Seed Research 46(2): 168-170, December, 2018

Short Communication

Characterization of Barnyard Millet Cultivars using Seed Image Analysis

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(Received : August 2018; Revised : October 2018; Accepted : November 2018)

Barnyard millet (*Echinochloa frumentacaea* L.) is commonly grown millet crop in the arid and semi-arid region of the world. It is commonly grown millet in Uttaranchal, Tamil Nadu, Andhra Pradesh, Karnataka and Chhattisgarh state of India. Under favourable moisture and temperature condition, the grain could ripen within 45 days of sowing [1]. The glumes totally enclose the kernel. The mature pericarp consists of two epidermal layers. The cells of inner epidermis are closely compressed against those of the outer part. Barnyard millet has an aleuronic layer thought to contain strongly cutinized cell walls [2-3]. It contains protein 5–8.5%, fat 3.5–4.6%, carbohydrate 57–66%, ash 2.5–4.0%, fibre 6.4–12.2 at moisture content 0.25–0.05 kg kg^{-1} dry matter. At present varietal identification based on morphological features in essential for quality seed production surface area, length, width, perimeter, circularity, shape were an important, physical features in process of harvesting, cleaning, drying, milling, cooling and also germination

Machine vision is a computerised tool for cultivar identification; and the seed technologists will be able tosimplify machine vision refers to the acquisition of data (shape, size etc.,) via. video camera or similar system and subsequent computer analysis of these data following suitable processing. The measurement of geometry of single seed is possible with image analysis technique [4]. Generally, cultivar identification is done manually on the basis of distinctive traits such as shape, size, colour of the testa and ornamentations. Machine vision systems provide an alternative to manual inspection of samples for characteristic properties, where the information could be visually obtained repeatedly, monotonously and non-destructive inspection with much faster [5]. It is an attractive system and easily employed in many environments and gives a real time analysis and inexpensive [6]. The use of machine vision system to discriminate the varieties by their seed morphological characters was reported in lucerne [7], sesamum [8], mustard [9] and oats [10] has been successfully employed the image analysis techniques for preliminary identification of seeds based on morphological features. In the light of the above facts, the present study was initiated to characterise the barnyard millet cultivars by using image analysis systembased on morphological characters.

The genetically pure barnyard millet genotypes were obtained from Department of Plant Breeding and Genetics, Agricultural College and Research Institute, Madurai. The laboratory experiments were carried out in the Department of Seed Science and Technology, Agricultural College and Research Institute, Madurai during 2018. Measurement of geometry of seed was done using image analysis technique. The genetically pure barnyard millet varieties were subjected to image analysis technique with three replication having twenty five seeds each (Plate 1).

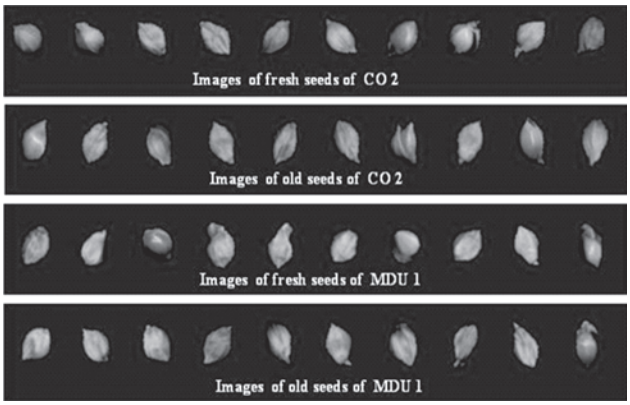

Plate 1: Images of fresh and old seeds of CO2 and MDU 1 varieties

Image analysis was carried out using Satake RSQI10A Grain Scanner. The sample has been placed on to the tray and clicked "Start Scan". The results appear in moments and quick colour and shape measurement - Up to 1,000 grains in 60 seconds was measured. Shape and colour information and morphological parameters on each individual grain were measured, including images and graphs. Statistical data for the whole samples were also displayed with histograms and average values of area, perimeter, length, width, shape factor and circularity;

Area: Multiplication of length and breadth of the object and expressed in cm^2.

Perimeter: Multiplication of length, breadth and height of the object and expressed in cm.

Length: Distance between two points marked on screen using the mouse (or) diameter of the smallest circumscribed circle that will fit around an object and expressed in cm.

Width: Length is measured in horizontal X-axis and expressed in cm.

Shape factor: Shape factor is the ratio of the actual perimeter to that of a circle with the same area.

$$S = \frac{P}{PC}$$

where, P is the perimeter of the object and P_C is the perimeter of a circle with the same area as the object. P_C is calculated as follows.

$$P_c = 2\ (\pi \times A)\ 0.5$$

where, A is the actual area of the object.

Circularity: Circularity is the square root of the ratio of the actual area of the object to the area of a circle with the same circumscribed shell.

$$C = \sqrt{\frac{A}{AP}}$$

where, A is the actual area of the object, AP is the area of a circle with a diameter equal to the circumscribed diameter (or) length of the object.

The data obtained from different experiments were analysed by the 'F' test of significance following the methods described by [11]. Wherever necessary, the per cent values were transformed to angular (Arc-sine) values before analysis. The critical differences (CD) were calculated at 5 per cent probability level. The data were tested for statistical significance. If the F test is non-significant it was indicated by the letters NS.

From the result, individual seed area was recorded maximum in fresh seeds of CO 2 and MDU 1 (4.008 cm^2 for CO 2 and 3.874cm^2 for MDU 1) and it was minimum

Table 1. Seed morphological characters measurement of barnyard millet cultivars using Image Analysis

Parameters	Cultivar (CO 2)		Cultivar (MDU 1)	
	Fresh seed	Old seed	Fresh seed	Old seed
Area (cm^2)	4.008	3.881	3.3274	3.874
SEd	0.0875	0.0923	0.0687	0.0830
CD (p=0.05)	0.1839**	0.1939**	0.1444**	0.1744**
Perimeter (cm)	8.026	7.908	7.764	7.840
SEd	0.1809	0.1383	0.1588	0.1622
CD (p=0.05)	0.3800**	0.2906**	0.3337**	0.3408**
Length (cm)	3.016	2.803	2.633	2.933
SEd	0.0666	0.0497	0.0646	0.0549
CD (p=0.05)	0.1400**	0.1044**	0.1357**	0.1153**
Width (cm)	2.009	1.877	1.892	2.104
SEd	0.0490	0.0432	0.0472	0.0466
CD (p=0.05)	0.1029**	0.0909**	0.0992**	0.0978**
Circularity	0.807	0.76	0.712	0.841
SEd	0.0207	0.0262	0.0264	0.0302
CD (p=0.05)	0.0436**	0.0550**	0.0555**	0.0635**
Rectangularity	0.712	0.693	0.691	0.706
SEd	0.0221	0.0300	0.0221	0.0160
CD (p=0.05)	0.0464**	0.0631**	0.0465**	0.0336**

NS- Non Significant ** - Highly Significant

in old seeds (3.881cm^2 for CO 2 and 3.3274cm^2 for MDU 1). Perimeter was observed highest in CO 2 fresh seeds (8.026cm) and it was lowest in old seeds of MDU 1 (7.764cm). The length of the seed was recorded maximum in (3.016cm) fresh seeds of CO 2 and it was minimum in (2.633cm) old seeds of MDU 1. Fresh seeds of MDU 1 registered maximum width (2.104cm) and it was minimum in old seeds of CO 2. The circularity of seed was recorded highest in fresh seeds of MDU 1 (0.841) and it was lowest in fresh seeds of MDU 1 (0.712). Rectangularity of seeds was recorded highest in fresh seeds of CO 2 (0.712) and it was lowest in old seeds of MDU 1 (0.691) (Table 1). Digital image analysis enables measurements faster and more accurately computer vision includes the capturing, processing and analysing images, facilitating the objective and non-destructive assessment. The measurement of geometry of single seed is possible with image analysis technique. Manual evaluation of plant morphology was compared with image analysis system [12]. Similar works on image analysis system was used in white cabbage and carrot seeds [13], lentil seeds [14] rice [15], mustard [9] and oat [10].

The existence of variation in seed morphological parameters may be due to genetic nature of the parent. This method proved to be quick, requiring less than one minute for scanning and measurement does not need any kind of chemical reagents. The image analysis system of single seed helped for varietal discrimination in linseed and sunflower [16, 17]. From the observations, it is considered to be more exact and reliable than manual method and produces purposeful measures of seed features and also helped for grouping of cultivars.

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