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Effect of threshing, drying and storage methods on purity and germination of farmer managed rice seed in Uganda

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Abstract

A total of seventy farmer-saved rice seed samples from three districts of Uganda namely Bugiri, Pallisa, and Lira were examined for purity and germination following procedures described by the International Seed Testing Association. The results revealed that postharvest handling practices (threshing, drying and storage) significantly ($P<0.001$) affect the quality of rice seed and their effects are additive as indicated by observed significant differences for the 2 and 3-way interaction effects of storage and threshing, and storage, threshing, and drying, respectively. Threshing by "beating" significantly reduced the quality of the seed while drying on cemented floors and polyethylene sheets reduced the germination percentage but maintained the physical purity of the seed. Rice seed stored in polyethene and polyline bags exhibited the highest proportion for germination and purity tests. Thus, postproduction operations need to be considered as part of an approach to minimise losses in quality of farmer saved rice seeds.

Key words: Farmer-saved seed, postharvest, seed quality

Introduction

In Uganda, much of the rice crop is produced by small-scale farmers. They save and use their own seed for rice production year after year. Under such a production system, there is little control over seed quality (Mew, 1998) yet seed quality is a key to raising a healthy crop (Amana *et al.*, 2003). Consequently, most rice farmers in Uganda raise their crop from inferior seed. Such seed are characterized by low germination percentage, weak seedlings, slow growth rate, susceptibility to stress and poor crop stand. Subsequently, poor yields are obtained, making these families more food insecure and unable to have any surplus for sale.

The production and postharvest handling practices used in rice production vary from farmer to farmer. In Uganda, the role of the different practices and their influence on seed quality is not well known since there has been little emphasis on postharvest quality management. However, with increasing commercialisation of rice production in the country, farmers need to recognise the value of high quality seed and therefore, the need for good postharvest handling practices. The aim of this study therefore was to elucidate the effect of the different postharvest handling practices used by farmers on germination and purity of rice seeds in Uganda.

Materials and methods

Rice seed sample collection

Seed samples (70) were collected from three districts of Uganda namely Lira, Bugiri, and Pallisa. These districts were selected basing on differences in agro-ecologies, production practices, history of rice production and the fact that they are among the main rice producers in the country. Details about these districts with regard to rice production are given by Biruma *et al.* (2003).

The seed samples were collected from individual households situated at least 10-20 kilometres apart. A pre-tested questionnaire was used during seed sample collection to gather postharvest information. Questions focused on methods of threshing, drying and storage.

Purity analysis

All the 70 samples were analysed for purity following procedures outlined by the International Seed Testing Association (ISTA, 1999). Forty grams of each sample were physically separated into pure seed, other seeds and inert matter. Separation was based on examination of each particle in the sample. The respective weights of the different components were then expressed as percentage by composition.

Germination test

All the 70 samples were tested for germination capacity using paper roll method (ISTA, 1999). Four hundred (400) seeds (working sample) in four replicates each of 100 seeds were taken from each sample and placed on previously moistened germination papers following procedures described by (ISTA, 1999). Two sheets of square blotters (AGF 725-230 x 265 mm) were wetted using distilled water, leaving an adequate margin of about 2 centimetres. One hundred seeds were then placed evenly on the wet blotter and rolled. The rolls were then placed upright inside a plastic bag to avoid drying and incubated at 28 ±2°C, in alternating 12 hours near ultra violet (NUV) light and 12 hours darkness for 14 days. On the 14th day, normal, abnormal, diseased seedlings, hard seed/dead seeds were counted and placed in separate plastic petri-dishes. Seedlings were considered normal when found intact with all the essential structures or with slight defects and secondary infection. Abnormal seedlings were those with any of the essential structures irreparably damaged, deformed and or decayed. Dead seeds are those that at the end of the test period had not produced any part of a seedling (ISTA, 1999). The numbers of normal, abnormal and dead seeds was recorded.

Data analysis

All data obtained from the laboratory (purity and germination) were subjected to analysis of variance (ANOVA) and the differences between treatment means tested using Fishers' protected Least Significance (LSD) test at 5% probability level (Steel *et al.*, 1997). Quantitative data from the questionnaires were analysed using the statistical package for social scientists (SPSS).

Results and discussion

Rice postharvest handling methods

All farmers used the traditional method of sun-drying where the harvested grains was spread under sunshine. However, the drying surfaces or grounds differed among farmers and within the three districts (Table 1). Four types of drying surfaces/materials were encountered and these were; drying on bare ground, ground smeared with cowdung, polyethelene sheets, and cemented floors. Further, three storage methods were employed and included; storage in baskets (15%), polyethelene bags (62.3%), and polyline bags (22.7%). Two methods of threshing, namely, hand threshing and "beating" were commonly used. In the former method, rice panicles are squeezed between hands to dislodge grains from the panicles while in the later, grains are dislodged by beating with sticks. The relative use of the two threshing methods is given in Table 2.

Effect of postharvest practices on rice seed purity

The threshing techniques significantly influenced seed purity. Generally, hand threshed seed had higher purity percentage values compared to beaten seed (Table 3). This is probably because hand threshing results in intact seeds with minimal cases of broken seeds compared to beating. Hand threshing is also a more controlled activity with seed most likely being carefully collected in a clean container while beating to some extent is uncontrolled, with seed scattering widely, and, in the process of gathering such seeds, other materials are inevitably included in the seed which eventually reduces the quality of the seed. Proctor (1994) reported a 4% reduction in purity due to broken seed resulting from threshing by beating. In an earlier study, Chancellor (1965) noted that besides the high percentage of broken seed associated with beating, it also leads to mixing of rice with debris of varied origin notably soil and small pebbles of which winnowing does not completely remove and thus contributes to reduced purity of the seed.

Overall, drying material had a significant effect on seed purity ($P<0.05$). The highest purity was obtained from seeds dried on cemented floors fellowed in descending order by those dried on polyethene sheets, ground smeared with cowdung and bare ground (Table 4). However, there were no significant differences in seed purity among seeds dried on polyethene and cemented floors. Nevertheless, the seed purity attributed to these two drying methods was significantly different from that attributed to bare and ground smeared with cowdung (Table 4). The present findings suggests that seeds dried on bare ground are more prone to contamination compared to the rest of the drying surfaces used. Kregyer (1972) observed that contamination with dirt of seeds dried on bare ground cannot be avoided and thus recommended plastic sheets to ensure clean dried grains. Therefore the role of the drying material in maintaining the seed quality highly depends on how best the material restricts contamination of the seed with other materials.

Storage methods significantly ($P<0.001$) influenced seed purity. The highest purity (98.2%) was obtained from seeds stored in polyline bags while the lowest (96.5%) was obtained from seeds stored in baskets (Table 5). The drastic reduction in purity of the rice seed with respect to storage methods

Table 1. Percentage of farmers using the different drying surfaces and storage methods in the districts of Pallisa, Lira and Bugiri.

Drying surface	Pallisa	Lira	Bugiri
Bare ground	48.2	0.0	27.3
Ground smeared with cowdung	33.3	9.4	9.0
Cemented floor	3.7	59.4	18.2
Polythene sheets	14.8	31.2	45.5
Storage method			
Polythelene bags	66.7	65.6	54.5
Polyline bags	18.5	31.3	18.2
Baskets	14.8	3.1	27.3

Table 2. Percentage of farmers using the two threshing methods in Lira, Bugiri and Pallisa districts.

Threshing method	Pallisa	Lira	Bugiri
Hand threshing[1]	55.6	9.4	72.7
Beating[2]	44.4	90.6	27.3
Total	100	100	100

1 Rice grains dislodged from husks by squeezing between hands.
2 Rice grains dislodged from husks by beating with sticks.

might be attributed to a number of factors either acting independently or in combination. For example, Verma (2002) noted that at higher moisture levels, the heat of respiration can cause much damage to stored seeds especially where the seed is not well protected from weather and this partly accounts for the very low percentage purity observed in seeds stored in baskets. On the other hand baskets are made from locally available materials, which cannot completely keep out moisture, and other materials including dust, stones and vermin, which collectively lower the purity of the seed. Thus, the implications of the present findings is that storage techniques that minimise contamination of the seed and prevent stored seed from reabsorbing moisture should be used in order to maintain the quality of the seed.

Effect of postharvest practices on rice seed germination

Hand threshed seed had significantly higher percentage germination compared to seeds dislodged from panicles through beating (Table 3). The low percentage germination obtained in seeds threshed by beating is attributed to the mechanical stress and damage imposed on the seed during the threshing process. Verma (2000) noted that traditional methods used by rice farmers such as threshing by 'stick beating' significantly affects the viability and vigour of rice seed and seedlings. Proctor (1994)

Table 3. Mean percentage purity and germination of rice as influenced by threshing methods.

Threshing method	Percentage purity	Percentage germination
Hand threshing	98.3	69.4
Beating	96.9	66.3
Mean	97.6	67.8
$LSD_{(0.001)}$	0.1	1.4
CV%	0.4	5.0

Table 4. Mean percentage purity and germination as influenced by drying methods.

Drying method	Percentage purity	Percentage germination
Bare ground	95.0	75.8
Ground smeared with cowdung	97.7	68.4
Polyethene sheets	98.6	64.2
Cemented floors	99.0	63.1
Mean	97.7	67.9
$LSD_{(0.001)}$	0.2	2.0
CV%	0.4	5.0

Table 5. Mean percentage purity and germination as influenced by storage methods.

Storage method	Percentage purity	Percentage germination
Polyethene	98.0	72.4
Polyline	98.2	72.7
Baskets	96.5	58.6
Mean	97.6	67.9
$LSD_{(0.001)}$	0.2	1.7
CV%	0.4	5.0

reported that threshing by "beating," mechanically stresses the grain and this may have a direct influence on the endogenous process of the seed and thus affects its viability. It is therefore suspected that threshing by beating reduces the germinability of the seed by negatively affecting the physiological process within the seed. However, the actual damage inflicted and or physiological processes affected remain unknown and need to be investigated.

The drying surfaces significantly affected seed germination. The highest (75.8) and lowest (63.1) germination percentage was obtained from seeds dried on bare ground and cemented floors, respectively (Table 4). Germination percentage was highest in seeds dried on polyethene sheets, and least on those dried on bare ground. The significant variations among the drying surfaces with respect to germination is likely due to three factors; heat absorption, retention and dissipation of the different drying surfaces used. Where the surface absorbed and retained a lot of heat for long hours, the grain probably suffered more damage and *vice versa*. Procter (1994) noted that excessive heat might subject the seed to hydrolytic stress and consequently reducing the viability of the seed. Kreyger (1972) reported that the viability of the grain is directly linked to the temperatures attained by the grain during drying. In particular, Chancellor (1965) and Soetoyo and Soemardi (1979) observed that temperatures above 50°C reduce the viability of the seed. Similarly, Yadav and Sharma (2000) reported that high temperatures accelerate the rate of hydrolytic enzyme activity causing more rapid detororiation and viability loss. From the foregoing, results of the present study suggests that polythene sheets and cemented floors have the capacity to absorb and retain a lot of heat compared to bare ground and ground smeared with cowdung. This explains the lower percentage germination obtained in seeds dried on polyethene sheets and cemented floor.

Storage methods significantly ($P<0.001$) affected seed germination. The highest germination (72.7%) was obtained from seeds stored in polyline bags but this was not significantly different from germination percentage of seeds stored in polyethelene bags (71.9%). However, the two storage methods resulted in significantly higher germination percentage as opposed to seed stored in baskets (58.6%) (Table 5). Studies conducted elsewhere reported similar findings. For example, Verma (2000) observed reduced viability and vigour in seeds stored in open environment than those stored in sealed polyline bags. This was attributed to fluctuations in temperature and moisture content of the stored grains (Roberts, 1972). Similarly, Copeland and McDonald (1985) reported that moisture proof containers such as polyethene bags prevent re-absorption of moisture from the atmosphere and thus, maintains the viability of the seed. In the present study, the low germination percentage observed in seeds stored in baskets was attributed to the inability of baskets to act as desiccation materials and also guard against entry of other materials including possible pathogens and insect pests (Christensen, 1972; Roberts, 1972; Copeland and McDonald, 1985; Agrawal, 1988; Biruma *et al.*, 2003). Several studies indicate that increases in seed moisture content during storage encourages insect pest and fungal activity which eventually leads to reduced viability and vigour of the seedlings. Therefore, the variations in germination with respect to different storage materials used were partly attributed to the ability of the different materials to control grain moisture fluctuations.

Conclusions

Results of this study have provided evidence that postharvest handling practices influence the quality of rice seed. The study demonstrated that storage method is an important aspect influencing seed quality as indicated by the third order significant interaction effects. Though threshing and drying affects the quality of grains, they are practices that take relatively short period and if done properly may not affect seed quality as much as storage. Despite the fact that these processes are generally recognised by farmers, the question is how best they can be applied and integrated in the postharvest production process so as to maintain the quality of the seed. From this study, seeds with both high percentage purity and germination can be obtained when the seed is hand threshed, dried on ground smeared with cowdung and stored in polyline bags. This however, may not be practical for large scale farming.

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References

Agrawal, P.K. 1988. Seed storage and packaging. In: Van Gastel, A.J.G. and Kerley, J. (eds.). Quality Seed Production. ICARDA, Syria. pp. 55-71.

Amana, M.J., BhattaCharjee, M. and Wanjama, J.K. 2003. Effects of hydration-dehydration and iodination on seed-borne fungi of *duma* wheat variety. African Journal of Science and Technology 4(1):62- 66.

Biruma, M., Okori, P., Mudingotto, J., Edema, R., Tusiime, G., Mathur, S.B. and Adipala, E. 2003. Seed-borne fungi associated with farmer saved rice seed in Uganda and their effect on germination. MUARIK Bulletin 6:53- 58.

Chancellor, W. J. 1965. An experiment on sun drying of paddy. Malaysian Agricultural Journal 45:65-75.

Christensen, C.M. 1972. Microflora and seed deterioration. In: Roberts, E. H. (ed.). Viability of Seeds. Chapman and Hall Ltd, London. pp. 59-93.

Copeland, L.O. and McDonald, M.B. 1985. Principles of Seed Science and Technology. 2nd Edition, Mcmillan Publishing Company, USA.

International Seed Testing Association (ISTA), 1999. International rules for seed testing, 1999. Seed Science and Technnology. 333pp.

Kreyger, J. 1972. Drying and storage of grains, seeds and pulses in temperate climates. Report 205, Institute of Storage and Processing of Agricultural Products, Wageningen.

Mew, T. W. 1998. Characteristics and evaluation of key seed-borne fungal pathogens of rice. Pages 120-122. In: DFID and the Consultative Group on International Agricultural Research (CGIAR): the competitive research facility, 1990-1997, Warham, E. J. (ed.), illus. London: Department for International Development, 1998.

Proctor, D.L. 1994. Grain storage techniques. Evolution and trends in developing countries. FAO Agricultural Services Bulletin No. 109.

Roberts, E.H. 1972. Storage environment and the control of viability. In: Roberts, E.H. (ed.). Viability of Seeds. Chapman and Hall Ltd, London. pp. 14-57.

Soetoyo, R. and Soemardi, R. 1979. The effect of thickness of paddy sun drying on milling quality. In: Proceedings of 2nd Annual Grains Post-harvest Workshop, Jakarta, 16-18 January 1979. Manila, South East Asia Co-operative Post-harvest Research and Development Programme.

Steel, R.G.D., Torrie, J.H. and Dickey, D.A. 1997. Principles and Procedures of Statistics: A Biometrical Approach. Third Edition. McGraw-Hill Book Company Inc., New York, USA. 666pp.

Verma, O.P. 2002. Seed quality *vis-à-vis* delayed threshing in rice. Seed Research 30(1):70-73.

Yadav, S.P. and Sharma, S.P. 2000. Effect of delayed planting and threshing on seed quality in soybean. Seed Research 28 (1):13 - 16.