ones, were better than ordinary brown paper and cloth bags in keeping grass seed for a long period without spoilage and subsequent loss of viability. All the four grasses showed an inherent dormancy characteristic, losing it gradually while under storage with peak percent germination attained after a period of storage which varied with species, ranging from 8 weeks for both *C. roxburhiana* and *E. macrostachyus* to 36 weeks for *E. superba*. Based on the results of this study we recommend further research is conducted to refine the conclusions and generate suitable guidelines.

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