

Assessment of the Performance of Sun Drying of Maize Grains on Perforated Surfaces

Silayo*, V.C.K., S.T.A.R. Kajuna and B.Omari
Sokoine University of Agriculture, P.O. Box 3003, Morogoro, Tanzania.

Abstract

Sun drying of maize grains on different mesh sizes of perforated trays using different heights from the ground was investigated. The mesh sizes used were 1.5 mm and 3 mm at the elevations of 30, 60 and 90 cm. The results show that both mesh size and height from the ground affect the drying rate and seed viability. The combination of 90 cm elevation and 3mm mesh size gave the highest drying rates and lowest seed viability loss.

Keywords: Sun drying, perforations, height from ground, maize

Introduction

Conventional sun drying usually involves direct exposure of crop produce to solar radiation at a reasonable depth. This method is the simplest and cheapest means of drying. However, it is associated with setbacks such as long drying periods required, vulnerability to pest attack and deterioration due to bad weather, e.g. rain and dust. The inherent long drying periods are due to periodical and intermittent nature of solar radiation. In Tanzania, the intermittency of solar radiation is more pronounced in the period around June-July. During this time the average insolation is about 600-700 cal/cm² or 25 - 29 MJ/m² (Colliver, 1991; Dejong, 1973; Duffie and Beckman, 1980; Loffet *al.*, 1966). Unfortunately, this is also the harvesting time for most field crops. Long drying periods may lead to mould growth.

Alternative drying methods that are superior to sun drying can be used to give fast drying rates and eliminate problems inherent to sun drying. However, such methods

may be difficult to adopt in Tanzania and other developing countries due to the prevailing subsistence agriculture and overall poor economy. Under such circumstances, the emphasis has to be mainly on improving sun drying itself. This may include regular stirring of produce, drying in thin layers (1-2 cm) and drying on a perforated surface (Silayo, 1995). Bassey (1981) and Silayo (1995) have reported that the use of perforated surfaces gives significant improvement to sun drying viz-a-viz conventional sun drying on the ground. However, they did not analyse the effects of size of perforations and height of the drying floor from the ground. This paper investigates the effects of size of perforations and height of the drying floor from the ground on grain quality during sun drying on perforated surfaces.

Materials and Methods

Sun drying experiment was carried out in the Department of Agricultural Engi-

*Corresponding author

neering and Land Planning - Sokoine University of Agriculture, using maize grain (*Staha cultivar*). Two levels of perforations namely 1.5 and 3 mm mesh size and three levels of heights namely 30, 60 and 90 cm were investigated. Due to the fluctuating nature of weather, all these combinations were tried on one day from 8.00 a.m to 5.00 p.m, during which solar radiation, relative humidity and temperature were recorded at the nearby meteorological station. Sun drying on the bare ground surface was the control experiment. Grain depth was maintained at about 10 cm, on a cross section area of about 2025 cm² (45 cm x 45 cm), guided by a wooden sided box with a depth of about 11 cm. Prior to sun drying, the grain was rewetted with tap water from moisture content of about 14% to about 22.50 % wet-weight basis, using the equation developed by Silayo (1995).

The response variables measured were grain moisture content and seed viability after drying. Moisture content was measured using the ventilated oven method at 130 °C for 38 hours (BS 4317: Part 15, 1981). Seed viability tests involved four replicates, each containing 100 seeds, put on a wet blotter paper and covered by another, in a germinator for seven days. The experiment was replicated twice, and the mean values for the response variables were plotted.

Results and Discussion

Figure 1 presents moisture contents attained after drying on trays with 1.5 and 3 mm square mesh at the heights of 30, 60 and 90 cm from the ground. With 3.0 mm mesh size the final moisture contents attained were 13.73, 13.07 and 12.67 % wet-weight basis at the heights of 30, 60 and 90 cm, respectively. These moisture values were lower than those at the same heights and 1.5 mm mesh. For the whole combination of mesh sizes (1.5 and 3 mm)

and heights (30, 60 and 90 cm), the final moisture contents registered (Fig. 1) were lower than for sun drying on the ground, which gave moisture content of about 14.57 % wet-weight basis. The implication of these results is that both the increase in height of the drying trays from the ground and the increase in mesh size give increased drying rates, as revealed by the decreased final moisture content. The effect of the difference between the drying rates of grains on the two mesh sizes was more pronounced at higher heights (60 and 90 cm) from the ground. The use of perforated surfaces resulted in lower moisture contents due to the effect of bulk natural convection of air through the perforations to the grain mass. The effect was more on the 3 mm (wider) square mesh, probably

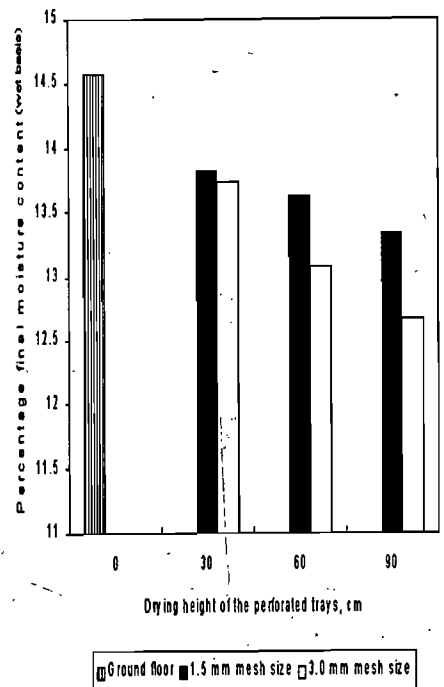


Figure 1: Final moisture content versus drying height of the perforated trays

due to less resistance to air movement through the mesh, implying that sun drying on trays with wider mesh are more suitable than those with narrow ones. The superiority shown by higher heights might have been caused by the availability of more bulk air below the trays.

Viability test results for the same run of experiments are presented in Fig. 2. These results show that drying at low heights on trays with small mesh size leads to low seed viability and vice versa. This is because high moisture content retention causes huge losses of viability. Seed viability results observed correspond well with the moisture profiles in Fig. 1, in which higher platform

heights and large perforation are more beneficial.

Conclusions

As for moisture removal and maintenance of seed viability during sun drying, perforated surfaces are superior to unperforated ones. The use of perforated surfaces with large aperture size at higher heights from the ground increases the effectiveness of drying. More work is being carried out to include more levels of mesh size and height from the ground.

Acknowledgements

The financial assistance provided by Sokoine University of Agriculture is highly appreciated.

References

- Bassey, M.W. (1981). Solar energy as a heat source in crop drying in Sierra Leone. In *Food Drying: Proceedings of the Workshop held at Edmonton, Alberta*. Ed. G. Yaciuk, IDRC, 1982, pp. 24-29.
- BS 4317: Part 15 (1981). Guide to Determination of Moisture Content of Maize (milled and whole). British Standard 4317. British Standards Institution, London.
- Colliver, D.G. (1981). Techniques of estimating incident solar radiation. In *Solar Energy in Agriculture*. Ed. B.F. Parker. Elsevier, New York.
- Dejong, B. (1973). Net Radiation Received by a Horizontal Surface at the Earth. Monograph No. 7, Delft University Press, The Netherlands.
- Duffie, J.A. and Bekman, W.A. (1980). *Solar Engineering of Thermal Processes*. John Wiley & Sons, New York.
- Loff, D.O.G., Duffie, J.A. and Smith, C.O. (1966). World Distribution of Solar Radiation. Engineering Experimental Station Report No. 21. University of Wisconsin, Madison.
- Silayo, V.C.K. (1995). Sun drying of grains on perforated and unperforated surfaces. PhD thesis, University of Newcastle upon Tyne, U.K.

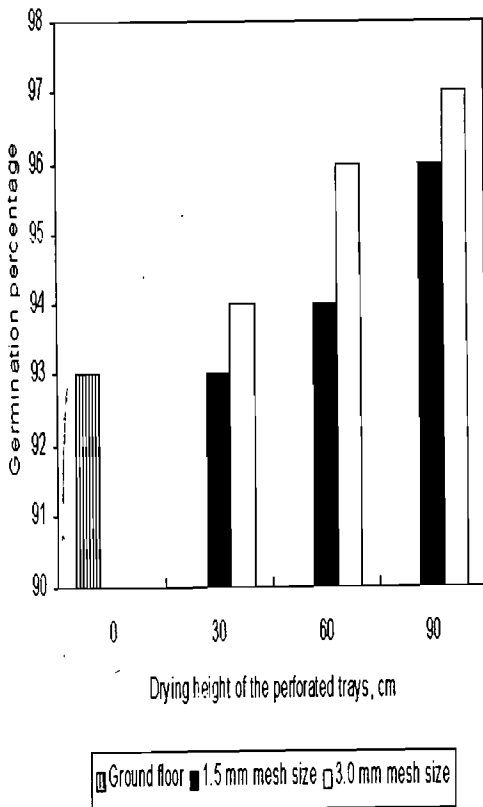


Figure 2: Germination percentage versus drying height of the perforated trays

Instruction to Authors

Submission of Papers

Submission of a paper to this journal implies that it reports original and unpublished work and if it is accepted the paper will not be published elsewhere in the same form. All contributions will be in English language.

Manuscripts should be submitted directly to:
The Chief Editor
Tanzania Journal of Agricultural Sciences
Sokoine University of Agriculture
P.O. Box 3001, Chuo Kikuu
Morogoro, TANZANIA.

Types of contributions

Papers reporting results of original research, review articles, short communications and book reviews.

Manuscript handling

Submit the original and two complete copies of each manuscript, including figures and tables.

For each manuscript, provide a separate cover page giving the following information:

1. Title; 2. Author(s); 3. Postal Address of each author (if different); 4. Short title (for page headings); 5. Key words; 6. Number of text pages; 7. Name of corresponding author to whom the galley proofs and reprints are to be sent; 8. Special instructions to printer, such as magnification of photographs, layout of figures, etc.

Typing presentation

Type manuscripts in double space on one side of a good quality A4 paper. All margins should be kept wide and lines should preferably be numbered. Papers should be divided into sections as follows: Title of the paper followed by Author(s) names and affiliation(s), Abstract, Introduction, Materials and Method, Results, Discussion (or Results and Discussion) and Conclusion, Acknowledgements and References:

- **Title:** Type title in lower case, left justified. Do not underline;
- **Authors:** Type names of author (s) in capitals, left justified;
- **Authors affiliation (s):** Type authors affiliation (s) in lower case, left justified;
- **Headings:** Use lower case headings in dividing and subdividing the paper:
 - * Level 1 headings (section): Left justified, not underlined;

- * Level 2 headings (sub-section): left justified, underlined;
- * Level 3 headings (sub-sub-sections): In the paragraph, underlined.

Figures, tables and plates

Figures, plates and tables should be added separately i.e. not inserted in the typed text. Captions to figures and plates should be collected into one or more separate pages:

- **Figures** including all lettering should be drawn in blank ink, preferably on drawing paper. Good quality computer drawn figures may be accepted. The figure/diagram should be drawn on such a scale that they can be reduced to a width of 75mm (one column) or if necessary to a width of 160 mm (two columns) without losing resolution. All lettering on figures should be in lower case. Legends should be inserted in the figures where possible.
- **Tables** must be printed in a small letter type and should be provided with descriptive headings. All column headings begin with capital letter. Tables should be arranged so that they can be printed in one column (75mm) or two columns (160 mm). All column headings should be typed left justified over that part of the Table they are covering, which is indicated by line.
- **Plates** (photographs) may be included in the paper only if they are necessary or they provide additional information. When the plates are to be composed from a number of different photographs, the layout of the plates should be carried out by the author (s). Colour plates will not be accepted except under very special circumstances. Position of tables, figures and plates should be indicated in the left margin.

Units

Only SI units should be used.

References

References to literature in the text should be made by mentioning author and year. In the case of two authors, both should be mentioned, but with three or more, only the name of the first author plus et al. should be given. Do not use in list or text: unpublished results or in preparation. An "in press" or "submitted manuscript" references should only be mentioned in the text but copies of these papers should be enclosed for reference by reviewers.