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RESEARCH ARTICLE

PHYSICAL CHARACTERIZATION OF FRUITS AND SEEDS OF Delonix regia (Bojer ex Hook.) RAF. (FABACEAE – CAESALPINOIDEAE)

***,[1]Alan Mario Zuffo, [1]Fábio Steiner, [1]Aécio Bush and [2]Joacir Mario Zuffo Júnior**

[1]Mato Grosso do Sul State University, Vegetal Production Dept., MS 306, km 6, 4, ZIP CODE: 79540-000, Cassilândia, MS, Brazil
[2]Mato Grosso State University, Agronomy Dept. Nova Xavantina Campus, BR-158, Km 148, ZIP CODE: 78690-000, Nova Xavantina, MT, Brazil

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ABSTRACT

Flamboyant [*Delonix regia* (Bojerex Hook.) Raf.] is an exotic forest species highly adapted to the Brazilian edaphoclimatic conditions; thus; it has been widely used in afforestation of parks and streets in all Brazilian regions due to its high ornamental value. Therefore, this work aims to determine the main physical and biometric characteristics of the *Delonix regia* fruits and seeds and establish correlation estimates among the variables. Ripe fruits of *D. regia*were collected in fifteen seed trees, in Cassilândia, MS, Brazil. An total of 100 fruits and 100 seeds were analyzed in terms of longitudinal length, width, thickness, fresh mass of the fruit and the seed, number of seeds per fruit, dry mass of the fruits and seed and water content of the seed. The biometric characteristics were analyzed using descriptive statistical analysis, frequency distribution and Spearman's correlation analysis (rS). Flamboyant fruits and seeds present variability to most of the characteristics evaluated. Flamboyant seeds presentgreat potential from the number of seeds seedsper fruit, making it possible to select fruits with bigger numbers of seeds seeds through characteristics such as fresh mass of the fruits.

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INTRODUCTION

Flamboyant [*Delonix regia* (Bojerex Hook.) Raf.] is a tree species from Madagascar region, belonging to the Fabaceae family – Caesalpinioideae. It is a plant widely used in reforestation programs, due to its high ornamental value (Lorenzi *et al.,* 2003). This forest exotic species, highly adapted to environmental conditions of tropical climate, therefore, has been used in the afforestation of parks and streets in all Brazilian regions (Lucena *et al.,* 2006; Ataíde *et al.,* 2013). Based on the ornamental potential of the flamboyant, biometry studies and its interrelations become necessary for characterization of this species fruits and seeds. Since it may contribute to the determination of plants patterns in genetic improvement programs, besides providing knowledge for direct and indirect selection in those characteristics (Gusmão *et al.,* 2006). Considering the flamboyant potential associated to the lack of knowledge about its physical characteristics, it is justified the need for basic research on the fruits and seeds biometry.

****Corresponding author: Alan Mario Zuffo***
Mato Grosso do Sul State University, Vegetal Production Dept., MS 306, km 6, 4, ZIP CODE: 79540-000, Cassilândia, MS, Brazil.

Therefore, this study aims to determine the main physical characteristics of the flamboyant fruits and seeds, plus establish the estimates of the correlation among those characteristics.

MATERIAL AND METHODS

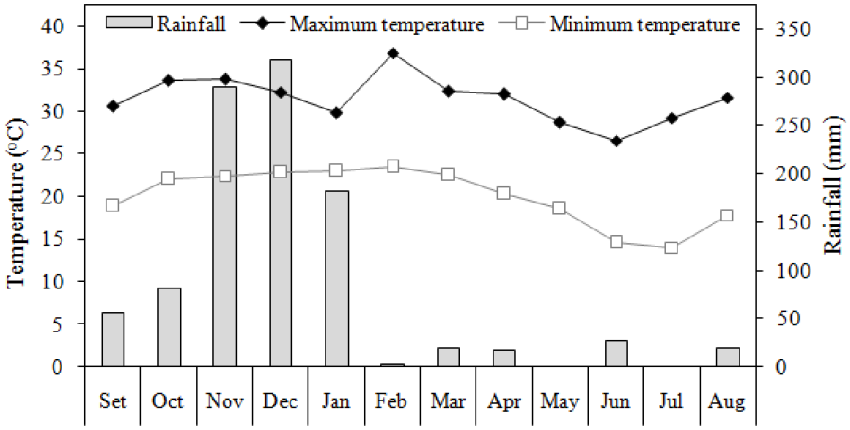
The fruits were harvested in the campus of Mato Grosso do Sul State University, in vegetation of natural occurrence, equidistant about 10 km from de center of Cassilândia (19º06'48'' S; 51º44'03'' W), with average altitude of 470 m, city located in the Mato Grosso do Sul East Mesoregion, Brazil. The weather in the region, according to Köppen classification, is type Aw, with rainy summer and dry winter. The climate data were obtained in the meteorological station of the National Institute of Meteorology – INMET (Figure 1). The ripe fruits were harvested from the top of the tree, during the fourth week of August of 2016, dry season in the region. After the harvest, the fruits were transported to Crop Science Laboratory in Mato Grosso do Sul State University, in Cassilândia (MS). Afterwards, the evaluations started. There were selected 120 visually healthy fruits, full and without deformation and, among those, a sample of 100 fruits was randomly taken and had the following characteristics evaluated: longitudinal length (FLL), width (FW), thickness

(FT) of the fruits with the aid of a digital pachymeter (Clarke – 150 mm), with accuracy degree of ±0,01 mm. After measuring the size, the fruit fresh mass (FFM) was determined, and then, through counting, the number of seeds per fruit was determined. The removal of seeds was performed after manual peeling, having determined the longitudinal length (SLL), width (SW), thickness (ST), fresh mass (SFM) and humidity (SH) of 100 seeds. O determine the seeds relative humidity (SH), it was used the greenhouse method, at 105°C (± 3 °C) for 24 hours (Brazil, 2009). To determine the fruitand the seeds fresh mass, it was used precision analytical balance (0.0001g). The physical characterization of the fruits and seeds were analyzed by frequency distribution. It was calculated the Spearman's non parametric correlation coefficient (rS) and the respective significance level) P) among the variants through the t test (Zar, 1996). All the statistical analysis were performed using the BIOESTAT 5.0 program (Ayres *et al.,* 2007).

RESULTS AND DISCUSSION

The physical characterization of the variants determined in the flamboyant fruits and seeds are mentioned in Table 1. The asymmetry and kurtosis values were near zero for longitudinal length, fruits fresh mass, number of seeds per fruit and seeds water content, which indicates a nearly normal distribution. For the variation coefficient (VC), the values vary from 11.92 a 30.82% for the fruits and from 5.60 to 35.25% for the flamboyant seeds. It was evidenced that the biggest VC was the fresh mass one and the humidity, at around 30.82% e 35.25%, respectively.

Those values were within the ones reported by Zuffo *et al.* (2014) in the baru biometric characteristics (*Dipteryx alata*Vog.) and Zuffo *et al.* (2017) in thecanafistula (*Peltophorum dubium* (Sprengel) Taubert). In the biometric variants analyzed for the flamboyant fruits around 69% presented longitudinal length (FLL) situated in two classes distributed between45.33 to 56.16 mm (Figure 2a). For width, around 44% presented values situated between 3.85 to 4.30 mm (Figure 2b); 38% presented thickness (FT) between 10.16 to 11.35 mm (Figure 2c). For the fresh mass (FFM), it was found that about 46% was concentrated between 43.40 to 58.13 g (Figure 2d). The number of seeds per fuit (NSF) presented three classes, with about 83% of the fruits presenting from 28 to 46 seeds (Figure 2e). The averages obtained for the length, width, thickness, fresh mass of the fruits and the number of seeds per fruit were 51.39 mm, 4.47 mm, 10.09 mm, 63.16 g and 36.35 unities, respectively (Table 1). These values resemble to the ones observed by Arun *et al.* (2010). The authors noticed values between 30-45 seeds per fuit in the *Delonix Regia,* between 30-50 of length, 5-7.6 cmfor the fruits width. For the variants obtained in the flamboyant seeds, about 65% of these presented longitudinal length (SLL) located in two classes between 17.93 to 19.77 mm (Figure 3a), with average of 19.06 mm. The length (SL) presented average of 6.44 mm, 39% concentrated between 6.57 to 7.05 (Figure 3b). In relation to the thickness (ST), the seeds were quite dispersing in the six classes, it was found that about 25% were grouped especially in the class of 4.92 to 5.32 mm, and 23% were distributed in the class 4.11 to 4.52 mm (Figure 2c). For the fresh mass (SFM), 46% of them presented between 0.45 to 0.51 g (Figure 3d), and, in 47% of the cases, the dry mass (SDM) varied from 0.44 to0.49 g (Figure 1e).



Source: Experimental Station of INMET in Cassilândia, MS.

Figure 1. Maximum and minimum temperature (°C) and monthly precipitation (mm) occurred during the formation of fruits in the years of 2015 and 2016

Table 1. Morphometric characterization of flamboyant fruits and seeds [*Delonix regia* (Bojer ex Hook.) Raf.]. N=100 fruits e N=100 seeds

Parameter	Average (Sx)	Asymetry	Kurtosis	s	CV (%)
Fruits					
Length(cm)	51.39 (0.61)	-0.45	0.29	6.12	11.92
Width (cm)	4.47 (0.05)	1.12	0.85	0.56	12.71
Thickness (mm)	10.09 (0.12)	-0.75	1.17	1.22	12.10
Fresh Mass	63.16 (1.94)	0.61	-0.45	19.46	30.82
Numberofseeds (unit.)	36.35 (0.69)	-0.55	0.45	6.96	18.98
Seeds					
Length (mm)	19.06 (0.10)	0.12	0.17	1.06	5.60
Width (mm)	6.44 (0.05)	-0.90	1.29	0.55	8.60
Thickness (mm)	4.56 (0.06)	-0.01	-1.03	0.60	13.36
Fresh Mass (g)	0.46 (0.006)	-0.75	0.53	0.06	14.03
Dry Mass (g)	0.44 (0.006)	-0.64	0.60	0.06	14.24
Humidity (%)	4.92 (0.17)	0.79	0.66	1.73	35.25

(Sx): Standard Error of the Mean; s: Standard Deviation; CV: coefficient of variation

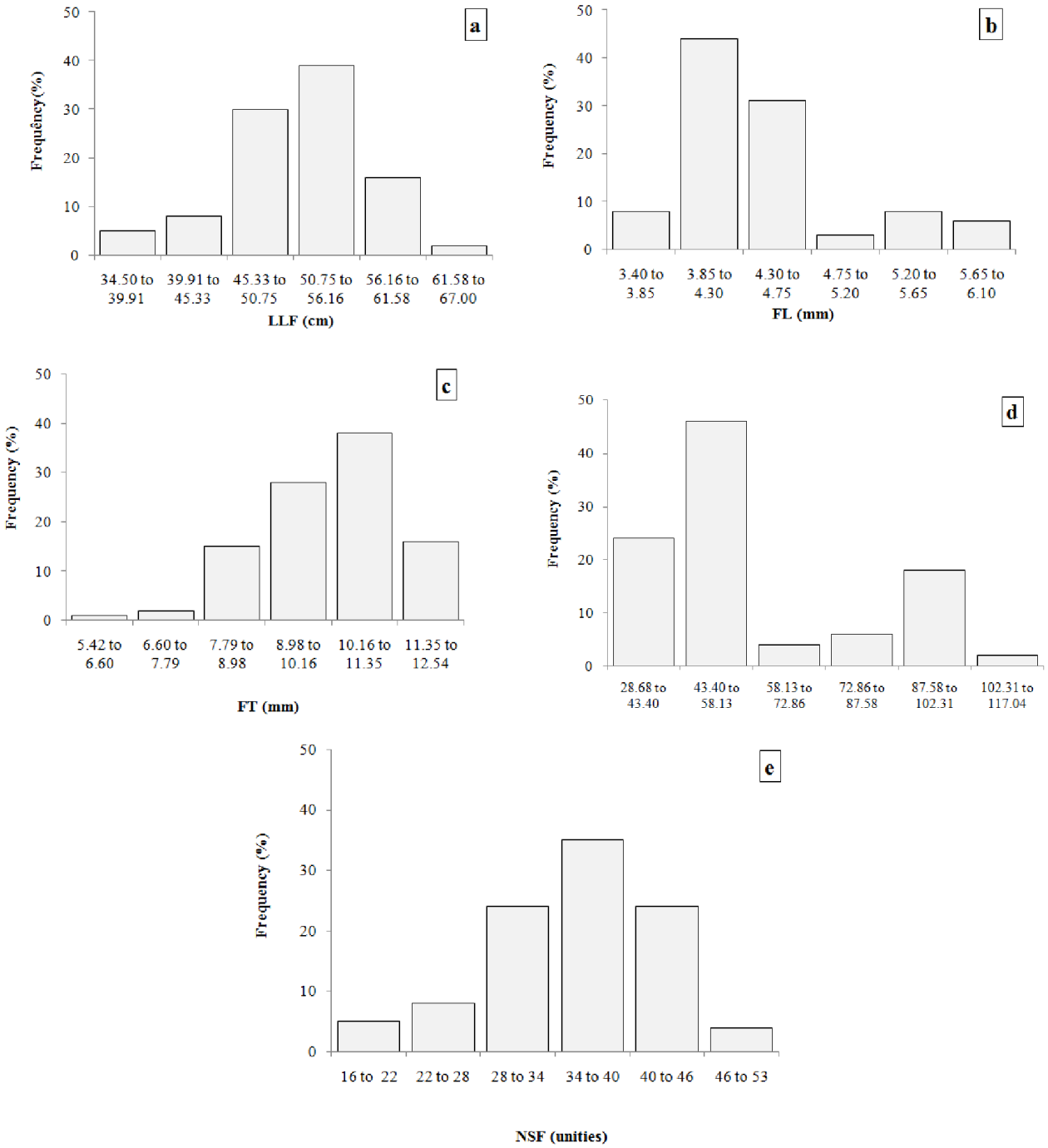


Figure 2. Frequency on the evaluated biometric parameters of the fruit: a) longitudinal length (FLL); b) width (FW); c) thickness (FT); d) fresh mass (FFM); e) number of seeds per fruit (NSF) of flamboyant [*Delonix regia* (Bojer ex Hook.) Raf.], in the city of de Cassilândia, MS, in the year of 2016. N=100 fruits and N= 100 seeds

About 62% of the seeds presented moisture content (MC) in two central classes situated between 3.26 to 4.70% (Figure 3f), with an overall average of 4.92%. According to Arun *et al.* (2010), the length and weight of the flamboyant seed is 2 cm and 0.4 g, respectively. Those values support the finding in this study. Besides the physical characteristics of the isolated fruits and seeds, their association must also be analyzed in order to verify the extent of interference ofone characteristic over the other with economic interest, as well as practicing the indirect selection (Zuffo *et al.,* 2016). Therefore, the Spearman's correlation coefficient is used to express the level of association between two numerical variables. The values obtained for the Spearman's correlation of flamboyant (Table 2) indicated there was positive and significant association between the fruit longitudinal length (FLL) and seed humidity (SH); the fruit thickness (FT) with the seed thickness (ST); the fruit fresh mass with the number of seeds per fruit (NSF); and the seeds width (SW); the seed fresh mass (SFM) with the seed dry mass (SDM). The biggest coefficients of correlation were observed between the fruit fresh mass and the number of seeds per fruit (NSF) (rS=0.426; p=0.01) and between the seed fresh mass (SFM) and the seed dry mass (SDM) (rS=0.981; p=0.01). In both cases these results were expected, considering that the biggest proportion of the fruit is composed of the seedand also the existing association between the seeds fresh mass with the dry mass, probably due to its contribution in the definition of this last variable. The selection of plants with fruits of bigger fresh mass promotes the enhancement of the species, since the selection of plants with fruits of bigger fresh mass values will end up in an increasing of the seeds number per fruit.

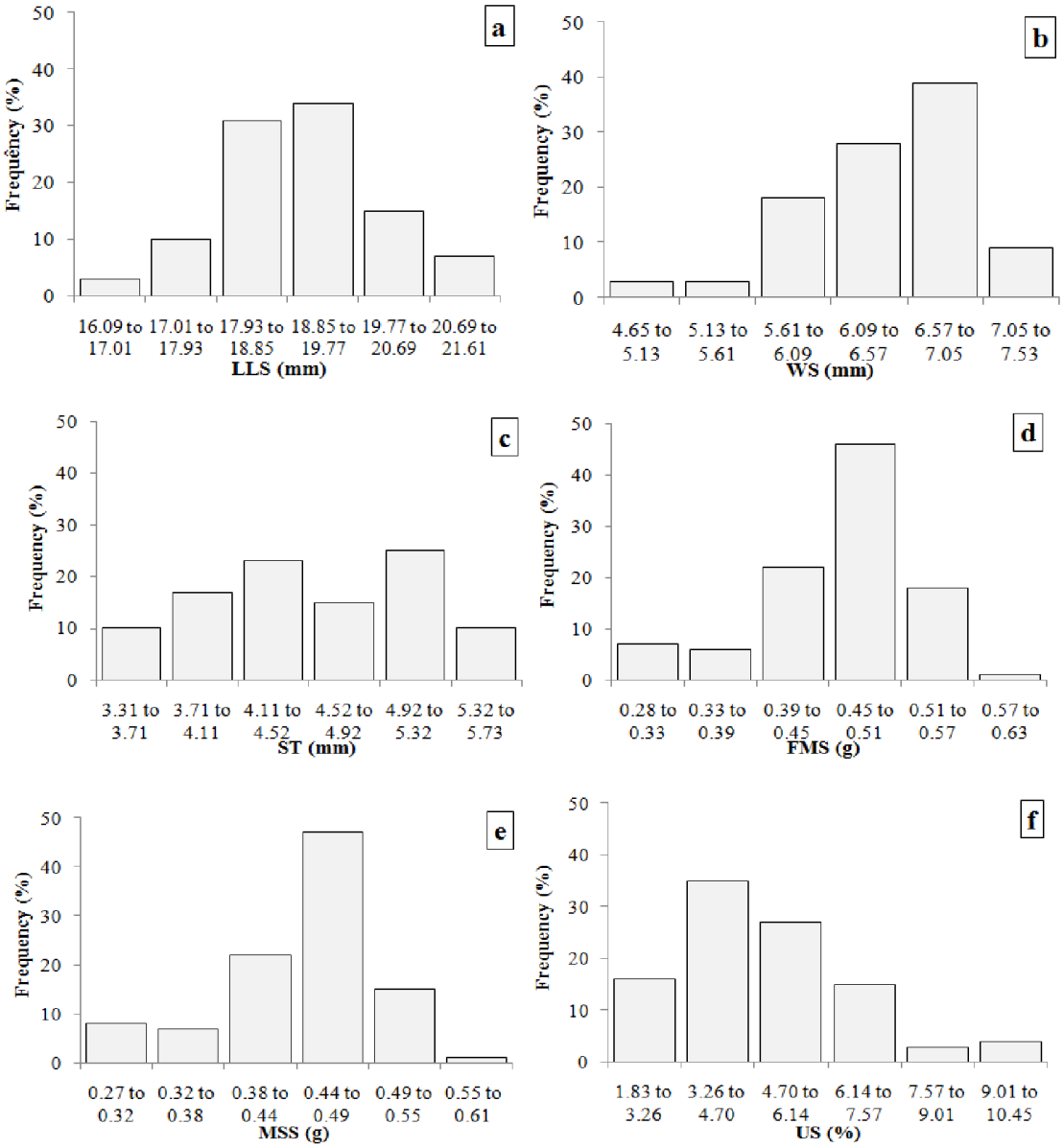


Figure 3. Frequency on the evaluated biometric parameters of the seed:a) of longitudinal length (LLS); b) width (SW); c) thickness (ST) d) fresh mass (SFM); e) dry mass (SDM) f) and seeds humidity (US) of flamboyant [*Delonix regia* (Bojer ex Hook.) Raf.], in the city of Cassilândia, MS, in the year of 2016. N=100 fruits and N= 100 seeds

Table 2. Spearman's correlation (rS) for the biometric variables of the flamboyant fruits and seeds [*Delonix regia* (Bojer ex Hook.) Raf.]

	FLL	FW	FT	FFM	NSF	SLL	SW	ST	SFM	SDM
LF	-0.050^{ns}									
FT	-0.040^{ns}	-0.020^{ns}								
FFM	0.111^{ns}	0.114^{ns}	-0.131^{ns}							
NSF	0.029^{ns}	-0.026^{ns}	-0.247**	0.426**						
SLL	-0.112^{ns}	-0.013^{ns}	-0.135^{ns}	0.077^{ns}	0.108^{ns}					
SW	0.193*	0.159^{ns}	0.009^{ns}	0.189*	-0.013^{ns}	-0.153^{ns}				
ST	0.091^{ns}	0.060^{ns}	0.250**	0.062^{ns}	-0.175^{ns}	-0.441**	0.049^{ns}			
MFS	0.065^{ns}	-0.029^{ns}	0.033^{ns}	-0.028^{ns}	-0.033^{ns}	-0.103^{ns}	0.170^{ns}	0.075^{ns}		
SDM	0.026^{ns}	-0.036^{ns}	0.059^{ns}	-0.026^{ns}	-0.041^{ns}	-0.129^{ns}	0.161^{ns}	0.081^{ns}	0.981**	
SW	0.218**	0.037^{ns}	-0.149^{ns}	0.016^{ns}	0.145^{ns}	0.094^{ns}	0.091^{ns}	0.001^{ns}	-0.133^{ns}	-0.279**

**significant at 1% of probability; *significant at 5% of probability; ns: non-significant. LLF-longitudinal length; FW- fruit width; FT-thickness; FFM- fruit fresh mass; NSF-number of seed per fruit; SLL-seed longitudinal length; SW-seed widthST-thickness; SFM-fresh mass; SDM-seed dry mass; SH-seed humidity.

In contrast, there was negative and significant correlation between the fruit thickness (FT) with the number of seeds per fruit (NSF); longitudinal length of the seed (LLS) and the thickness of the fruit; the dry mass of the seed (DMS) with the humidity of the seeds (HS) indicating inversely proportional relationship between these variables.

In summary, based on the data found in this work, it was possible to see that some biometric characteristics of the fruits and seeds evaluated in the flamboyant presented high correlation, making it possible to practice direct and indirect selection for these characteristics.

Conclusions

Flamboyant fruits and seeds present variability for most of the biometric characteristics analyzed. The flamboyant seeds present great potential through the number of seeds per fruit, making it possible the selection of fruits with bigger number of seeds through characteristics such as the fresh mass of fruits.

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