SOME ENGINEERING PROPERTIES REQUIRED TO PRECISION SEEDING OF DIFFERENT RICE GENOTYPES

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Abstract

Knowledge on physical properties of rice grains is an important tool for designing agricultural machines and other equipment to handle planting, harvesting, processing, packaging and storing. The most common rice genotypes grown in Egypt is 19 rice genotypes (12 rice cultivars and 7 promising lines) but the data on its physical properties is still lacking. The aim of this study is to investigate some engineering properties of 19 rice genotypes which grown in Egypt and setup database for rice genotypes as well as its use to design Precision agriculture machines at different seed moisture contents for various manner of direct seeded rice approaches. Laboratory experiments were carried out during 1stMay of 2016 and 2017 seasons at the Farm of Rice Research Department, Field Crops Research Institute, Kafr El-Sheikh Governorate collaborated with Tractor Farm Machinery Test and Research Station - Alex). The rice grains properties of (dry, soaked and incubated for 24 and 48 hours) were tested. The obtained results indicated that, the mean values of moisture contents for all rice genotypes were (14.38%,14.81%, 25.67%, 26.02%, 28.98% and 29.37%) for dry, soaked (1day) and incubated (2days) in 2016 and 2017 seasons, respectively. Also the grain dimensions gradually parallel increased with additional moisture content increased for all rice grains genotypes. From these results, it was clear that the shortest dimensions of rice grains recorded (1.92 ± 0.08 mm) with dry seeds. Herein, it leads to design the hole diameter for seed plate less than 1.92 mm for precision machine. Therefore, the pertinent hole diameter for all rice grains genotypes was 1.5 mm. The results obtained were used to establish a database of all rice cultivars in Egypt to use in the development of direct agriculture machines with a precision farming system and determine the optimum number of grains per unit area according to the technical recommendations for growing rice cultivars.

Keywords: Physical properties, varieties, dry, soaked, incubated.

INTRODUCTION

Rice is considered one of the most important cereal crops in Egypt after wheat. The cultivated area of rice crop was about 1.430 million feddans (1 hectare = 2.38 fed.) in year of 2016 that produced about 5.434 million ton paddy rice *(RRTC, 2016)*.

The main objectives of the National Rice Research Institute program are to develop a new variety of economic high-yield under water shortage as well as salt affected soils.

The precision agriculture is very important for reducing production costs and allows for a one seed or more by category on specified distance for each class. Precision cultivation of crops that require precise control of plant density, spacing between and within the rows. The crops include in this category all horticultural crops, field crops, and for a minute cultivation of rice crop was necessary to set up a database of all natural and engineering properties of seeds of rice cultivars and promising lines which help for designing of precision agriculture machines.

Matouk et al., (2004) indicated that the bulk density at loose and vibrated fill conditions was found to be inversely proportional to grain moisture content for the studied varieties of wheat, corn and barley, while it was directly proportional to grain moisture content for rice varieties. Also he found that, the true density for rice varieties increased with the increasing of grain moisture content, while it was decreased for wheat, corn and barley varieties.

Ibrahim et al., (2008) studied some physical properties of rice seeds before and after soaking procedures. They found that, the values of shape index (SI), actual seeds density (ρ) and mass of 1000 seeds were about 2.81, 99.96 g/cm^3 and 33.03 g for dry rice grains (Giza 178) at 12.6 % seed moisture content, and about 2, 48.13 g/c m^3 and 78.47 g for hasting emergence rice seeds at 35.2 % seed moisture content, respectively. While the mass of 1000 grains of Egyptian hybrid rice No.1 were 22, 89 g according to *Abo-Yousef et al., (2011)*. Also, from demonstrated data, it can be seen that weight 1000 grains and grain real density take the same trend, whereas its values were significantly increasing with increasing moisture content.

Varnamkhasti et al., (2008) mentioned some engineering properties of Sazandegi and Sorkheh varieties which may be useful for designing mulch of the equipment used for rough rice processing. It is recommended that other engineering properties such as mechanical, thermal, and rheological properties which measured or calculated to provide a fairly comprehensive information on design parameters involved in rice processing. Also, it is recommended that the effect of grain moisture content on physical properties should be investigated.

Bashar et al., (2014) revealed that 1000 seed mass, basic dimensions, sphericity and bulk density were increased when the moisture content increased from (14.26 up to 22.50%) Meanwhile porosity and true density were decreased when moisture content increased from (14.26 to 22.50%). These data are highly essential for designing and development of dehulling machine, raising rice seedling singly in nursery tray and as well as transplanter to plant seedling singly.

Abo-Habaga et al., (2014) studied the physical and engineering properties of hybrid rice 1 seeds in laboratory experiments including the moisture content of the seeds (dry - soaked - incubated), seed dimensions (length - width - thickness), shape index, seed density, weight of 1000 seeds, sphericity, arithmetic mean diameter, geometric mean diameter, repose angle, dynamic coefficient of friction and terminal velocity. The results obtained were used to develop and manufacture a precision vacuum planter unit suitable for planting hybrid rice1 seeds in two rows with 150 mm apart between and within rows. Therefore, the main objective of current study was to investigate some engineering properties of 19 rice genotypes (12 cultivars and 7 new promising lines) in Egypt, in order to setup the database for rice genotypes and its impact on Precision agriculture systems at different seed moisture contents for direct sowing (dry - soaked - incubated) rice seeds.

MATERIALS AND METHODS

Laboratory experiment was carried out in 2016 and 2017 summer season at Rice Research section - Sakha Station at Kafr El-Sheikh Governorate collaborated with Tractor and Farm Machinery Test and Research Station –Alex. The current investigation aimed to stady some engineering properities of rice seeds, grain moisture content (Mc), mean dimensions Length (L), Width (W) and Thickness (Th), shape index (Si), bulk and true density (ρ), weight of 1000 seeds (Wi), sphericity (Sp), arithmetic mean diameter (Da), geometric mean diameter (Dg) and germination ratio (%). for some Egyption rice genotypes which included 12 rice cultivars as well as 7 promising rice lines under laboratory centitions as presented in Table (1) under three moisture conditions of rice seeds (dry- soaked- and incubated).

Studied characters:

(1) Grain moisture content:

Seed moisture content was determined using Grain Moisture Tester Model Kett KM No. 148-C Japan accuracy of 0.5%. Three samples 50 seeds each were taken to determine the seed moisture content for all varieties at dry, soaking and incubated.

(2) Mass of 1000 grains:

Means of mass of 1000 seeds from (dry, soaked and incubated) rice grains, samples of 1000 seeds were randomly selected. Each sample was weighted using an electronic balance with an accuracy of 0.01 g.

Table 1. Genotypes and pedgree of 12 cultivated rices and 7 newely promising rice lines.

No	genotypes	Origin	Parentage	Salient feature	Grains shape
1	Sakha 101	Egyptian	Giza 176×Milayang79	Japonica type/late maturing / high yielding.	Medium
2	Sakha 102	Egyptian	GZ4096×Giza177	Japonica type / very early maturing / high yielding.	Medium
3	Sakha 103	Egyptian	(Giza 177×Suweon 349)	Japonica type / very early maturing / high yielding.	Medium
4	Sakha 104	Egyptian	GZ4096×Gz41oo	Japonica type/moderately maturing / high yielding.	Medium
5	Sakha 105	Egyptian	GZ5581×Gz4316	Japonica type / very early maturing / high yielding.	Medium
6	Sakha 106	Egyptian	(Giza 177×Hexi 30)	Japonica type/early maturing-high yielding.	Medium
7	Sakha 107	Egyptian	Giza 177×BL1	Japonica type/ early maturing / high yielding.	Medium
8	Giza177	Egyptian	Giza 171×Yamj No1	Japonica type / very early maturing / high yielding.	Medium
9	Giza178	Egyptian	(Giza175×Milyang49)	Indica/Japonica/moderately maturing/high yielding.	Medium
10	Giza179	Egyptian	(Gz 6296 ×Gz 1368-S-5-4)	Indica/Japonica moderately maturing - high yielding.	Medium
11	Giza182	Egyptian	(Giza 181×IR39422) ×Giza 181	Indica-moderately maturing-moderately yielding.	Slender
12	Hybrid rice1	Egyptian	IR69625×Giza 178	Indica/Japonica moderately maturing / high yielding.	Medium
13	GZ10355-9-1-1-3	Egyptian	GZ7456×BY-Gc-30	Japonica type / very early maturing / high yielding.	Medium
14	GZ10333-9-1-1-3	Egyptian	SKC23822×Yan len4	Japonica type / very early maturing / high yielding.	Medium
15	GZ10332-19-2-2-2	Egyptian	SKC23822×IR73964	Japonica type / very early maturing / high yielding.	Medium
16	GZ10305-24-1-2-3	Egyptian	GZ7768×Milyang 95	Japonica type / very early maturing / high yielding.	Medium
17	GZ10154-3-1-1-1	Egyptian	GZ6522×Sakha 101	Japonica type / very early maturing / high yielding.	Medium
18	GZ10305-2-1-3-1-1	Egyptian	GZ7768×Milyang 95	Japonica type / very early maturing / high yielding.	Medium
19	GZ10264-9-2-1-2	Egyptian	Sakha 101×SR22746	Japonica type / very early maturing / high yielding.	Medium

(3) Shape index:

One hundred grains were taken randomly at the same time to estimate shape index in terms of length (L), width (W), and thickness (T) by using a digital caliper with a sensitivity of 0.01 mm. The obtained data were used to calculate the shape index of each sample, according to *Ismail (1988).*

Shape index (SI) = $\frac{L}{\sqrt{W.T}}$ ……………….. (1)

At (SI) > 1.5 the seed is considered oval and (SI) < 1.5 the seed is considered spherical.

(4) Geometric, arithmetic mean diameter and grain surface area:

The geometric, arithmetic mean diameter and seed surface area of hybrid rice seeds are determined from the samples taken in the same time of determining the seed moisture content using the following equations according to *Mohsenin, (1986)*:

$$D_g = (LWT)^{1/3} \quad \text{.......... (2)}$$

$$D_a = \frac{L + W + T}{3} \quad \text{.......... (3)}$$

$$A_s = 2\pi\,(L.W) \quad \text{.......... (4)}$$

Where:

D_g = Geometric mean diameter (mm), A_s = Seed surface area (mm^2),

D_a = Arithmetic mean diameter (mm), L = Length of seed (mm),

W = Width of seed (mm), and T = Thickness of seed (mm).

(5) The degree of sphericity:

The degree of sphericity *(ϕ)* were determined from the samples of linear dimensions of all rice seed varieties in the same time of determining the seed moisture content using the following equations according to (*Mohsenin, 1986*).

$$\phi = \frac{(L\ \ W\ \ T)^{(1/3)}}{L} \times 100 \quad \text{.......... (5)}$$

(6) Grain true and bulk density:

The true density (ρ_t) was determined by the toluene displacement method .The grain bulk density was determined using the liquid displacement method by immersing a certain mass of grain in a certain benzene alcohol solution. The increase in the cylinder volume gave the absolute volume of rice grain. Ten samples were taken to determine the grain density for each grain treatment. The density of rice grains was determined by using the following equation: (*Mohsenin, 1986*).

$$\rho_s = \frac{M}{V} \quad \text{.......... (6)}$$

Where:

ρ_s = grain bulk density (g/cm^3),

M= mass of grains (g), and

V = volume of the grain (cm^3).

RESULTS AND DISCUSSION

Grains moisture content:

Fig. (1) Showed that the average values of grains moisture content for all rice verities at dry, soaked and incubated grains. The results indicated that the mean values of moisture content for all rice genotypes in 2016 and 2017 seasons were (14.38, 25.67 and 28.98%) and 14.81, 26.02 and 29.37%) respectively for dry, soaked for one day and incubated for two days seed respectively. These means that the seed treatment either soaking or incubating impelled water to penetrate the seed and increase grain moisture content.

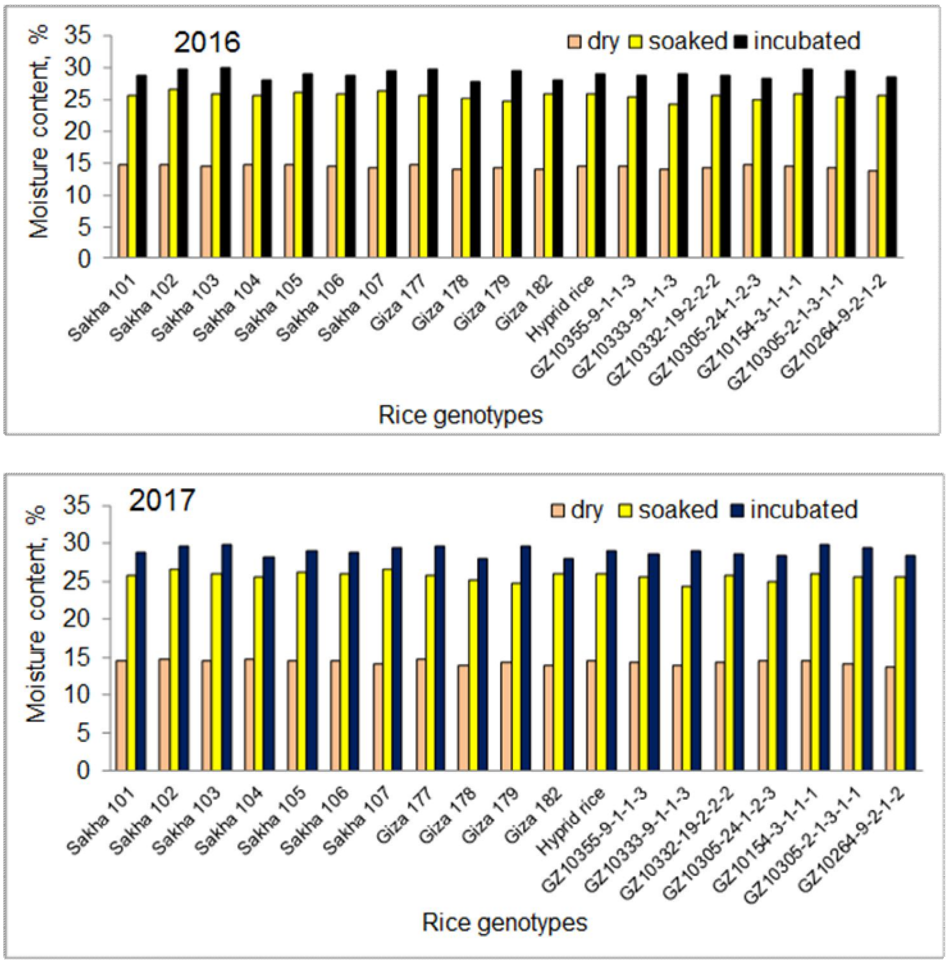

Fig. 1. Rice grain moisture content at different treatments
when 2016 and 2017 seasons.

Effect of grain moisture content on grain dimensions:

The average values of axial dimensions of rice grains dimensions (length, width and thickness) in 2016 and 2017 seasons at varying moisture content are shown in Table (2). It was noted that grain dimensions gradually increased with additional moisture content increased for all rice grains genotypes. From previous results, it was clear that the shortest dimensions of rice grains were at dry seeds, (1.92 ± 0.08 mm) and so it was designed the hole diameter for seed plate less than 1.92 mm for precision machine. Therefore the pertinent hole diameter for all rice grains genotypes was 1.5 mm.

Effect of grains moisture content on bulk density of rice grains all rice genotypes:

The effect of grains moisture content on bulk density of rice grains of all rice genotypes are shown in Figs (2 and 3). In general the bulk density increased with the increasing of grain moisture content for all rice genotypes. For old rice varieties, Giza178 recorded the highest values of bulk density, which increased from 535.24 to 546.27 to 574.22 kg/m^3 with increasing of grain moisture content from 14.38 to 25.67 to 28.98 % for season 2016 and which increasing from 531.87 to 543.82 to 571.70 kg/m^3 with increasing of grain moisture content from 14.81 to 26.02 to 29.37 % for season 2017 respectively. Meanwhile, Rice variety (Giza 177) recorded the lowest values of bulk density, which increased from 437.68 to 458.04 to 464.99 kg/m^3 with increasing from 14.38 to 25.67 to 28.98 % for season 2016 and which increasing from 435.18 to 455.59 to 462.47 kg/m^3 with increasing of grain moisture content from 14.81 to 26.02 to 29.37 %, respectively.

Also, rice genotype (GZ 10332-19-2-2-2) recorded the highest values of bulk density, which increased from 453.24 to 532.55 to 555.64 kg/m^3 with increasing of grain moisture content from 14.38 to 25.67 to 28.98 % for season 2016 and which increasing from 452.55 to 530.58 to 554.45 kg/m^3 for season 2017, with increasing of grain moisture content from 14.81 to 26.02 to 29.37 %, respectively. Meanwhile, rice genotype (GZ10305-2-1-3-1-1) recorded the lowest values of bulk density, which increased from 442.64 to 473.48 to 479.98 kg/m^3 with increasing of grain moisture content from 14.38 to 25.67 to 28.98 % for season 2016, and which increasing from 441.51 to 471.51 to 478.79 kg/m^3 for season 2017 respectively for new rice genotypes respectively. From above results, it can be recorded that increasing the period of soaking seeds increased the average bulk density for all rice genotypes within the time period used in the study.

Table 2. The average values of axial dimensions with standard deviation of all rice varieties in 2016 and 2017 seasons.

Variety	Moisture content	Length (mm)			Width (mm)			Thickness(mm)		
		2016	2017	SD	2016	2017	SD	2016	2017	SD
Sakha 101	Dry	7.74	7.80	± 0.27	3.20	2.24	± 0.13	2.08	2.10	± 0.09
	Soaked	7.87	7.93	± 0.21	3.27	3.31	± 0.13	2.28	2.30	± 0.09
	Incubated	7.88	7.94	± 0.22	3.29	3.33	± 0.14	2.31	2.33	± 0.07
Sakha 102	Dry	7.71	7.77	± 0.25	3.24	3.28	± 0.12	2.12	2.14	± 0.08
	Soaked	7.81	7.78	± 0.21	3.32	3.36	± 0.11	2.34	2.36	± 0.09
	Incubated	7. 96	8.02	± 0.23	3.35	3.39	± 0.10	2.38	2.40	± 0.08
Sakha 103	Dry	7.12	7.18	± 0.23	3.19	3.23	± 0.11	2.10	2.11	± 0.09
	Soaked	7.17	7.23	± 0.23	3.26	3.30	± 0.12	2.28	2.30	± 0.08
	Incubated	7.27	7.33	± 0.22	3.27	3.31	± 0.13	2.34	2.36	± 0.09
Sakha 104	Dry	7.77	7.83	± 0.22	3.18	3.22	± 0.12	2.06	2.08	± 0.09
	Soaked	7.96	8.02	± 0.20	3.37	3.41	± 0.16	2.31	2.33	± 0.07
	Incubated	8.69	8.75	± 0.22	3.43	3.47	± 0.16	2.35	2.37	± 0.09
Sakha 105	Dry	7.84	7.90	± 0.25	3.17	3.21	± 0.12	2.11	2.13	± 0.09
	Soaked	7.86	7.92	± 0.26	3.18	3.22	± 0.13	2.28	2.30	± 0.07
	Incubated	7.96	8.02	± 0.24	3.21	3.25	± 0.12	2.30	2.32	± 0.10
Sakha 106	Dry	7.43	7.49	± 0.21	3.16	3.20	± 0.11	2.14	2.16	± 0.09
	Soaked	7.47	7.53	± 0.22	3.22	3.26	± 0.15	2.32	2.34	± 0.08
	Incubated	7.51	7.57	± 0.23	3.32	3.36	± 0.13	2.39	2.41	± 0.08
Sakha 107	Dry	7.50	7.56	± 0.28	3.35	3.39	± 0.19	2.20	2.22	± 0.08
	Soaked	7.63	7.69	± 0.30	3.37	3.41	± 0.16	2.33	2.35	± 0.08
	Incubated	7.82	7.88	± 0.34	3.39	3.43	± 0.19	2.37	2.39	± 0.10
Giza 177	Dry	7.44	7.50	± 0.22	3.23	3.27	± 0.13	2.17	2.19	± 0.12
	Soaked	7.48	7.54	± 0.27	3.24	3.32	± 0.13	2.32	2.34	± 0.08
	Incubated	7.53	7.59	± 0.28	3.33	3.37	± 0.15	2.41	2.43	± 0.11
Giza 178	Dry	7.18	7.24	± 0.23	2.82	2.80	± 0.12	1.98	2.00	± 0.09
	Soaked	7.32	7.38	± 0.24	2.86	2.90	± 0.13	2.15	2.17	± 0.09
	Incubated	7.35	7.41	± 0.37	2.88	2.92	± 0.10	2.29	2.31	± 0.07
Giza 179	Dry	7.24	7.30	± 0.22	2.88	2.92	± 0.11	2.07	2.09	± 0.09
	Soaked	8.03	8.09	± 0.23	3.03	3.07	± 0.12	2.13	2.15	± 0.07
	Incubated	8.18	8.24	± 0.31	3.16	3.20	± 0.13	2.23	2.25	± 0.07
Giza 182	Dry	9.41	9.47	± 0.31	2.56	2.60	± 0.13	1.92	1.94	± 0.08
	Soaked	9.44	9.50	± 0.44	2.62	2.66	± 0.12	2.09	2.11	± 0.08
	Incubated	9.64	9.70	± 0.39	2.69	2.73	± 0.12	2.11	2.13	± 0.08
Hybrid rice 1	Dry	8.05	8.11	± 0.26	2.89	2.93	± 0.11	1.96	1.98	± 0.07
	Soaked	8.05	8.11	± 0.26	2.93	2.97	± 0.10	2.09	2.11	± 0.07
	Incubated	8.18	8.24	± 0.27	2.97	3.01	± 0.12	2.19	2.21	± 0.06
GZ10355-9-1-1-3	Dry	7.56	7.62	± 0.26	3.32	3.36	± 0.18	2.16	2.18	± 0.11
	Soaked	7.88	7.94	± 0.31	3.40	3.44	± 0.18	2.21	2.23	± 0.07
	Incubated	8.03	8.09	± 0.29	3.51	3.55	± 0.18	2.31	2.33	± 0.06
GZ10333-9-1-1-3	Dry	7.43	7.49	± 0.35	3.33	3.37	± 0.13	2.16	2.18	± 0.11
	Soaked	7.54	7.60	±0.27	3.34	3.41	± 0.18	2.22	2.24	± 0.09
	Incubated	8.01	8.07	± 0.27	3.39	3.43	± 0.18	2.27	2.29	± 0.07
GZ10332-19-2-2-2	Dry	7.40	7.46	± 0.28	3.37	3.41	± 0.14	2.10	2.12	± 0.07
	Soaked	7.47	7.53	± 0.28	3.40	3.44	± 0.19	2.18	2.20	± 0.11
	Incubated	7.52	7.58	± 0.27	3.44	3.48	± 0.15	2.24	2.26	± 0.10
GZ10305-24-1-2-3	Dry	7.20	7.26	± 0.28	3.35	3.39	± 0.17	2.14	2.16	± 0.11
	Soaked	7.41	7.47	± 0.28	3.36	3.45	± 0.18	2.28	2.30	± 0.08
	Incubated	7.53	7.59	± 0.29	3.46	3.50	± 0.15	2.34	2.36	± 0.12
GZ10154-3-1-1-1	Dry	7.84	7.90	± 0.25	3.12	3.16	± 0.13	2.08	2.10	± 0.08
	Soaked	7.89	7.95	± 0.33	3.13	3.21	± 0.12	2.25	2.27	± 0.10
	Incubated	7.96	8.02	± 0.26	3.19	3.23	± 0.18	2.28	2.30	± 0.09
GZ10305-2-1-3-1-1	Dry	7.37	7.43	± 0.27	3.31	3.35	± 0.16	2.13	2.15	± 0.06
	Soaked	7.41	7.47	± 0.27	3.36	3.45	± 0.18	2.31	2.33	± 0.07
	Incubated	7.44	7.50	± 0.25	3.45	3.49	± 0.1	2.35	2.37	± 0.11
GZ10264-9-2-1-2	Dry	7.24	7.30	± 0.20	3.21	3.25	± 0.11	2.12	2.14	± 0.09
	Soaked	7.95	8.01	± 0.23	2.88	3.92	± 0.12	2.13	2.15	± 0.10
	Incubated	8.14	8.20	± 0.25	3.19	3.98	± 0.13	2.26	2.28	± 0.11

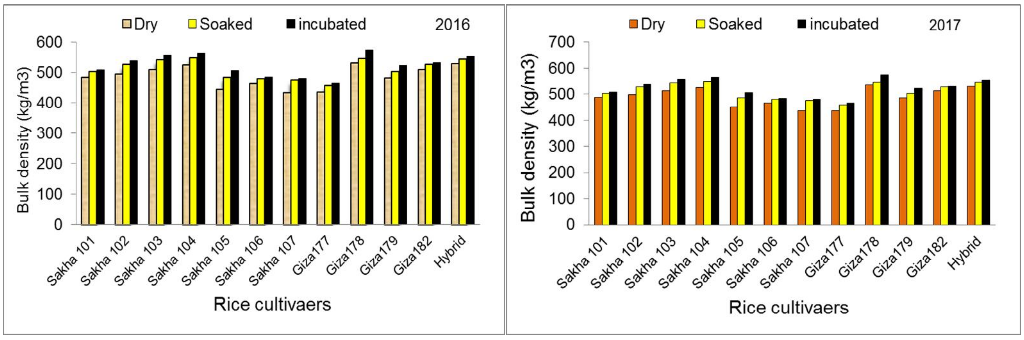

Fig. 2. Effect of grains moisture content on bulk density of rice grains for rice cultivars in 2016 and 2017 seasons.

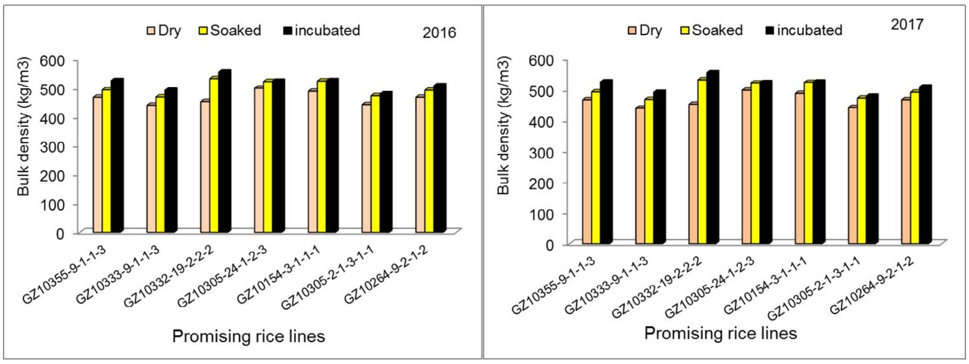

Fig. 3. Effect of grains moisture content on bulk density of rice grains for promising rice lines in 2016 and 2017 seasons.

Effect of grains moisture content on true density for all rice genotypes:

The effect of grains moisture content on true density of rice grains of all rice genotypes are shown in Figs (4 and 5). In general the true density increased with the increasing of grain moisture content for all rice genotypes. For old rice varieties, Sakha 104 recorded the highest values of true density, which increased from 1192.94 to 1372.60 to 1407.27 kg/m^3 with increasing of grain moisture content from 14.38 to 25.67 to 28.98 % for season 2016 and which increasing from 1192.94 to 1367.21 to 1402.38 kg/m^3 with increasing of grain moisture content from 14.81 to 26.02 to 29.37 % for season 2017 respectively. Meanwhile, Rice variety (Giza 177) recorded the lowest values of true density, which increased from 1074.44 to 1208.97 to 1224.63 kg/m^3 with increasing from 14.38 to 25.67 to 28.98 % for season 2015 and which increasing from 1068.96 to 1203.58 to 1219.74 kg/m^3 with increasing of grain moisture content from 14.81 to 26.02 to 29.37 %, respectively.

Also, rice genotype (GZ 10355-9-1-1-3) recorded the highest values of true density, which increased from 1165.1 to 1267.3 to 1367.2 kg/m^3 with increasing of grain moisture content from 14.38 to 25.67 to 28.98 % for season 2016 and which increasing from 1160.5 to 1263.0 to 1361.5 kg/m^3 for season 2017, with increasing of grain moisture content from 14.81 to 26.02 to 29.37 %, respectively. Meanwhile, rice genotype (GZ10333-9-1-1-3) recorded the lowest values of true density, which increased from 1075.9 to 1201.6 to 1223.1 kg/m^3 with increasing of grain moisture content from 14.38 to 25.67 to 28.98 % for season 2016, and which increasing from 1071.4 to 1197.3 to 1217.4 kg/m^3 for season 2017 respectively for new rice genotypes respectively.

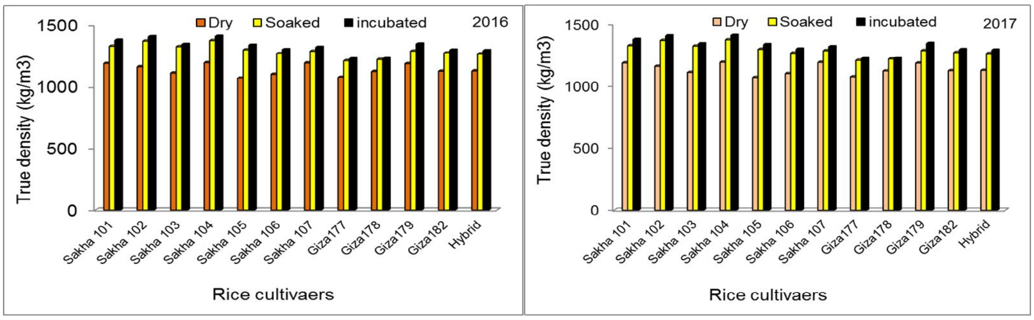

Fig. 4. Effect of grains moisture content on true density of rice grains for rice cultivars in 2016 and 2017 seasons.

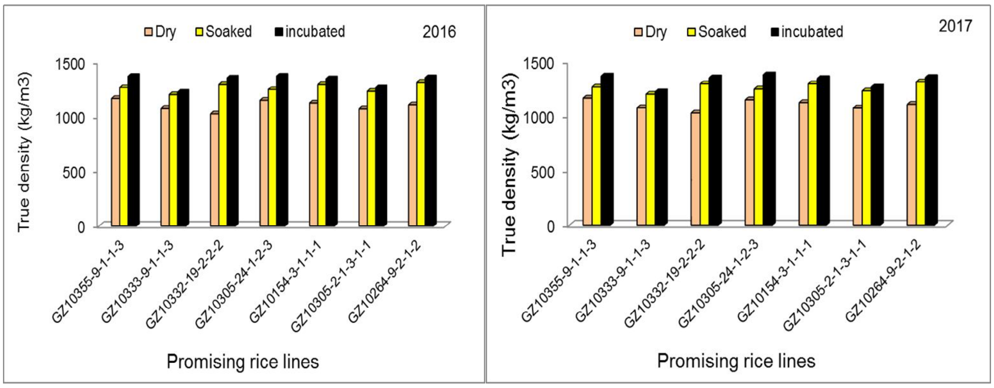

Fig. 5. Effect of grains moisture content on true density for promising rice in 2016 and 2017 seasons.

From the above results, it can be mentioned that increasing the period of soaking seeds increased the average true density for all rice genotypes within the time period used in the study.

Table 3. The average values of 1000 mass, arithmetic and geometric mean diameters, sphericity, surface area and shape index for all cultivated rice.

Variety	Moisture content	Geometric mean diameter (mm)		Arithmetic mean diameter (mm)		1000 mass (g)		Degree of sphericity		surface area (mm^2)		Shape index	
		2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
Sakha 101	Dry	3.64	3.85	4.37	4.56	28.89	29.02	0.477	0.510	43.89	43.94	3.04	3.07
	Soaked	380	4.01	4.48	4.67	34.91	35.04	0.495	0.528	47.28	47.33	2.87	2.9
	incubated	3.91	4.12	4.79	4.98	37.13	37.26	0.526	0.559	48.00	48.05	2.76	2.79
Sakha 102	Dry	3.36	3.57	4.19	4.38	27.07	27.2	0.481	0.514	44.35	44.40	2.98	3.01
	Soaked	3.53	3.74	4.49	4.68	36.54	36.67	0.503	0.536	47.47	47.52	2.80	2.83
	incubated	3.98	4.19	4.89	5.08	37.45	37.58	0.504	0.537	48.50	48.55	2.79	2.82
Sakha 103	Dry	3.65	3.86	4.18	4.37	24.05	24.18	0.503	0.536	41.91	41.96	2.80	2.83
	Soaked	3.76	3.97	4.22	4.41	31.30	31.43	0.528	0.561	44.39	44.44	2.61	2.64
	incubated	3.86	4.07	4.75	4.94	33.07	33.2	0.528	0.561	45.00	45.05	2.51	2.54
Sakha 104	Dry	3.81	4.02	4.34	4.53	27.4	27.53	0.489	0.522	42.42	42.47	3.03	3.06
	Soaked	3.96	4.17	4.55	4.74	33.40	33.53	0.497	0.530	45.29	45.34	2.85	2.88
	incubated	4.08	4.29	4.48	4.67	36.12	36.25	0.528	0.561	49.17	49.22	3.81	3.84
Sakha 105	Dry	3.77	3.98	4.44	4.63	25.29	25.42	0.481	0.514	44.73	44.78	3.11	3.14
	Soaked	3.85	4.06	4.45	4.64	34.55	34.68	0.489	0.522	45.58	45.63	2.92	2.95
	incubated	3.89	4.10	4.69	4.88	35.13	35.26	0.489	0.522	46.58	46.63	2.84	2.87
Sakha 106	Dry	3.73	3.94	4.27	4.46	26.04	26.17	0.502	0.535	43.68	43.73	2.89	2.92
	Soaked	3.82	4.03	4.34	4.53	33.33	33.46	0.512	0.545	44.91	44.96	2.73	2.76
	incubated	3.94	4.15	483	4.83	35.03	35.16	0.558	0.591	45.67	45.72	2.71	2.74
Sakha 107	Dry	3.85	4.06	4.24	4.43	28.06	28.19	0.686	0.719	39.75	39.80	2.79	2.82
	Soaked	3.89	4.10	4.41	4.60	34.69	34.82	0.516	0.549	47.12	47.17	2.69	2.72
	incubated	3.94	4.15	4.69	4.88	36.00	36.13	0.540	0.573	47.86	47.91	2.65	2.68
Giza177	Dry	3.74	3.95	4.29	4.48	25.79	25.92	0.500	0.533	43.97	44.02	2.83	2.86
	Soaked	3.82	4.03	4.33	4.52	31.43	31.56	0.514	0.547	45.27	45.32	2.79	2.82
	incubated	3.95	4.16	4.83	5.02	33.47	33.6	0561	0.594	45.94	45.99	2.73	2.76
Giza178	Dry	3.45	3.66	4.05	4.24	19.83	19.96	0.496	0.529	37.32	37.37	3.15	3.18
	Soaked	3.57	3.78	4.12	4.31	26.13	26.26	0.487	0.520	39.91	39.96	2.94	2.97
	incubated	3.89	4.10	4.51	4.70	27.25	27.38	0.519	0.552	40.76	40.81	2.91	2.94
Giza179	Dry	3.74	3.95	4.39	4.58	26.88	27.01	0.462	0.495	43.85	43.90	3.22	3.25
	Soaked	3.82	4.03	4.43	4.62	33.86	33.99	0.481	0.514	45.22	45.27	3.01	3.04
	incubated	3.85	4.06	4.54	4.73	35.83	35.96	0.475	0.508	45.71	45.76	3.05	3.08
Giza182	Dry	3.59	3.80	4.64	4.83	24.00	24.13	0.381	0.414	40.51	40.56	4.25	4.28
	Soaked	3.73	3.94	4.72	4.91	31.33	31.46	0.395	0.428	43.69	43.74	4.03	4.06
	incubated	3.79	4.00	4.89	5.08	32.27	32.4	0.344	0.377	43.89	43.94	3.99	4.02
Hybrid rice1	Dry	3.57	3.78	4.31	4.50	22.91	23.04	0.443	0.476	40.19	40.24	3.39	3.42
	Soaked	3.67	3.88	4.36	4.55	29.88	30.01	0.456	0.489	42.32	42.37	3.25	3.28
	incubated	3.86	4.07	4.72	4.91	30.51	30.64	0.458	0.491	42.66	42.71	3.22	3.25

Effect of moisture content on 1000 mass weight, arithmetic and geometric mean diameters, sphericity, surface area and shape index for all cultivated rice:

Tables (3 and 4) shown the effect of moisture content on average values of 1000 mass weight, arithmetic and geometric mean diameters, sphericity, surface area and shape index for all rice varieties for two studied seasons 2016 and 2017. It were noted that the 1000 mass, arithmetic and geometric mean diameters, sphericity, surface area and shape index gradually increased with additional grains moisture content increased for all cultivated rice. It can be recorded that the increase in 1000 mass, arithmetic and geometric mean diameters, sphericity, surface area and shape index in the first period from dry to soaked seeds are a larger period than for the second period of the soaked to the incubated seeds and this is normal because the seeds will be saturated with water.

Table 4. The average values of 1000 mass, arithmetic and geometric mean diameters, sphericity, surface area and shape index for all new promising rice lines.

Variety	Moisture content	Geometric mean diameter (mm)		Arithmetic mean diameter (mm)		1000 mass (g)		Degree of sphericity		surface area (mm^2)		Shape index	
		2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
GZ10355-9-1-1-3	Dry	3.78	3.99	4.35	4.54	24.75	24.88	0.386	0.419	44.94	44.99	2.96	2.99
	Soaked	3.92	4.13	4.54	4.73	32.53	32.66	0.489	0.522	48.28	48.33	2.93	2.96
	incubated	3.95	4.16	4.91	5.10	35.58	35.71	0.501	0.534	49.03	49.08	2.82	2.85
GZ10333-9-1-1-3	Dry	3.81	4.02	4.21	4.40	27.57	27.70	0.485	0.518	45.91	45.96	2.96	2.99
	Soaked	3.82	4.03	4.37	4.56	30.89	31.02	0.507	0.540	46.21	46.26	2.77	2.80
	incubated	3.86	4.07	4.82	5.01	33.70	33.83	0.517	0.550	47.37	47.42	2.69	2.72
GZ10332-19-2-2-2	Dry	3.74	3.95	4.29	4.48	23.29	23.42	0.505	0.538	43.96	44.01	2.82	2.85
	Soaked	3.82	4.03	4.36	4.55	31.53	31.66	0.508	0.541	45.76	45.81	2.76	2.79
	incubated	3.88	4.09	4.92	5.11	32.90	33.03	0.516	0.549	46.73	46.78	2.69	2.72
GZ10305-24-1-2-3	Dry	3.78	3.99	4.34	4.53	25.28	25.41	0.503	0.536	44.89	44.94	2.81	2.84
	Soaked	3.84	4.05	4.35	4.54	31.23	31.36	0.519	0.552	46.42	46.47	2.67	2.70
	incubated	3.88	4.09	4.66	4.85	36.31	36.44	0.524	0.557	47.15	47.20	2.63	2.66
GZ10154-3-1-1-1	Dry	3.72	3.93	4.39	4.58	25.85	25.98	0.468	0.501	43.55	43.60	3.12	3.15
	Soaked	3.81	4.02	4.42	4.61	31.97	32.1	0.481	0.514	45.66	45.71	2.98	3.01
	incubated	3.85	4.06	4.73	4.92	35.42	35.55	0.491	0.524	46.56	46.61	2.91	2.94
GZ10305-2-1-3-1-1	Dry	2.59	2.80	4.29	4.48	24.33	24.46	0.502	0.535	46.26	46.31	2.81	2.84
	Soaked	3.76	3.97	4.36	4.55	31.62	31.75	0.521	0.554	46.73	46.78	2.66	2.69
	incubated	3.87	4.08	4.56	4.75	35.49	35.62	0.536	0.569	47.06	47.11	2.62	2.65
GZ10264-9-2-1-2	Dry	3.50	3.71	4.18	4.37	26.21	26.34	0.467	0.500	43.34	43.39	3.13	3.16
	Soaked	3.54	3.75	4.48	4.67	35.03	35.16	0.489	0.522	44.34	44.39	2.92	2.95
	incubated	3.85	4.06	4.68	4.87	36.12	36.25	0.525	0.558	46.67	46.72	2.86	2.89

From the above results, it can be recorded that the increase in seeds soaking period resulted in increase the 1000 mass weight, arithmetic and geometric mean diameters, sphericity, surface area and shape index of rice grain within the time period used in the study. Because of these findings have an important role in the field of design, development and manufacturing of precision direct seeding machine as well as conduct in damage and distribution uniformity of rice grains after soaking and incubating.

From previous results, it was clear that all values of shape index for all rice genotypes higher than 1.5, this intend that all rice treatment take oval shape. This contributed us to fabricate precision direct seeding machine seed holes as a cylindrical shape and to disqualify spherical form.

In general the results could be summarized as flow:-

- The mean values of moisture content for all rice genotypes in 2016 and 2017 seasons were (14.38, 25.67 and 28.98%) and 14.81, 26.02 and 29.37%) respectively for dry, soaked for one day and incubated for two days seed respectively.
- The grain dimensions gradually increased with additional moisture content increased for all rice grains genotypes. From previous results, it was clear that the shortest dimensions of rice grains were at dry seeds (1.92 ± 0.08 mm) as well as using the database to design of hole diameter for seed plate less than 1.92 mm for precision machine. Therefore the pertinent hole diameter for all rice grains genotypes was 1.5 mm.
- It can be recorded that increasing the period of soaking seeds increased the average bulk and true density for all rice genotypes within the time period used in the study.
- It can be recorded that increasing the period of soaking seeds increased the 1000 mass, arithmetic and geometric mean diameters, sphericity, surface area and shape index of rice grain within the time period used in the study.

CONCLUSION

- The aimed of this study to investigate some engineering properties of 19 rice genotypes (12 rice cultivars and 7 promising lines) cultivated in Egypt, in order to setup database for rice genotypes as well as its use to design Precision agriculture machines at different seed moisture contents for various manner of direct seeded rice approaches.
- Laboratory experiment was carried out during summer season of 2017 at (Rice Research Department - Field Crops Research Institute - Kafr El-Sheikh Governorate collaborated with Tractor Farm Machinery Test and Research Station –Alex). The rice grain properties of (dry, soaked and incubated) were tested.

REFERENCES

1. Abo-Habaga, M. M.; A. E. Abo-Elmagd; M. A. El-Sadany; M. I. Egela and M.I. El-Meadawy. 2014. Development of a suitable planter for hybrid rice crop. J. Agric. Sci. and Agric. Eng., Mansoura Univ., 5 (5): 721 – 737.
2. Abo-Youssef, M. I.; S. Gh. Sorour, M. Z. Abdelkrem, and M. A. Tawfik. 2011. The effect of sowing date on the productivity of some rice varieties. J. Agric. Res. Kafer El-Sheikh Univ., 37 (2): 317-330.
3. Bashar, Z. U., A. Wayayok and A. M. S. Mohd. 2014. Determination of some physical properties of common Malaysian rice MR219 seeds. AJCS 8(3):332-337 ISSN:1835-2707.
4. Ibrahim, M. M.; H. N. Abd El-Mageed, and T. H. Abd-Alla. 2008. Evaluation the field performance of a developed planting machine sutable for soaked rice". Misr J. Ag. Eng., 25(3): 677-692
5. Ismail, Z. E. 1988. "Some of the phsio-mechanical properties for potato tubers". J. Agric. Sci. Mansoura Univ. 13 B (4): 2259 – 2270.
6. Matouk, A. M.; S. M. Radwan; M. M. El–Kholy and T. R. Ewies. 2004. Determination of grains density and porosity for some cereal crop. Misr J. Ag. Eng., 21(3): 623-641.
7. Mohsenin, N. N. 1986. Physical properties of plant and animal materials". Gordon and Breach Science Pub., N.Y.: 103-105.
8. Varnamkhasti, M. G.; H. Mobli; A. Jafari; A.R. Keyhani; M. Heidari Soltanabadi; S. Rafiee and K. Kheiralipour. 2008. Some physical properties of rough rice (Oryza Sativa L.) grain. Journal of Cereal Science 47: 496–501.

مراجع عربية

- مركز البحوث والتدريب فى الأرز (RRTC, 2016) . التوصيات الفنيـــة لمحصـــول الأرز . برنامج الأرز – مركز البحوث الزراعية – وزارة الزراعة.

بعض الخواص الهندسية اللازمة لمتطلبات الزراعة الدقيقة لأصناف الأرز المختلفة

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يعتبر محصول الأرز واحد من أهم محاصيل الحبوب في مصر والكثير من دول العالم، حيث يمثل الغذاء الأساسى لمعظم الشعوب على مدار العام فضلاً عن أهميته التصديرية لبعض الدول. وفى مصر يعتمد عليه الكثير من المزارعين كمصدر دخل رئيسى حيث كانت المساحة المزروعة منه حوالي ١٤٣٠٠٠٠ فدان فى موسم ٢٠١٦م والتى أعطت إنتاجية كلية حوالي ٥٤٣٤٠٠٠ طن من الأرز الشعير بمعدل إنتاجية حوالي ٣,٨ طن / فدان ***(مركز البحوث والتدريب فى الأرز – RRTC, 2016)***. لذا تولى الدولة اهتماماً كبيراً لزيادة إنتاج هذا المحصول عن طريق الزراعة المباشرة لإنخفاض تكاليفها مقارنةً بالشتل اليدوي والذى أصبح من أشق العمليات الزراعية هذا فضلاً عن إرتفاع تكاليفه لإرتفاع أجر العمالة اليدوية. وزراعة الأرز باستخدام الشتل الآلي مرتفعة التكاليف ولا تغطى إلا مساحة صغيرة جدا لا تتعدى ٢٠٠٠ فدان من إجمالي المساحة المنزرعة ولا تعطى الكثافة الزراعية الموصى بها لمعظم أصناف الأرز.

وتعتبر الزراعة الدقيقة من طرق الزراعة الحديثة التى تقلل من تكاليف إنتاج المحاصيل المختلفة حيث يتم التحكم فى عدد البذور فى الجورة الواحدة حسب نوع المحصول والأصناف المختلفة وبالمسافات المحددة الموصى بها بين النباتات و بعضها البعض، وتستخدم هذه الطرق عادةً لزراعة المحاصيل التى تتطلب مراقبة دقيقة للكثافة النباتية. وتشمل هذه المحاصيل معظم المحاصيل البستانية والحقلية ، ولإستخدام الزراعة الدقيقة مع محصول الأرز كان لابد من إنشاء قاعدة بيانات تشمل جميع الخواص الطبيعية والهندسية لأصناف الأرز المختلفة فى مصر، حيث تساعد هذه البيانات في تصميم وتشغيل آلات الزراعة الدقيقة لمحصول الأرز. لذا فإن الهدف الرئيسي من هذه الدراسة هو تقدير الخواص الطبيعية والهندسية لأصناف الأرز المختلفة كأحد المتطلبات الأولية للزراعة الدقيقة عند محتويات الرطوبة للبذور المستخدمة في الزراعة المباشرة لمحصول الأرز (جافة – منقوعة – مكمورة).

وأجريت تجارب معملية بغرض دراسة مجموعة من الخواص الهندسية لبذور الأرز منها المحتوى الرطوبي للبذور (جافة – مبتلة – مكمورة)، أبعاد البذور (طول – عرض – سمك)، متوسط وزن ١٠٠٠ بذرة، متوسط الكثافة الظاهرية والحقيقية للبذور، متوسط القطر الهندسي للبذور، متوسط القطر الحسابي للبذور، معامل شكل البذور و درجة كروية البذور.

وتم الاستفادة من النتائج المتحصل عليها في إنشاء قاعد بيانات لجميع أصناف الأرز الموجودة حالياً في مصر والتى تساعد في تطوير آلات الزراعة المباشرة بنظام الزراعة الدقيقة لتحديد العدد الامثل من الحبوب لوحدة المساحة طبقا للتوصيات الفنية لزراعة أصناف الأرز المختلفة.