Image processing and biometrical investigations for choosing the most ranked rice cultivars

[1]Asad Masoumi Asl, [1]Reza Amiri Fahliani and [2]Alireza Khoshroo

[1]Department of Agronomy and Plant Breeding, Faculty of Agriculture, Yasouj University, Yasouj, Iran; [2] Department of Agricultral engineering, Faculty of Agriculture, Yasouj University, Yasouj, Iran. Corresponding author: masumiasl@yahoo.com

Abstract: Rice (*Oryza sativa* L.) is one of the vital food staples in our daily life, amongst the oldest cultivated crops worldwide, ranks as the most widely grown crop. It serves as a vital nutritional material to more than half of the world increasing crowd. This experiment was conducted for evaluation and selection of the most ranked rice cultivars: Kamfirooz, Yasouj, Dom Siah, Gharib, Dollar, Hassan saraei, 304, Lenjan, and Musa Tarom (MTA) as the well-known and prevalent varieties in the 'Fars' and 'Kogilouyeh-o-BoyreAhmad' provinces, Iran, along with other countries. Rough rice grains of the varieties were randomly selected and their principal dimensions were imaged using camera and a special box for light controlling and including Perimeter, Area, MajorAxis Length, MinorAxis Length, Solidity, Eccentricity, and Equiv Diameter, following with image analyzing by image processing software, in a labratroy experiment. The data were statistically analyzed and graphically plotted using SPSS v.17 and MINITAB v.16 software programs. The results of the image analysis indicated that there were significantly differences between most cultivars in the case of physical traits. The cluster categorization of the cultivars showed also that 9 cultivars clustered in 5 groups, i.e. Yasouj and Lenjan cultivars were located in different groups individually, where cultivars: Kamfirrooz, Dom Siah and Dollar in a unique cluster, but Gharib and 304 in the 4th group and MTA and Hassan Saraei in the 5th group. The results of this experiment showed the separateness of rice most recent cultivars according to agronomic and physical status, and leads to picking the most valuable cultivars for upcoming food nutritional values and also experiments.

Key words: agronomic traits, image processing, physical traits, rice.

Introduction

Rice (*Oryza sativa* L.) is among the oldest of cultivated crops and ranks as the most widely grown food grain crop, serving as the staple food for about half the world`s population. world rice production increased from 520 million tones in 1990 to 637.4 million tones in 2008, while in Iran rice production increased from 1.3 million tones in 1980 to 3.6 million tonnes in 2008 (FAOSTAT, 2008).

Grain quality is dependent on cooked and uncooked grain size, width and shape (Fotoukian et al., 2007). Higher grain yield and quality are two major subjects for many breeding programs. Physical properties of rice grains includes grain length, width and shape, have direct effect on marketability, and therefore the commercial success of modern rice cultivars (Redona et al., 1998). Rice kernels are usually used to cook as a meal for the human, thus the main indices for evaluation of rice quality are cooking and eating quality and appearance. Important eating quality indicators are amylose content (AC), gelatinization temperature (GT), gel consistency (GC). Appearance features includes milling quality, percentage of chalky grains, chalkiness (often defined the opaque parts in the endosperm) and transparency. Rice consumers in most countries including Iran give more attention to the appearance and cooking quality. The appearance quality directly affects commercial values of rice, and the chalkiness is a key index of appearance quality (Jian-chang et al, 2007, He et al., 1999). In most Asian countries, commercial cultivars belong to the medium or long grain class. Long and slender grained Basmati cultivars of Indian and Pakistan command premium prices in the international market, while short and bold grained cultivars are preferred in Japan and Sri Lanka (Redona et al., 1998).

Image analysis has been used in discriminating among various types of cereal grains (Lai et al., 1989, Zayas et al., 1986) and among wheat classes and varieties (Zayas et al., 1985, Zayas et al., 1986). A digital image processing system was described by Sapirstein et al (1987) to determine composition of mixtures of wheat, oats, barley, and rye. Neuman et al (1987) used digital image analysis to classify wheat cultivars according to kernel type. Travis and Draper (1985) used image processing and statistical analysis to obtain principal axis and confidence regions for 49 crop and weed species (Zayas et al., 1989). Appearance is mainly determined by the grain shape as specified by grain length (GL), grain width (GW), aspect ratio (length-to-width ratio) and the translucency of the endosperm (Tan et al., 2000). Genetic analyses of GL and GW of rice grains have shown that grain shape is quantitatively heritable (Kou & Hsieh 1982 , Chen & Zhu 1998). It has been shown that rice grain shape is simultaneously controlled by triploid endosperm genes, cytoplasmic genes, embryo and maternal plant genes and their genotype-environment interaction (Shi & Zhu 1996 , Shi et al., 2000).

In Iran, different Iranian or foreign rice varieties are cultivated. Yasouj local cultivar is cultivated in Kohgilooyeh & Boyer-Ahmad province, but there is no information about it. Precise quantification of local rice variety shape and physical features by image processing techniques and comparing the features with other Iranian and foreign varieties is the first step toward breeding program for selecting the most suitable cultivars. The aim of this study is characterizing shape features of selected rice varieties and classifying these varieties based on the features.

Material and Methods

The rice grain used in this research was obtained from IRRI, Kamfirooz and yasouj cities in Fars and Kogilooye & Boyer-Ahmad province in Iran. The varieties (Kamfirooz, Yasouj, Dom Siah, Gharib, Dollar, Hassan saraei, 304, Lenjan, Mosa Tarom (MTA)) used in the current research are the famous and prevalent varieties in the "Fars" and "Kogilooye & Boyer-Ahmad" province. The randomly selected rough rice grains of these varieties were imaged by using camera and a special box for light controlling. Then the images were analyzed by MATLAB software to extract the features. Feature analysis of the rice grains includes determining geometric features and shape related features. Geometric features including perimeter, area, and major and minor axis length were measured from the binary images. The perimeter of a region is defined as the length of its boundary. The area is the number of pixels within the boundary. Major axis length is the distance between the end points of the longest line that can be drawn through the kernel. Minor axis length is the distance between the end points of the longest line that can be drawn through the object while keeping perpendicularity with the major axis. Equivalent diameter is the diameter of a circle with the same rice grain region.

$$Equivalent\ \text{diameter} = \sqrt{\frac{4 \times \text{Area}}{\pi}}$$

The statistical data analysis were carried out using SAS 9.1 and clustering were plotted in Minitab 16 software.

Results and Discussion

Perimeter ranged from 19.244 (DS) to 22.468 mm (Yasouj), Area from 18.949 (142) to 24.016 mm (Yasouj), Major Axis Length from 7.955 (Kamfirooz) to 9.570 (Yasouj), Minor Axis Length from 2.715 (141) to 3.418 (304), Solidity from 0.957 (MTA) to 0.979 (DS), Eccentricity from 0.903 (304) to 0.958 (141) and equival Diameter from 57.887 (142) to 65.235 (Yasouj). Physical values of measured traits were significantly difference ($P<0.05$) between 9 rice cultivars (table 1). For diameter trait, Kamfirooz, 304, DS and 142 have non-significant differences. 141, MTA, Lenjan and 144 have non-significant differences. Yasouj, 141 and MTA have non-significant differences, but between that groups have significantly differences. For another traits were noted in table 1. LSD (0.05) values indicate the correction of comparisons.

The distribution was bimodal for Minor Axis Length and trimodal for Major Axis Length with values falling into two and three general groups, respectively. For Major Axis Length, cultivars falling in different groups. 2 cultivar in one group (~7 mm), 4 cultivar in another group (~8 mm) and 3 cultivar in a group (~9 mm). For Minor Axis Length, 3 cultivars in one group (~2 mm) and 6 cultivars in another group (~3 mm). For commercial classification of rice for grain dimensions, the values of Major Axis Length and Major Axis Length/Minor Axis Length were used. Standards of grain size and shape vary in different countries. Brown rice is classified as long grain Indica (GL > 6.6 mm and L/W > 3), long grain Japonica (GL > 6.6 mm and L/W= 2- 3), medium grain Japonica (GL 5.5-6.6 mm and L/W= 2-3) and round grain Japonica (GL < 5.5 mm and L/W < 2) (Council Regulation (EC), 1987, No. 3877). Based on the above criteria, 3 cultivars could be classified as long grain Indica and 6 cultivar as long grain Japonica (Table 1), This results to be confirmed by Koutroubas et al for European rices (He et al., 1999).

The application of digital image analysis was used for classification of wheat cultivars according to kernel type and identity. Perfect type classification was obtained for four durum wheat varieties in admixture with tencommon wheat's representing a broad range of kernel types. Likewise, samples of each of five Canada Western Red Spring (CWRS) wheat varieties were all correctly allocated to the CWRS class (Neumna et al, 1987).

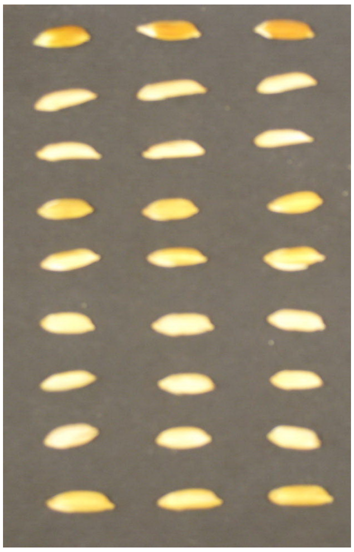
Also, computer imaging technique was used for classifying giant ragweed seeds by preparing digital images of the seed top and side views. Seed samples of 20 different giant ragweed plants (classes) were prepared and digitally scanned. Variation of area and perimeter was least within classes but most among classes, thus these features can discriminate among seeds of different plants in giant ragweed. This experiment showed that in giant ragweed, imaging technique can be used to identification of different species seeds (Yusako et al*.*, 2001).

In another research, digital image analysis was used to assay the quality parameters of six varieties of *Triticum aestivum* L. and one variety of *Triticum duro-compactum* L. The results of this research showed that image analysis an easy and rapid method for obtaining the physical parameters of wheat grain (Firatligi-Durmus et al., 2010).

In India, the grain quality of 100 upland/ahu rice genotypes was tested. I this research, parameters such as grain length, grain width, cooked grain length, cooked grain width, grain elongation ratio after cooking, grain widening ratio after cooking, alkali spreading value, gel consistency, starch, amylose, amyl pectin and total soluble sugar contents were measured. Analysis of variance demonstrated highly significant differences between those characteristics of genotypes (Sunayana et al., 2010).

On the other hand, the conventional methods for classifying cultivars of paddy rice relies on physical morphological observation. This method requires experiences to identifying cultivars using charts and illustrations of kernel characteristics. For example, to classify the different cultivars of paddy rice, the characteristics such as ratio of length to perimeter of the kernel, the existence of beards and the length of beards, the color of the hull, the color of the inner and outer awn, the floss growth situation, etc. must be observed. Except for those characters, categorizing the cultivars that have a similar appearance by using only physical observation so difficult and it was prone that it has human error and also time-consuming. In addition, remarkable time was required to train such proficiencies. Zayas et al (1986) classified 77–83% of hard red winter and soft red winter wheat by using machine vision. Barker et al (1992) showed that visage ratios supported 60–63% correct classification for eight wheat cultivars, compared with 52–55% for slices. Shatadal et al (1995) classified and separated kernels of hard red spring wheat, durum wheat, barley, oats, and rye with 95% correct kernel classification (Chang-chu et al., 2005).

Clustering of cultivars showed that 9 cultivars were falling in 5 group. Yasouj and Lenjan cultivars maked one group sloley, Kamfirrooz, DS and 142 cultivars in one group, 144 and 304 in one group and MTA and 141 in another group (figure 2). Quantitative features were extracted from the seed images, including perimeter, area, majorAxisLength, minorAxisLength, solidity, eccentricity and equival diameter. Fisher's linear discriminant with UPGMA classification was used to classification of cultivars (Yusako et al., 2001). Luo et al (1999) reported on the classification of cereal grains using the k-nearest neighbor statistical classifier or multi- player neural network classifier with classification rates of 96.9– 99% (Chang-chu et al., 2005).



142
141
MTA
Kamfirooz
Lenjan
144
DS
304
Yasouj

Figure 1. Image of 9 rice cultivar

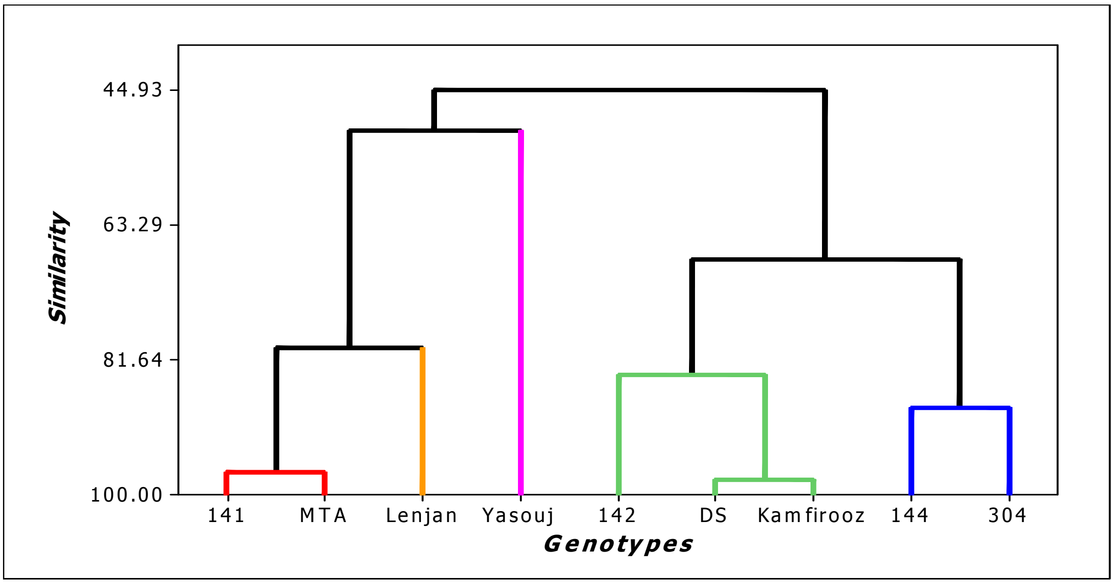


Figure 2. Dendrogram of 9 rice cultivars by physical traits.

Table 1. Physical traits of 9 rice cultivars and their mean comparisons. The dimension of some traits is mm.

Traits / Genotypes	Perimeter	Area ea	MajorAxis Length	MinorAxis Length	Solidity	Eccentricity	Equiv Diameter	MajorAxisLength/MinorAxis Length
142	20.22cde	18.94d	8.63c	2.82c	0.97ab	0.94bc	57.88d	3.05
141	21.81ab	20.03cd	9.63a	2.71c	0.96bc	0.95a	59.58cd	3.54
MTA	21.29abc	19.75cd	9.29ab	2.80c	0.95c	0.95ab	59.15cd	3.31
Kamfirooz	19.26e	19.77cd	7.95e	3.18ab	0.97a	0.91ef	59.19cd	2.49
Lenjan	20.97bc	21.18bc	8.76bc	3.11b	0.96bc	0.93cd	61.22bc	2.81
144	20.62bcd	22.73ab	8.54cd	3.41a	0.97a	0.91ef	63.46ab	2.50
DS	19.24e	19.57cd	8.07de	3.10b	0.97a	0.92de	58.86cd	2.60
304	19.50de	21.32bc	7.97e	3.41a	0.97a	0.90f	61.47bc	2.33
yasouj	22.46 a	24.01a	9.57a	3.24ab	0.97ab	0.94bc	65.23a	2.94
LSD0.05	1.1972	2.2050	0.5489	0.2679	0.0109	0.0138	3.2580	-

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