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Research Article

SEED DEVELOPMENT AND MATURATION IN FOXTAIL AND LITTLE MILLET

SRIDEVI R.*[1], MANONMANI V.[2], RENUGADEVI J.[3] AND RAVIKESAVAN R.[4]

[1]Department of Seed Science and Technology, Imayam Institute of Agriculture and Technology, Trichy, 621 206, Tamil Nadu Agricultural University, Coimbatore, 641 003
[2]Professor, Department of Seed Science and Technology, Agricultural Research Station, Bhavanisagar, 638 451, Tamil Nadu, India
[3]Professor, Department of Seed Science and Technology, Tamil Nadu Agricultural University, Coimbatore 641 003, Tamil Nadu, India
[4]Professor, Department of Millets, Tamil Nadu Agricultural University, Coimbatore, 641 003, Tamil Nadu, India
*Corresponding Author: Email - agrirose.28@gmail.com

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Abstract- Study on seed development and maturation revealed that optimum stage of physiological maturity was attained at 42 DAA and 35 DAA in foxtail and little millet, respectively which was accompanied by maximum length and breadth of panicle, fresh and dry weight accumulation in panicle and seeds, 1000 seed weight, enzyme activities and nutrient accumulation such as α-amylase content, dehydrogenase activity, carbohydrate content, calcium content and phosphorus content with decreased moisture content in panicle and seeds.

Keywords- *Physiological maturity, Panicle, Seeds, Nutrient accumulation*

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Introduction

In general, seed crops should be harvest when seed quality is maximal. However, the stage during seed development at which seeds attain maximum quality is subject of some controversy. Seeds developed in fleshy-fruited species generally attain maximum germination and vigour at the end of the seed-filling period, when physiological maturity is reached [1]. Successful agriculture depends on the quality of seeds used for sowing. Good quality seeds imply vigour, uniformity and structural soundness besides its genetic and physical purity. Production of quality seeds and its maintenance till next sowing are very important in commercial cultivation of any crop. Stage of maturity at harvest is one of the most important factors that can influence the quality of seeds [2]. For seed crop, physiological maturity is the right stage [3] and the maturity stages have been found to induce several physiological and biochemical changes during seed growth and development. The correct stage of harvesting seed crop is physiological maturity stage which decides the vigour potential. Hence, this study was done to verify the development stage when foxtail and little millet seeds acquire maximum quality and to define the optimum harvest date.

Materials and methods

The foxtail millet cv. CO (Te) 7 (*Setaria italica* Beauv.) and little millet cv. CO4 (*Panicum miliare* L.) seeds obtained from Department of millets, Tamil Nadu Agricultural University, formed the base material for the present investigation. The foxtail and little millet crops were raised in the field following all the recommended agronomic practices. The panicles were selected randomly during anthesis, tagged and harvested at weekly intervals to fix the optimum stage of physiological maturity. The days taken for attainment of physiological maturity varied. The following observations were recorded at each maturity stages. The panicle characters such as length, breadth, fresh weight, dry weight and moisture content of the panicle were recorded. The seeds were extracted and the seed characters such as fresh weight, dry weight, 1000 seed weight, moisture content and colour were observed.

The enzymatic changes and nutrient accumulation such as α-amylase content, dehydrogenase activity, carbohydrate content, calcium content and phosphorus content were estimated during development and maturation stages.

Results and discussion

Study on seed development and maturation revealed that the length and breadth of panicle, accumulation of fresh and dry weight of panicle and seeds, 1000 seed weight, enzyme activities and nutrient accumulation was maximum with decreased moisture content of panicle and seeds on 42 DAA and 35 DAA in foxtail and little millet, respectively which indicated the attainment of physiological maturity. The length and breadth of panicle increased during the stages of seed development in foxtail and little millet (Plate 1 and 2) which might be due to increase in size and rapid cell expansion. The findings are in agreement with [4] in Blackgram, [5] in guinea grass, [6] in desmanthus, [7] in lab lab and [8] in cluster bean. In the present study, increase in seed fresh weight was noticed with the advancement of seed development stages [Table-1]. Increase in fresh weight of seeds with advancement of seed development stages was documented by [9] in small millets, [10] in Indian mustard, [11] in sunflower and [12] in birdwood grass. This might be due to the quick development of the seed and high moisture at earlier stages of development. After sexual fusion, the developing seed begins to increase in weight as a result of nutrient and water intake associated with rapidly accelerating cell division and elongation [13]. In the present investigation, the seed dry weight continued to increase rapidly during all developmental stages [Fig-1]. The increase in seed dry weight is associated with the greater accumulation of photosynthates in to the sink (seed) up to 42 DAA and 35 for foxtail and little millet, respectively which indicates the physiological maturity. This increase in dry weight might be due to synthesis and deposition of storage mineral like starch in endospermic tissues. Increase in dry matter accumulation may also be due to peak rise in respiration rate [14] who concluded that a continuous deposition of reserve materials caused increase in seed dry weight throughout the development

Table-1 Panicle and seed characters during seed development and maturation stage in foxtail millet

Stages of seed development	Parameters								
	Panicle characters					Seed characters			
	Length of panicle (cm)	Breadth of panicle (cm)	Fresh weight of panicle (g)	Dry weight of panicle (g)	Moisture content of panicle (%)	Fresh weight of seeds(g)	Dry weight of seeds(g)	1000 seed weight(g)	Moisture content of seeds (%)
7 DAA	15.1	1.9	3.41	1.38	80.2	-	-	-	-
14 DAA	19.3	2	3.83	1.63	78.6	-	-	-	-
21 DAA	20.3	2.2	4.46	2.88	67.1	2.05	1.59	1.15	66.5
28 DAA	20.9	2.2	5.53	3.62	55.4	3.61	2.31	1.41	53.6
35 DAA	21.8	2.3	6.25	4.96	36.8	4.96	3.74	2.39	34.1
42 DAA	23.5	2.6	7.63	5.15	28.3	5.34	4.2	3.06	27.8
49 DAA	23.5	2.6	7.42	5.07	25.1	5.11	4.03	2.92	24.3
Mean	20.6	2.2	5.5	3.53	53.1	3.01	2.26	1.56	29.5
SEd±	0.175	0.018	0.045	0.03	0.51	0.033	0.025	0.018	0.278
CD (P= 0.05)	0.364	0.038	0.093	0.064	1.061	0.07	0.052	0.037	0.579

[DAA – Days after anthesis]

Plate-1 Physiological maturity stages of foxtail millet

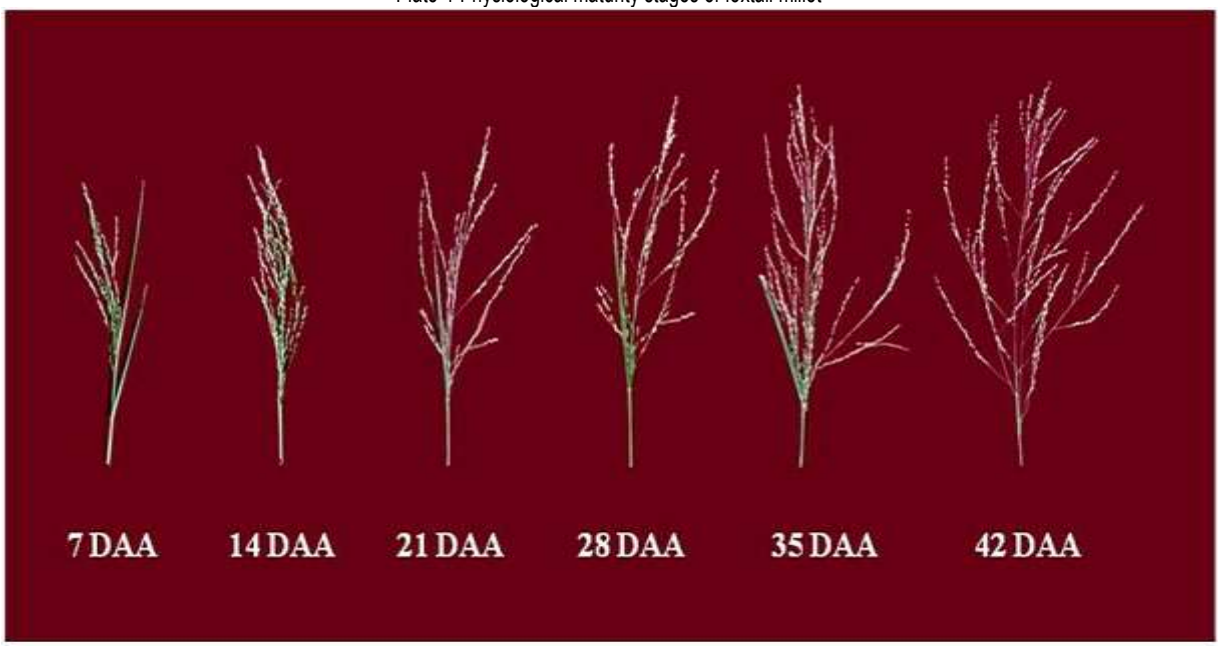

Plate-2 Physiological maturity stages of little millet

Table-2 Enzymatic changes and nutrient accumulation during seed development and maturation stage in little millet

Stages of seed development	α-amylase content (mg maltose min^{-1})	Dehydrogenase activity (OD value)	Carbohydrate content (%)	Calcium content (%)	Phosphorus content (%)
7 DAA	-	-	-	-	-
14 DAA	-	-	-	-	-
21 DAA	1.93	0.135	21.6	0.63	0.14
28 DAA	2.66	0.186	38.2	0.92	0.27
35 DAA	3.91	0.240	72.9	1.85	0.32
42 DAA	3.91	0.240	72.9	1.85	0.32
Mean	2.06	0.133	34.2	0.87	0.17
SEd	0.025	0.001	0.464	0.011	0.002
CD (P= 0.05)	0.054	0.003	0.976	0.024	0.004

[DAA – Days after anthesis]

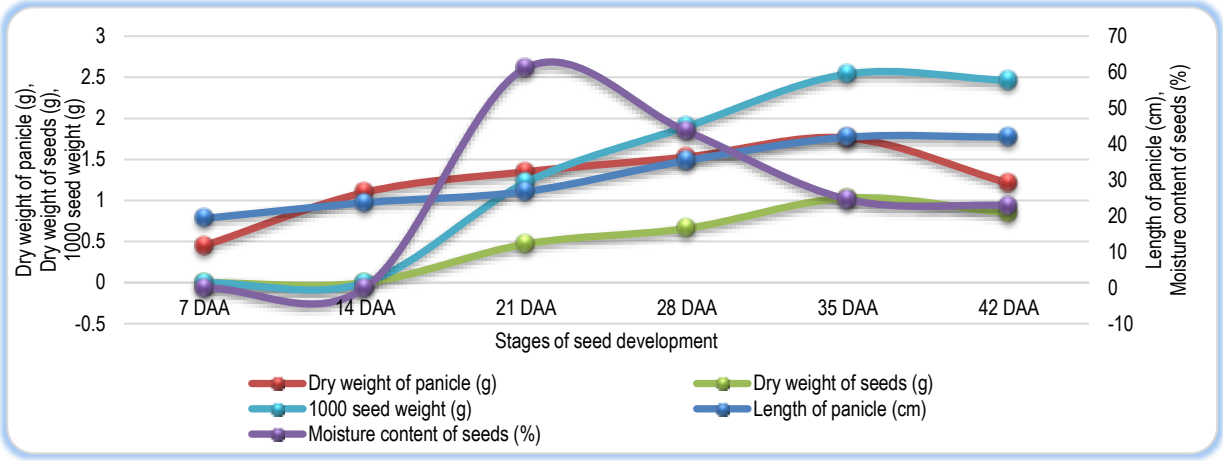

Fig-1 Panicle and seed characters of little millet at various stages of seed development

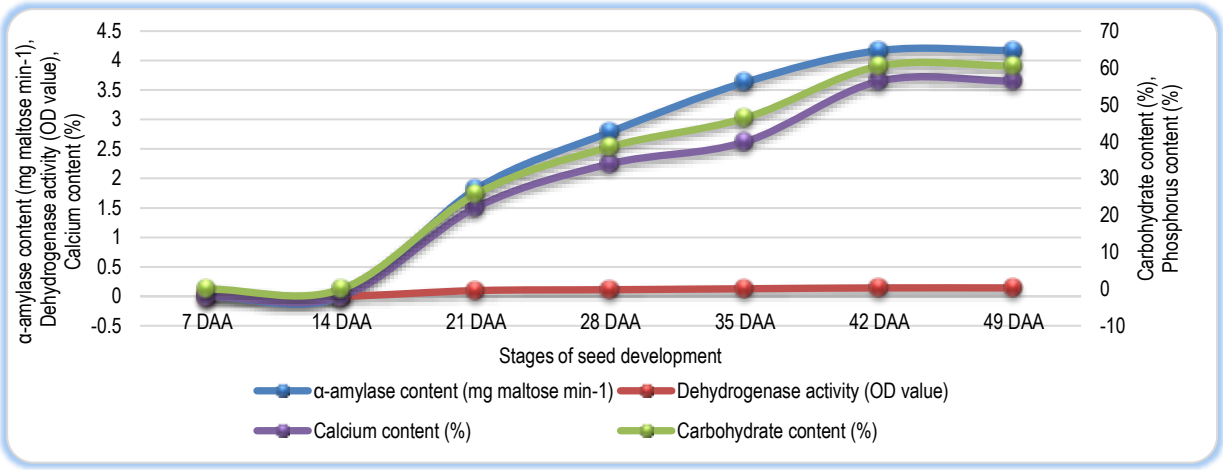

Fig-2 Enzymatic changes and nutrient accumulation of foxtail millet at various stages of seed development

and maturation. Similar result of dry weight accumulation was reported [15] and [16] in sunflower, [17] in forage sorghum and [18] in wheat. The loss of moisture during maturation is an inherent phase of development [19]. Loss of seed moisture during ripening and maturation of a seed is a common phenomenon and has been observed in many crops [20, 21]. The developing seeds started to loss the moisture content continuously as seed matured. When seed losses moisture and reach minimum, the vascular connection between developing seed and mother plant is broken and the synthesis or metabolic activities are started. The decrease in moisture content accompanied with increase in dry weight of seeds indicated the continuous accumulation of food reserves in the developing seeds [22, 23]. [24, 25] reported that the loss of water with accumulation of dry matter is the characteristic feature of seed development. As the maturity of seeds advanced, the α-amylase content, dehydrogenase activity, carbohydrate content, calcium content and phosphorus content also increased [Fig-2]. They reached the maximum at 42 DAA and 35 DAA for foxtail and little millet, respectively and thereafter a marginal decrease in this enzyme activity was noticed [Table-2]. The present findings are in agreement with the results of [26] in paddy and [12] in birdwood grass. α-amylase activity is the important indicator of starch degradation in the seed tissues. Seeds harvested at physiological maturity recorded higher α-amylase content than earlier harvest [27]. In the present study, the increase in amylase content confirms the completion of metabolic activity and attainment of physiological maturity of seed. Beyond physiological maturity α-amylase activity decreased which might be due to the lower gibberellins content and increased abscissic acid content in the later stage of seed development and maturity. Similar trend in α-amylase activity during development and maturation was observed by [28] in wheat, [26] in paddy, [17] in fodder sorghum and [18] in wheat.

Conclusion

The present study on finding physiological maturity of foxtail and little millet revealed that the panicle and seed characters like length and breadth of panicle, fresh and dry weight accumulation in panicle and seeds, 1000 seed weight, enzyme activities and nutrient accumulation such as □amylase content, dehydrogenase activity, carbohydrate content, calcium content and phosphorus content of seeds were maximum at 42 and 35 days after anthesis indicating the physiological maturity of foxtail and little millet, respectively.

Application of research: The correct stage of harvesting seed crop is physiological maturity stage. Hence, the correct stage of harvesting of foxtail and little millet had been identified for obtaining high vigorous seeds.

Research Category: Seed Science and Technology

Abbreviations: DAA-Days after anthesis, cm-centimeter, g–gram, %- Percentage, α- alpha, OD-optical density

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***Research Guide or Chairperson of research: Dr V. Manonmani**
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Author Contributions: All authors equally contributed

Author statement: All authors read, reviewed, agreed and approved the final manuscript. Note-All authors agreed that- Written informed consent was obtained from all participants prior to publish / enrolment

Study area / Sample Collection: Seeds obtained from Department of millets, Tamil Nadu Agricultural University, Coimbatore 641 003, Tamil Nadu, India.

Cultivar / Variety / Breed name: foxtail millet cv. CO (Te) 7, little millet cv. CO 4

Conflict of Interest: None declared

Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.
Ethical Committee Approval Number: Nil

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