Studies on Physical Properties of Different Horse Gram Varieties Suitable for Machine Sowing

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A B S T R A C T

Physical properties of two different varieties of horse gram (Paiyur 1 and Paiyur 2) which are highly suitable for rainfed sowing were studied and the observations revealed that the mean data with standard error on physical parameters viz., bulk density, true density, length, breadth, thickness, surface area, geometric diameter, sphericity and 100 seed weight vary within the two varieties as 0.923 g cm^{-3}, 1306.8 Kg m^{-3}, 5.19 mm, 3.73mm, 2.21mm, 7.86 mm^2, 3.49, 67.26 per cent and 4.92. Calibration of cup feed seed drill modified with the cup size of 6 mm, which was derived based on the major and minor axis of the physical properties of horse gram seeds.

Introduction

Horse gram is an important crop of South India. Its grain is used for human consumption as 'dal' as well as in preparation of so called 'rasam' and also as a concentrated feed for cattle. It may also be used as green manure. This crop is generally grown when the cultivator is unable to sow any other crop for want of timely rains and also grown in vacant space of citrus orchard. Horse gram is mainly cultivated in the states of Karnataka, Andhra Pradesh, Tamil Nadu, Odisha, Madhya Pradesh, Chhattisgarh, Bihar, West Bengal, Jharkhand, and in foot hills of Uttaranchal and H.P., in India. Horse gram is an underutilized pulse crop grown in wide range of adverse climatic conditions. It occupies an important place in human nutrition and has rich source of protein, minerals, and vitamins. Horse gram (*Macrotyloma uniflorum*) is one such underutilized crop belonging to Fabaceae and well known for its hardiness, adaptability to poor soil and adverse climatic condition. The crop has good adaptability under adverse climate conditions. It yield well on poor soils, is drought resistant, has high nitrogen fixation ability and also helps in soil conservation (Yadava and Vyas, 1994). It is a cheapest

source of protein and also rich in minerals such as calcium (Sawant *et al.,* 2015). The production of horse gram was 1.24 lakh tonnes and 1.36 lakh tonnes and in Tamil Nadu during kharif and rabi season, the production was 0.10 lakh tonnes and 0.57 lakh tonnes during 2014-15 respectively (Tiwari and Shivhare, 2016). The horse gram was used to make various foods and traditional medicines due to its nutritional composition and also has a place in ayurvedic medicine (Bhuvaneswari *et al.,* 2014). Horse gram has excellent therapeutic properties and traditionally used to cure kidney stones, asthma, bronchitis, leucoderma, urinary discharges, heart diseases, piles etc. Besides, it also possess anti-diabetic, anti-ulcer activity and also helps in dietary management of obesity due to the presence of beneficial bioactive compounds (Bhartiya *et al.,* 2015). The fibre content of horse gram was high and it helps in reducing the body fat (Kamala, 2009). Study was carried out to assess the physical properties of horse gram seeds with the available leading variety to modify the cups in the existing seed drill for machine sowing to achieve high productive potentials as compared to locally cultivated practices broad casting under real farm situation.

Climate requirement

Horsegram is extremely drought-resistant crop. Moderately warm, dry climatic conditions are suitable for its optimum growth. It does not grow well on higher altitudes because of cool and wet climate. Horsegram can be cultivated up to an altitude of 1000 m above the sea level.

The temperature range of 25-30°C and relative humidity between 50 and 80% is optimum for its growth. Heavy rains during the initial stages of crop growth affect nodule formation owing to poor aeration in the soil. A well-distributed rainfall of about 800 mm is sufficient for its successful cultivation, but it performs well even under low rainfall areas.

Materials and Methods

Evaluation of physical properties of horse gram seeds

In the present study, the existing cup feed seed drill used for multiple crops were taken to modify the cup size for horse gram seeds. To modify or to alter the cups in the existing seed drill, the physical characters of horsegram were studied with two different varieties, Paiyur 1 and Paiyur 2 which are highly suitable for rainfed sowing were selected as shown in Fig. 1. The bulk seeds of horse gram were cleaned to remove foreign matter, broken and immature seeds. The physical properties of horsegram viz., hundred-grain weight, projected area, bulk density, porosity, sphericity, size and shape were evaluated with of each of the varieties, as the size of grains represented by their equivalent diameter and sphericity is used to describe their shape and the surface area, which is calculated as the projected area (Asoegwu *et al.,* 2006).

Bulk density

Horse gram seeds (Paiyur 1 & Paiyur 2) were taken in containers of cubical and cylindrical shape. The volume of the containers is found by measuring length, breadth and height for cubical container and by measuring diameter and height for cylindrical container. The bulk density of the seeds was found separately as follows.

$$\text{Bulk density} = \frac{\text{Weight of grain (g)}}{\text{Volume of grain (cm}^3\text{)}}$$

True density

Known volume of water is taken in a measuring cylinder and 'N' numbers of grains of uniform size are taken, weighed and the

true density was calculated as follows:

$$\text{True density} = \frac{\text{Weight of grain (g)}}{\text{Volume of grain (cm}^3\text{) Exclude the voids of grain}}$$

Size

The size was determined by measuring the dimension of the principal axes *viz.,* major, intermediate and minor diameters of 100 randomly selected horse gram seeds using micro meter having a sensitivity of 0.01 mm (0-25 mm) as length, breadth and thickness.

Geometric mean diameter

The geometric mean diameter (Dg) was calculated using the following equation (Olajide and Igbeka, 2003):

$$Dg = LWT^{0.333}$$

Sphericity (Ø)

The sphericity was calculated using the following equations as per (Olajide and Igbeka, 2003).

$$\emptyset = \frac{LWT^{0.333}}{L} \quad \ldots\ldots\ldots \text{ (2)}$$

where: L is the major diameter; W is the intermediate diameter and T is the minor diameter.

Surface area

The surface area of the horse gram is determined by drawing the outline of the 50 numbers randomly selected seeds in graph sheet with the box size of 1 mm^2. The geometrical parameters namely length (L is the major diameter; W is the intermediate diameter and T is the minor diameter), surface area were measured. The surface area was used to calculate the projected area.

Hundred-seed weight

Hundred seeds in eight replications were selected from the Paiyur 1 and Paiyur 2 variety and weighed in a sensitive electronic balance of 0.001g as per the procedure given by ISTA rules (ISTA, 2013).

Shape

By visual observation the shape was classified based on length and breadth as oval/spherical /round /oval etc.

Results and Discussion

Seed properties of horse gram varieties

The physical properties of horsegram viz., hundred-grain weight, projected area, bulk density, porosity, sphericity, size and shape (Table 1).

The observations revealed that the mean data with standard error on physical parameters viz., bulk density, true density, length, breadth, thickness, surface area, geometric diameter, sphericity and 100 seed weight vary within the two varieties as 0.923 g cm^{-3}, 1306.8 Kg m^{-3}, 5.19 mm, 3.73mm, 2.21mm, 7.86 mm^2, 3.49, 67.26 per cent and 4.92.

Calibration of cups of the seed drill for horsegram

Based on the results of physical parameters for the horse gram cv. Paiyur 1 and Paiyur 2, it was found that the hole diameter of the cups to be reduced from 10 to 6 mm to accommodate the both the Paiyur 1and Paiyur 2 seed varieties. Hence a little modification was made to reduce the cup holes diameter from 10 to 6mm by applying the M-seal in the cup holes shown in Fig. 2. After the modification of cup holes again the calibration is done to calculate the seed rate.

Table.1 Physical properties of Horse gram seeds

Physical properties	Horsegram varieties		Mean
	Paiyur 1	Paiyur 2	
Bulk density	0.921 g cm^{-3}	0.924 g cm^{-3}	0.923 g cm^{-3}
Standard error	0.003	0.002	0.003
95% confidence limit	0.921 ± 0.0007	0.924 ± 0.0004	0.923 ± 0.0008
True density	1272.2 Kg m^{-3}	1341.3 Kg m^{-3}	1306.8 Kg m^{-3}
Standard error	0.38	0.53	0.46
95% confidence limit	1272.2 ± 0.76	1341.3 ± 1.06	1306.8 ± 34.6
Size			
Length (mm)	5.17	5.20	5.19
Standard error	0.042	0.033	0.38
95% confidence limit	5.17 ± 0.08	5.20 ± 0.07	5.19± 0.01
Width (mm)	3.82	3.63	3.73
Standard error	0.047	0.040	0.44
95% confidence limit	3.82 ±0.09	3.63 ± 0.08	3.73± 0.09
Thickness (mm)	2.20	2.21	2.21
Standard error	0.015	0.017	0.016
95% confidence limit	2.20 ±0.03	2.21 ± 0.03	2.21 ± 0.03
Surface Area(mm^2)	8.38	7.25	7.86
Standard error	1.751	1.642	1.697
95% confidence limit	8.38±3.50	7.25 ± 3.28	7.86±3.50
Geometric diameter	3.51	3.46	3.49
Standard error	0.195	0.192	0.193
95% confidence limit	3.51±0.390	3.46± 0.385	3.46± 0.385
Sphericity (%)	67.91	66.60	67.26
Standard error	0.040	0.039	0.040
95% confidence limit	67.91±0.08	66.60± 0.079	67.26± 0.0791
100 grain weight (g)	4.97	4.87	4.92
Standard error	0.001	0.002	0.002
95% confidence limit	4.97 ± 0.003	4.87±0.005	4.92±0.005
Shape	Oval	Oval	Oval

Fig.1 Varieties selected for measuring the physical properties
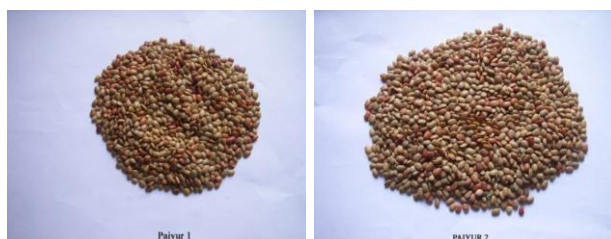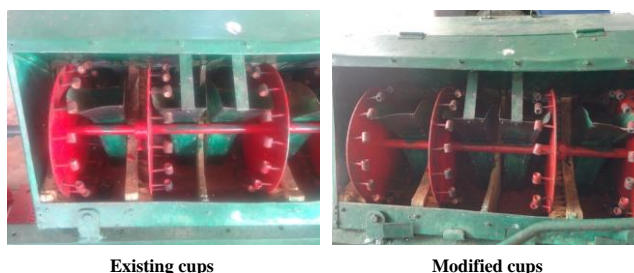
Fig.2 View of the cup hole size

Existing cups   **Modified cups**

From the calibration it is observed that each cup picks around 6 numbers of seeds from the hopper and the same was dropped to the funnel for sowing. around 11.07 kg ha^{-1} of seed will be used for sowing in the field when using this modified cup feed seed drill, which was 9 kg lesser than actual recommended seed rate for sowing horse gram which is 20kg ha^{-1} as per Crop Protection Guide, (2012).

In conclusions the physical parameters between varieties did not differ widely the mean physical parameters are measured as 0.923 g cm^{-3}, 1306.8 Kg m^{-3},5.19 mm, 3.73mm, 2.21mm, 7.86 mm^2, 3.49, 67.26 per cent and 4.92. Based on the above parameters the holes of the existing seed drill was modified 10 mm to 6mm by applying the M-seal, which reduced the seed rate as 11.07 kg/ha (Anon, 2012).

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