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Pattern of Seed Development and Maturation in Horse Gram (*Macrotyloma uniflorum* Lam.)

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ABSTRACT

Background: Seed maturation is genetically controlled process involves a series of morphological and physiological changes extending from fertilization to independence from the mother plant. Horse gram (*Macrotyloma uniflorum* Lam.) is an under exploited legume and it is an inexpensive source of protein, rich in minerals and vitamins. However, information on harvesting time of horse gram seeds are still limited. Therefore, this study was carried out in horse gram to determine the physiological maturity in obtaining good quality of seeds for better planting value.

Methods: The laboratory experiment was carried out at Department of Seed Science and Technology, Agricultural College and Research Institute, Tamil Nadu Agricultural University, Madurai, India to determine the appropriate time of harvesting horse gram var. Paiyur 2 seeds. The crop was raised as bulk in the field during *rabi* season of 2019 and the pods were harvested in interval of seven days from 7 days after anthesis (DAA) to 56 DAA and subjected for determinations of pod and seed characteristics.

Result: The result revealed that, pod length and pod fresh weight of seeds showed a steady increase upto 35 DAA showed maximum pod length (4.76 cm) and fresh weight of pods (6.903 g/10 pods). The seeds attained maximum germination (94%), dry weight (0.859 g/25 seeds) and vigour parameters *viz*., root length (17.7 cm), shoot length (8.8 cm), dry matter production (0.161 g/10 seedlings), vigour index I (2491) and vigour index II (15) on 49 DAA.

Key words: Germination (%), Horse gram, Physiological maturity, Seed development and maturation, Vigour index.

INTRODUCTION

Horse gram (*Macrotyloma uniflorum* Lam.) is an under exploited legume that belongs to the family Fabaceae. Horse gram is an inexpensive source of protein; rich in minerals such as calcium, phosphorus, iron and vitamins such as carotenes, thiamine, riboflavin, niacin and ascorbic acid. Due to wider adaptability of horse gram to different climatic conditions it is grown in various places of India. In India, horse gram is cultivated in 4.61 lakh ha with productivity of 1000 kg/ha in Telangana followed by Uttarkhand with a productivity of 923 kg/ha. In Tamil Nadu, horse gram is cultivated in 0.8 lakh ha with productivity of 691 kg/ha (Anonymous, 2019). Indeterminate flowering in horse gram leads to differential maturity of seeds resulting in wide difference in seed quality. Physiological maturity is the stage at which the quality of the seed is at its maximum; early harvested seeds results in immature seeds with low vigour, whereas late harvested risks seed deterioration and seed loss. It is needless to emphasize that good quality seed is a pre-requisite for optimum returns from the seed crop. Hence, it is imperative to determine the optimum stage of physiological maturity and stage of harvesting so as to obtain the quality seeds with maximum germination and vigour. Hence, the present study was undertaken with an objective to study the pattern of seed development and maturation in horse gram.

MATERIALS AND METHODS

Experimental site

The experiment was conducted at the Department of Seed Science and Technology, Agricultural College and Research Institute, Tamil Nadu Agricultural University, Madurai to determine the physiological maturity of the seed. The study was conducted with horse gram seeds obtained from Regional Research Station, Paiyur (Tamil Nadu) formed the base material for this study. The bulk horse gram crop was raised during *rabi* 2019 in field of B block which was geographically situated between 9°.54′ N latitude and 78°.54′ E longitude with an altitude of 147 meters above the mean sea level, which will comes under the southern agro climatic zone of Tamil Nadu.

Experimental details and observation details

Individual flowers were tagged at the time of flower opening. The pods were harvested at 7 days intervals and then

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measured pod length (cm), pod fresh weight (g/pod). After determining the fresh weight, the pods were dried in a hot air oven (70°C), until the pod reached constant weight. At the end of the prescribed period, the container was placed in a desiccator to cool for 30-40 minutes and the dry weight of pods were weighed and expressed in g/pod. Moisture content of pod was calculated by deducting the weight of dried pod from the fresh weight and expressed as percentage to the weight of fresh pods.

$$\text{Moisture content (\%)} = \frac{M_2 - M_3}{M_2 - M_1} \times 100$$

Where,

M_1 = Weight of empty moisture bottle (g).

M_2 = Weight of empty moisture bottle + sample before drying (g).

M_3 = Weight of empty moisture bottle + sample after drying (g).

The laboratory germination test was carried out using 4 × 100 seeds in paper medium. The test conditions of 25±2°C temperature and 95±3% relative humidity were maintained in the germination room. At the end of 9th day, number of normal seedlings (Anonymous 2013) was counted and the mean was expressed in percentage. From each replication, ten normal seedlings were used for measuring shoot length (cm), root length (cm) and dry matter production (g/10 seedlings) were the observations recorded. The vigour index I and vigour index II were calculated using following formula as per Abdul-Baki and Anderson (1973).

Vigour index I = Germination percentage × [Shoot length (cm) + Root length (cm)]

Vigour index II = Germination percentage × Dry matter production (g/10 seedlings)

Statistical analysis

The experiment was conducted using completely randomized design with four replications and the statistical analysis was done as per the design of the experiment as suggested by Gomez and Gomez (1984). The data taken as per cent were transformed to the arcsine value before subjecting them to analysis. The critical difference (CD) was worked at 5 per cent ($P \leq 0.05$) level and wherever 'F' value is non-significant it is denoted by "NS".

RESULTS AND DISCUSSION

Timely harvesting is a critical factor in seed production to decide the seed yield and quality. Seed lot performance depends on physiological and functional changes that occur at the time of anthesis until seeds are ready for harvest. Studies on pattern of seed development and maturation have superior effectiveness on production of quality seeds. Malarkodi and Srimathi (2007) reported that days, symptoms and phases for seed growth and maturation differed with crop to crop and studies on seed maturation were necessary not only for individual species but its to locations also. Harrington (1972) stated that in physiological maturity seed reach its dry weight at maximum and nutrient goes into seed from mother plant is stopped by breaking of vascular connection by abscission layer formation (Eastin *et al.,* 1973). In this study, prototype of seed development and maturation in horse gram was detected to fix the optimum time and symptoms of physiological maturity for harvesting of good quality seeds.

Changes in pod characteristics during seed development and maturation

Fresh weight of pod increased gradually and attains maximum of 6.903 g at 35 DAA. The fast growth of seed after fertilization to 35 DAA due to more uptake of water, nutrients and accumulation of photosynthates from source to sink which was increasing with seed maturity. Such results were also reported by Renugadevi *et al.* (2006) in cluster bean and Fakir *et al.* (2013) in *Dipogon lignosus.* Moisture content of pod was higher (92.2 %) at 7 DAA and decreased gradually to 15.1% at 56 DAA (Table 1). McIlrath *et al.* (1963) stated that water loss is considered as inherent phase of seed development and maturation and decreased due to dehydration and desiccation as opined by Abdul-Baki and Anderson (1973). Similar decrease in fresh weight of pods was also reported by Indira and Dharmalingam (1996) in fenugreek; Gnyandev (2009) in chickpea; Pushp *et al.* (2013) in groundnut; Ragupathi *et al.* (2017) in proso millet; Sridevi and Manonmani (2019) in proso millet and Hirpara *et al.* (2020) in soybean.

Pod length was increased upto 4.76 cm at 35 DAA and thereafter slight decrease was observed in length due to drying. By reason of drying, the pod was shrink and it result that decreasing of length of pod from 42 DAA (4.43 cm) to 56 DAA (4.30 cm). Similar results were observed by Deshmukh *et al.* (2011) in cowpea, Krishnakumary (2012) in cowpea and Sajjan *et al.* (2005) in okra. Pod weight was supported by increasing of pod length which attained the highest at 35 DAA (Table 1). Similar finding was also reported by Das and Fakir (2014) in *Lablab purpureus*. Maturation process leads with loss of water depending upon atmospheric condition. Khattra and Singh (1995) also stated that dry matter accumulation with moisture loss is characteristic feature that observed during seed development and maturation. Decrease of pod moisture content was at faster rate is due to replacement of osmotic materials such as starch and other large molecule with low hydration capacity. Ellis *et al.* (1987) discussed that harvest was delayed beyond optimum moisture content leads to decrease in viability and increasing of seedling abnormalities (Plate 1).

Physical changes in seed characteristics during seed development and maturation

Maximum fresh weight of seed was attained at 35 DAA and falls down of weight due to breakdown between source to sink and moisture content depeletion. Such results supported by Murali *et al.* (2019) in French marigold. The weight reduction is also due to reduction of volatile substances in semi fluid state that might have escaped along with water as opined by Rao and Rao (1975) and Delouche

Table 1: Changes in pod length (cm), fresh weight (g), dry weight (g), moisture content (%) of pod and no. of seeds per pod during seed development and maturation in horse gram.

Quality parameters / Days after anthesis (DAA)	Pod length (cm)	Fresh weight of 10 pods (g)	Dry weight of 10 pods (g)	Moisture content (%)	No. of seeds/ pod
7 DAA	4.11	2.512	0.595	92.2 (73.8)*	5.5
14 DAA	4.33	4.325	1.171	80.2 (63.6)	5.7
21 DAA	4.47	5.235	2.224	72.6 (58.5)	5.6
28 DAA	4.64	6.267	2.328	69.5 (56.5)	5.6
35 DAA	4.76	6.903	2.369	61.8 (51.8)	5.7
42 DAA	4.43	4.152	2.407	42.2 (40.5)	5.6
49 DAA	4.32	2.753	2.424	19.2 (26.0)	5.6
56 DAA	4.30	2.649	2.418	15.1 (22.9)	5.6
Mean	4.42	4.350	1.967	56.6 (48.8)	5.6
SEd	0.08	0.12	0.02	1.3	0.1
CD (P=0.05)	0.16	0.20	0.05	2.8	NS

(*Figures in parentheses indicate arcsine value).

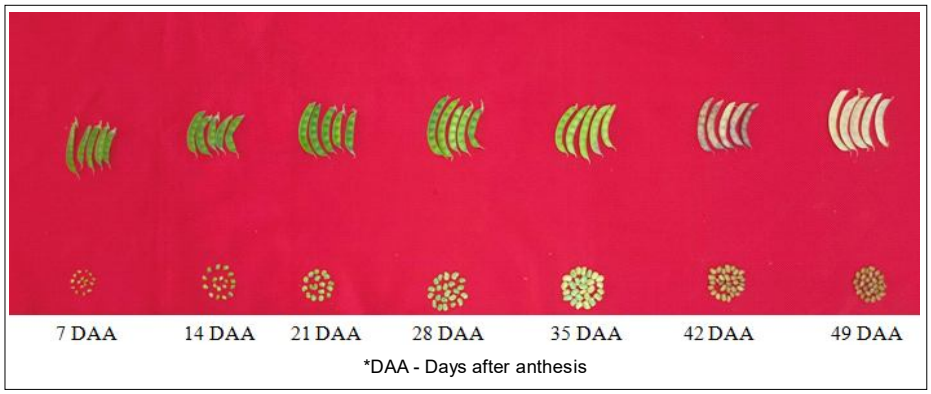


Plate 1: Studies on pattern of seed development and maturation of horse gram.

(1973). Physiological maturity occurs commonly in seeds to reproductive capacity is recapture for following germination and its overlap by attainment of maximum dry weight where flow of nutrients from mother plant to seed is stopped was opined by Harrington (1973). Seed dry weight is the main feature of seed maturation which maximized at 49 DAA (0.859 g/25 seeds) (Table 2). Synthesis and deposition of minerals like starch in endospermic tissue is a factor for increasing of seed dry weight. Duration of physiological maturation is the stage between fertilization and accumulation of maximum dry weight that results in maximization of seed and seedling quality characters. In last phase of horse gram (56 DAA), reduction in dry weight of pod and seed is due to exclusion of some amount of nutrients along with moisture elimination. Such result was obtained (Monalisa *et al.,* 2018) in sesame. Seed moisture content was quite high at 7 DAA (89.3%) which reduced significantly to 56 DAA (13.5%) due to desiccation and dehydration. Such result was obtained in Deepak *et al.* (2019) in rice. Pod and seed colour is the visual index of seed maturation. It was observed that pod colour changes from green group at 7 DAA to straw colour group at 49 DAA and the seed colour changes from green group at 7 DAA to brown group at 49 DAA (Plate 1). It could be seen that the process of physiological maturation in seeds was accompanied by visible changes in the external appearance and coloration of the pods and seeds, thus corroborating the results of Castro *et al*. (2008).

Physiological changes in seed characteristics during seed development and maturation

Germination is the important indicator of seed quality (Khan, 1977) where the final produce is seed, which is for regeneration capacity. In horse gram, seeds from 7 DAA to 28 DAA incapable to germinate due to the immature embryo, although the seeds from 35 DAA attained a germination of 47% which increased maximum at 49 DAA (94%) but after that it decreased to 90% at 56 DAA (Table 3).

Germination percent was maximum at 49 DAA might be due to attainment of potentiality for reproduction of miniature plant. Woodstock and Combs (1964) reported shoot length and root length is a measure of vigour which reveals the seed performance under environmental conditions. Seedling length was maximum in seeds from 49 DAA. Dry matter production increased gradually from 35 DAA to 49 DAA thereafter dry matter decreased slightly due

Table 2: Changes in fresh weight (g), dry weight (g), 100 seed weight (g) and moisture content (%) of seed during seed development and maturation in horse gram.

Quality parameters / Days after anthesis (DAA)	Fresh weight of 25 seeds (g)	Dry weight of 25 seeds (g)	Moisture content (%)	100 seed weight (g)
7 DAA	0.025	0.008	89.3 (70.9)*	0.098
14 DAA	0.089	0.021	73.3 (58.9)	0.355
21 DAA	0.246	0.081	69.7 (56.6)	0.986
28 DAA	0.570	0.382	68.1 (55.6)	2.282
35 DAA	1.501	0.549	52.8 (46.6)	5.992
42 DAA	0.947	0.766	30.4 (33.5)	3.613
49 DAA	0.919	0.859	17.2 (24.5)	3.779
56 DAA	0.906	0.814	13.5 (21.5)	3.722
Mean	0.650	0.435	51.8 (46.0)	2.591
SEd	0.02	0.01	1.1	0.05
CD (P=0.05)	0.04	0.02	2.3	0.11

(*Figures in parentheses indicate arcsine value).

Table 3: Changes in germination (%), root length (cm), shoot length (cm), dry matter production (g/10 seedlings) and vigour index I and II during seed development and maturation in horse gram.

Quality parameters / Days after anthesis (DAA)	Germination (%)	Shoot length (cm)	Root length (cm)	Dry matter production (g seedling^{-10})	Vigour index I	Vigour index II
7 DAA	0 (0.59)*	0	0	0	0	0
14 DAA	0 (0.59)	0	0	0	0	0
21 DAA	0 (0.59)	0	0	0	0	0
28 DAA	0 (0.59)	0	0	0	0	0
35 DAA	47 (43.28)	4.7	9.4	0.101	663	5
42 DAA	68 (55.55)	6.9	14.9	0.145	1482	10
49 DAA	94 (76.08)	8.8	17.7	0.161	2491	15
56 DAA	90 (71.57)	8.4	17.2	0.154	2304	14
Mean	37 (37.46)	3.6	7.4	0.070	868	5
SEd	0.73	0.12	0.25	0.001	33	1
CD (P=0.05)	1.55	0.26	0.53	0.002	70	1

(*Figures in parentheses indicate arcsine value).

to the development of inbuilt mechanism that involved in the disorganization of cell organelles after physiological maturity. Similar finding was also reported in peas by Mathews (1973) and in yard long bean by Sakthivel *et al.* (2023). The computed vigour index was maximum in 49 DAA which was positively correlated with the dry weight of seed. Similar results were also reported in Suresh Babu *et al.* (2003) in brinjal; Natarajan and Srimathi (2008) in petunia and Sundareswaran *et al.* (2011) in bhendi.

CONCLUSION

Thus, the studies on tracing the pattern of seed development and maturation through physical and physiological characters indicated that the seeds attained physiological maturation on 49 DAA with 17.0% moisture content, maximum 100 seed weight (3.779 g), germination (94%) and vigour index I and II (2491 and 15). Hence for high quality seeds, it is recommended that optimum date for harvesting pods was 49 DAA based on germination capacity of seed and seedling vigour.

Conflict of interest

All authors declared that there is no conflict of interest.

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