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## Determination of Physical Properties of Some Wheat Grain Varieties

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### ABSTRACT

Sub-Saharan Africa's top producer of wheat is Ethiopia. It covers roughly 1.80 million hectares a year, and Ethiopia's central, southeast, and northwest highlands are the primary wheat-growing regions. The physical characteristics of the wheat seed are crucial for maximizing the row seed drill machine's design parameters. Thus, it is crucial to determine and take into account physical attributes like size, sphericity, surface area, bulk density, thousand grain weight, and angle of repose. Determining the physical characteristics of a few dominant wheat varieties was the goal of this experiment. Thus, the physical characteristics of NPS fertilizer and five different types of wheat seeds Hidase, Danda'a, Ogolcho, Kekeba, and Digelwere ascertained. From the representative samples, 100 seeds and 50 fertilizers were chosen at random to determine the mean sizes of the seeds and fertilizer used in the study. The sphericity of Hidase, Danda'a, Ogolcho, Digelu, Kekeba and Fertilizer were found to be 58.94, 65.11, 63.23, 64.62, 62.58 and 87.07% respectively. Thousand seed weight 32.57, 37.63, 36.95, 30.75, 32.03 and 26.49gm were obtained for Hidase, Danda'a, Ogolcho, Digelu, Kekeba wheat seeds and Fertilizer particles respectively. Average angle of repose of Hidase, Danda'a, Ogolcho, Digelu, Kekeba wheat seeds and Fertilizer particles were recorded as 26.87 o, 26.63 o, 27.45 o, 25.12 o, 24.37 o and 30.96o respectively. The mean bulk density of the respective seed varieties and fertilizer particle were found to be 780.19, 828.58, 833.06, 811.50, 792.89 and 944.66kg/m<sup>3</sup> respectively. It was concluded that, physical properties of wheat seeds and fertilizer particles critically affect the design of seed drill machine's parts. Therefore, all in one approach is impractical, as the mechanical requirements for seeds and fertilizer diverge significantly. Thus, Separate hoppers and metering systems for seeds and fertilizer are desirable to prevent segregation and ensure accurate application rates.

### INTRODUCTION

A one- third of the world's population depends on wheat as a staple food, making it one of the most significant cereal crops in the world (Hussain & Shah, 2002). Sub-Saharan Africa's top producer of wheat is Ethiopia. In terms of area coverage, wheat comes in fourth place behind maize (*Zea mays*), sorghum (*Sorghum bicolor*), and teff. It comes in second place behind maize in terms of total production and productivity. It covers roughly 1.80 million hectares a year, and Ethiopia's central, southeast, and northwest highlands are the primary wheat-growing regions.

Oromia accounts for 57.4% of regional wheat production, followed by Amhara (27%), SNNP (8.7%), and Tigray (6.2%). There are 4.7 million farmers who produce wheat, with a productivity of 2.4 tons per hectare (CSA, 2014). Despite being the primary food crop for most of the nation's population, wheat yields 40q/ha, which is low when compared to other wheat-producing nations (FAO, 2009).

The crop's low productivity and production can be attributed to conventional farming methods, reliance on rainfall, and a lack of use of improved agricultural inputs (mechanical and biological). The primary cause of the low level of production in the nation is the inefficiency of the traditional farming system.

The consistent and prompt establishment of optimum

plant populations is necessary for yield increment. Due to the longer hours needed for meticulous hand metering of seeds, which restricts the amount of field that can be planted in rows, the manual method of local row planting is laborious, results in poor seed placement, low spacing efficiencies, and causes significant back pain for the farmer (Khan, 2017). Crop growth and yield are also significantly impacted by the proper application of fertilizer at the right location.

Row seed drill machines are crucial for resolving issues related to the establishment of the optimum wheat plant population. Accurately estimating the physical characteristics of seeds is crucial because these characteristics could be used as engineering parameters in the development of a row seed drill machine.

Physical characteristics The wheat seed is a crucial component in optimizing the row seed drill machine's design parameters. Thus, it is crucial to determine and take into account physical attributes like size, sphericity, surface area, bulk density, thousand grain weight, and angle of repose. The size or volume of the seed hopper can be determined by knowing the bulk density of the grains (Jouki & Khazaei, 2012).

The design of metering devices and the sizing of fluted rollers require an understanding of the geometric mean diameter, sphericity, length, width, and thickness of seeds (Konak *et al.*, 2002).

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The design and functioning of the different farm equipment used for agricultural operations depend on the physical and frictional characteristics. The key frictional and physical characteristics that directly affect seeder development will be identified. Designing, developing, and operating a seeder efficiently requires an understanding of its physical and frictional characteristics. The physical and frictional characteristics of the seeds determine how well they flow through a planter or seeder (Jouki & Khazaee, 2012). Fundamental knowledge of these characteristics is crucial and aids scientists and engineers in the development of equipment and its effective use. Thus, the purpose of this experiment is to determine the physical characteristics of a few dominant wheat varieties with the aim to study the physical properties of seeds of selected varieties of wheat.

## MATERIAL AND METHODS

The two primary parts of a seeder design that are used to place and transport seeds for sowing are the seed hopper and the seed metering device. When selecting the seeds using a metering device, we must prevent stammering of the seeds in the seed hopper and ensure that there is no damage to the seeds or missing seeds in order for the seeds to be properly conveyed to the furrow bottom. This can be done by designing the seed metering device with the right cell size so that the chosen seeds can be picked without being damaged or missing. Additionally, the side walls of the seed hopper should be made with the right inclination and sheet material to prevent stammering. Determining the physical and frictional characteristics of seeds is required to accomplish this.

### Determination of Properties of Wheat Seeds and Fertilizer

Wheat seeds' physical characteristics, including their length, width, thickness, geometric mean diameter, aspect ratio, sphericity, thousand seed weight, and bulk density, are crucial for the design of the seeder's metering mechanism and seed hopper because they determine the metering devices' size, thickness, and cell size as well as the seed hopper's capacity. Therefore, using standard procedures and techniques, the physical characteristics of five wheat seed varieties Hidase, Danda'a, Ogoicho, Kekeba, and Digelu varieties as well as NPS fertilizer were determined.

By choosing 100 seeds and 50 fertilizers at random from the representative samples and using calipers to measure their three principal diameters with an accuracy of 0.01 mm, the mean sizes of the seeds and fertilizer used in the study were determined.

#### Size

Size of each seed and fertilizer was determined by using the following formula (Mohsenin, 1986) mean diameter =  $\sqrt[3]{(abc)}$  (1)  
Where, a = length (mm), b = breadth (mm), c = thickness (mm)

#### Aspect Ratio (R)

The following relationship between width (w) and length (L) is known as the aspect ratio (Davies, R.M., 2009).

$$R = W/L \quad (2)$$

#### Sphericity

The following relationship was used to determine the sphericity of the seeds and fertilizer (Mohsenin, 1986):

$$\Phi = \sqrt[3]{((abc)/a)} \quad (3)$$

Where,  $\Phi$  = sphericity, a = length (mm), b = breadth (mm), c = thickness (mm)

#### Bulk Density

Separately, the seeds and fertilizer were added to a known-volume container without excessive pressure. Using an electronic balance meter, the masses of the seeds and fertilizer were measured independently with an accuracy of 0.01 g. According to Varnmakasti *et al.* (2007), the bulk density was computed using the mass of the seed and fertilizer as well as the container volume.

$$BD = M/V \quad (4)$$

Where, BD = bulk density, g/cm<sup>3</sup>, M = mass of seeds, g, V = volume of cylinder, cm<sup>3</sup>

#### Angle of Repose

In order to design the seed and fertilizer hopper, the angle of repose of the grain and fertilizer was established. Wheat seeds and fertilizer were added separately to an open-ended cylinder that was set on a level surface. The cylinder was carefully raised so that the fertilizer and seed could spread out and stand on their own. With extreme caution, the diameter and height that formed up when the cylinder was removed were measured, and the angle of repose was estimated using the following equation (Varnmakasti *et al.*, 2007).

$$\Phi = \tan^{-1}(2h/d) \quad (5)$$

#### Thousand Seed Weight

A 0.01 g accuracy electronic balance was used to weigh five randomly chosen samples, each of which contained 1000 seeds of each variety and 1000 fertilizer.

## RESULT AND DISCUSSION

The physical properties of wheat varieties and fertilizer exhibit significant variations that influences seed drill machines design. Among wheat varieties, Hidase has the longest seeds (6.50±0.36 mm), while Ogoicho and Digelu were shorter having 5.77±0.52 and 5.66±0.25 mm respectively, indicating a need designing of slots on fluted metering device in the drill to accommodate the maximum lengths. Seed width and thickness show moderate variability, with Danda'a and Digelu being slightly wider (3.30±0.29 and 3.29±0.25mm) and thicker (2.92±0.21 mm and 2.61±0.18), respectively. Fertilizer particles, though smaller in length (4.13±0.88 mm), have greater thickness (3.14±0.59 mm) and higher sphericity (87.07%) compared to wheat, suggesting smoother flow but potential segregation risks if mixed with seeds.

**Table 1:** Physical properties of Hidase, Danda'a, Ogolcho, Digelu and kekeba seeds

| Physical properties   | Hidase      | Danda'a     | Ogolcho     | Digelu      | kekeba      | Fertilizer    | Unit              |
|-----------------------|-------------|-------------|-------------|-------------|-------------|---------------|-------------------|
| Length (L)            | 6.50±0.36   | 5.95±0.29   | 5.77±0.25   | 5.66±0.25   | 6.01±0.33   | 4.13±0.88     | mm                |
| Width (W)             | 3.21±0.28   | 3.30±0.29   | 3.08±0.26   | 3.29±0.25   | 3.13±0.28   | 3.52±0.65     | mm                |
| Thickness(I)          | 2.71±0.22   | 2.92±0.21   | 2.77±0.50   | 2.61±0.18   | 2.84±0.21   | 3.14±0.59     | mm                |
| size                  | 3.83±0.22   | 3.85±0.21   | 3.65±0.26   | 3.64±0.17   | 3.76±0.22   | 3.56±0.63     | mm                |
| Sphericity            | 58.94±2.41  | 65.11±3.16  | 63.23±4.29  | 64.62±2.56  | 62.58±2.53  | 87.07±7.46    | %                 |
| Thousands seed weight | 32.57±1.84  | 37.63±1.52  | 36.95±0.80  | 30.75±1.00  | 32.03±1.24  | 26.49±0.66    | gm                |
| Angle of repose       | 26.87±0.92  | 26.63±1.08  | 27.45±0.98  | 25.12±0.72  | 24.37±0.74  | 30.96±0.94    | Deg.              |
| Bulk density          | 780.19±4.49 | 828.58±2.08 | 833.06±3.48 | 811.50±2.13 | 792.89±1.90 | 944.66±215.38 | Kg/m <sup>3</sup> |

Sphericity values for wheat varieties were ranged from 58.94±2.41 to 65.11±3.16%. Navneet (2016) determined sphericity of wheat grain about 59% which is nearly similar with results obtained in this study. This indicated that all seeds had more or less spherical shape. Thousand seed weight (TSW) was varied notably, with Danda'a and Ogolcho being heaviest (37.63–36.95 g) which requires calibration adjustments to maintain seeding rates, whereas fertilizer's TSW was lower (26.49 g) which implies lighter particles that may demand separate metering device. The angle of repose is higher for fertilizer (30.96°), when compared to wheat which ranges from 24.37 to 27.45°, which could lead to blockages if not addressed through hopper design. Almost similar result of angle of repose of wheat seeds was determined as 28° by Clover (1998). Bulk density differences were noticed, with fertilizer having the highest density (944.66 kg/m<sup>3</sup>), nearly 20% greater than wheat varieties (780–833 kg/m<sup>3</sup>), which can affect hopper capacity and metering mechanisms to ensure consistent discharge rates.

### CONCLUSION

The physical properties of wheat seeds and fertilizer particles critically affect the design of seed drill machine's parts. Wheat varieties differ in size, shape, and weight, requiring adjustable components to handle dimensional variability and ensure uniform sowing. Fertilizer's distinct characteristics such as higher sphericity, bulk density, and angle of repose indicate the challenges of integrating seed and fertilizer application in a single hopper and metering system. These differences may lead to inconsistent flow, segregation, or blockages if not properly addressed. Therefore, all in one approach is impractical, as the mechanical requirements for seeds and fertilizer diverge significantly.

### Recommendations

To optimize seed drill performance, designers should prioritize modular components, such as interchangeable seed plates or adjustable metering mechanisms, to accommodate different seed dimensions and weights. Separate hoppers and metering systems for seeds and

fertilizer are desirable to prevent segregation and ensure accurate application rates.

The slope of the seeds and fertilizer hopper should be designed as per the angle of repose of seeds and fertilizer which will keep more than their angle of repose for free flow of the seeds and fertilizer from hopper.

### REFERENCE

Clover, Thomas J. Pocket Ref. Littleton, (1998) *Colorado: Sequoia Publishing, Inc.* [http://en.wikipedia.org/wiki/Angle\\_of\\_repose](http://en.wikipedia.org/wiki/Angle_of_repose), April 2010

CSA. (2014). *Report on area and production for major crops: Private peasant holding 'Meber' Season.* Statistical Bulletin, Central Statistical Authority, Addis Ababa, Ethiopia.

Davies, R. M. (2009). Some physical properties of groundnut grains. *Research Journal of Applied Sciences, Engineering and Technology*, 1(2), 10-13.

Dhruwe, N. K. (2016). *Development of Light Weight Five Row Animal Drawn Multi Crop Planter* (Doctoral dissertation, Indra Gandhi Krishi Vishwavidyalaya, Raipur).

FAO. (2009). *How to feed the world in 2050.* ([www.fao.org/fileadmin/templates/wsfs/docs/expert\\_paper/Howto\\_feed\\_the\\_World\\_in\\_2050](http://www.fao.org/fileadmin/templates/wsfs/docs/expert_paper/Howto_feed_the_World_in_2050)).

Hussain, M. I., & Shah, S. H. (2002). Growth, yield and quality response of three wheat (*Triticumaestivum* L.) cultivars to different levels of N, P and K. *Int. J. Agri. Bio* 4, 362-364.

Jouki, M., & Khazaei, N., (2012). Some physical properties of rice seed. *IIOABI*, 3(4), 15-18.

Konak, M., Carman, K., & Aydin, C. (2002). Physical properties of chick pea seeds. *Biosystems Engineering*, 82(1), 73–78,

Manoharan, M., & MM, T. (2018). A comprehensive study on physical properties of black gram and green gram for developing a planter. *International Journal of Agricultural Science and Research*, 8(6), 71-74.

Mohsenin, N. N. (1986). *Physical properties of plant and animal materials.* Gordon and Breach Science Publishers, New York.

Varnamkhasti, M. G., Mobli, H., Jafari, A. L. I., Rafiee, S., Heidarysoltanabadi, M., & Kheiralipour, K. (2007). *Some engineering properties of paddy* (var. Sazandegi).