Research Journal of Agriculture and Biological Sciences, 4(5): 585-590, 2008

Studies on Seed Development and Maturation in Petunia

[1]K. Natarajan and [2]P. Srimathi

[1]Department of Seed Science and Technology, Tamil Nadu Agricultural University, Coimbatore-641003, Tamilnadu, India.
[2]Department of Seed Science and Technology, Tamil Nadu Agricultural University, Coimbatore-641003, Tamilnadu, India.

Abstract: Petunia is an important floricultural crop of ornamental and export value. Studies were made to identify the duration and symptoms of physiological maturation for the harvest of the quality seeds which is essential in this crop bearing dehiscent pods.The results revealed that Seeds attained physiological maturation at 25 DAA with the physical indices of maximisation of fresh and dry weight of pod and seed and pod length and the visual indices as turning of pod to yellowish brown colour and the seed to dark brown.The moisture content of the seed at the time of maturation was 26.5 per cent while the dryweight was 2.0 mg while the seed attained germinability 20 days after anthesis and the maximization of 96 per cent coincided with days of physiological maturation(25 DAA).The delayed harvest of pod after 2 to 3 days of physiological maturation leads to 100 per cent shattering loss.

Key words: Petunia, maturation, physical, physiological, visual, symptom, shattering loss

INTRODUCTION

Seed is a miracle. Floriculture is the fast emerging venture in world trade. Production of ornamental plants and their trade once considered as gardeners profession is now fastly becoming an important commercial venture. Flowers and gardens have been very closely associated with Indian culture from ancient times, as flowers are symbolic of beauty, love and tranquility from time immemorial and form the soul of a garden to convey the message of nature to man. No religious ceremony and social gathering is complete in this country without appropriate flowers and foliage. Apart from socio-economic importance, there is a great potential to develop the floricultural products as an industry. Today floriculture has emerged as a lucrative profession with much higher potential for returns than most of the field and horticultural crops. Flower seed production is the need of the hour as it has enormous potential for export value[1]. Petunia is one such valuable crop having aesthetic value and is widely utilized for vase material, interior decoration and as bedding material in home garden. Seed production in this crop fetches importance owing to their severe nature of shattering habit on attainment of maturity. On reviewing the maturity status of different crops opined that prediction of duration and symptoms of seed maturation during growth and development is warranted for each crop as it vary from crop to crop but unique to seed to seed[2]. Hence studies were made to trace the duration and developmental changes during maturation in petunia cv. Mix through physical, physiological and visual symptoms.

MATERIALS AND METHODS

Bulk crop was raised during June and just before anthesis or flower opening, about 200 flower buds were tagged. The pods were collected at five days interval upto 30 days *i.e*., 5, 10, 15, 20, 25 and 30 days after anthesis (DAA) in four replicates of five pods each. At each interval, pod characters *viz*., pod length and diameter (cm), fresh and dry weight of pod^{-1} (g), pod moisture content (%) were measured and the seeds were extracted manually and the seed characters *viz.*, pod to seed recovery (%), number of seeds pod^{-1}, fresh and dry weight of seed pod^{-1} (mg), seed moisture content (%)[3], (The seeds were weighed initially and kept in open condition for a period of 24 h as per ISTA as the moisture content was expected to be high. Then as per the normal procedure the seed moisture content was calculated. Empty weight of moisture bottle with lid (M_1) was recorded. Then fresh seed (not less than 1g) were weighed along with moisture bottle (M_2) and placed in a hot air oven maintained at 105°C±2°C for 16 h. Then the bottles were taken out

Corresponding Author: K. Natarajan, Department of Seed Science and Technology, Tamil Nadu Agricultural University, Coimbatore-641003, Tamilnadu, India.
Email: natarajan_seed75 @ rediffmail.com, natarajan_seed@yahoo.co.in

and cooled in a desiccator for 20 minutes. The weight of bottle along with dried seeds were recorded individually. The moisture content was calculated using the following formula.

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

fresh and dry weight of 100 seed (mg)[3] were observed. The seeds of each maturation groups were evaluated for seed and seedling quality characters *viz.,* germination (%)[3], (Four replicates of hundred seeds were sown in petridishes adopting top of paper method and kept under the germination room condition illuminated with fluorescent light. After the test period of ten days the normal seedlings were counted and the mean values expressed as percentage[3] to the total number of seeds placed for germination), abnormal seedlings (%),dead seeds (%), root and shoot length of seedlings(cm),drymatter production of 20 seedlings (mg) and vigour index[4]. The data gathered were analysed statistically adopting the procedure described by (5). Wherever necessary, the percentage values were transformed to angular (arc sine) values, before carrying out the statistical analysis. The critical difference (CD) was worked out at 5 per cent (P = 0.05) level and wherever 'F' value is non-significant it is denoted by "NS".

RESULTS AND DISCUSSION

Highly significant results were obtained for all the evaluated pod, seed and seedling characteristics (Table1).

Seed maturation as the period between fertilization and harvest during which the crop undergoes morphological, physiological and functional changes in both fruit and seed[6]. In understanding the critical period and stage for harvesting the seed with maximum seed quality, studies on tracing the pattern of seed development and maturation is warranted as these studies fetches much importance in crops with dehiscent pods / fruits owing to the probability of loss of total seeds due to their inherent shattering habit after maturation. In the present investigation with petunia highly significant results were obtained for all the evaluated pod, seed and seedling characteristics (Table 1). The observations taken on the pod characters revealed that fresh weight of pod observed a steady increase with advances in maturity status upto 20 days and reached the maximum of 0.0748 g at 25 days after anthesis. The weight of pod was also supported by the increase in morphological structure of pod which were measured through the length and width of pod. These observations attained their maximum measurement at 25 days after anthesis which was in increasing order up to that period. But thereafter (25 DAA) it reduced to a tune of 4 to 5 per cent. In balsam[7], in marigold[8], in phlox[9], and in zinnia[10] also observed similar increase in physical characters of pod with advances in maturation process due to the development of zygote to matured seed.

The loss of moisture in maturing seed as an inherent phase of seed development[11,12]. [13]also supported the statement expressing that accumulation of drymatter with loss of moisture as the characteristic feature during seed development and maturation in any crop. In line with these views, in the present study also the pod moisture content decreased from 70.5 to 37.8 per cent with periods of maturation (15 DAA to 25 DAA). The observed decrease in moisture content of pod with advancement in maturation correlated well with higher dehydration rate of pod as noted in small seeded agricultural and horticultural crops by[14,15]. [16]opined that this could be due to the replacement of osmotic material by starch and other large molecules with low hydration capacity. In agricultural crop[17] and in flower crops[8,10] also reported similarly as that the present study expressing dehydration as the cause for improvement in dry weight of the pod with advances in days of maturation.The pods left in the field after 25 days of anthesis resulted in shattering of seed upto a tune of 100 per cent with the earliest interval of two days (Plate1). This necessitate to harvest the crop at the time of physiological maturation, the lack of which might have resulted in complete loss of seeds which could be due to dehiscent nature of pod that rests with the genetic nature of the crop. In *Gymnema sylvistre*[18] and in palmarosa[19] also reported similar dehiscence of seed after pod maturation even within 1 to 3 days.

Physiological maturation occurs commonly in seeds to recapture the reproducing capacity of the younger generation and this normally coincide with attainment of maximum dry weight, where the flow of nutrients are freezed to the seed from the mother plant[20]. The observed seed characters of the present study expressed similar trend as that of pod in maximization of fresh weight (0.0679 g) at 25 DAA and reduction of moisture content with advances in period of maturation. The dry weight of the seed also maximised at 25 DAA in line with pod maturation. Similar trend in maximization of dry weight with physiological maturation was also observed in agricultural crops[15,21] and small seeded medicinal plants[22].The reduction in dry weight of pod and seed during the last phase of the present study might be due

Table 1: Influence of seed development and maturation on seed and seedling quality characteristics

Parameters	10 DAA	15 DAA	20 DAA	25 DAA	30 DAA	CD (P = 0.05)
			Pod characteristics			
Pod length (cm)	-	1.0	1.7	2.1	2.0	0.356
Pod diameter (cm)	-	1.2	18	2.4	2.2	0.213
Fresh weight of pod^{-1} (g)	-	0.0276	0.0483	0.0748	0.0682	0.005
Dry weight of pod^{-1} (g)	-	0.0085	0.0217	0.0496	0.0488	0.001
Pod moisture content (%)	-	70.5	52.3	37.8	26.1	3.383
Number of seeds pod^{-1}	-	460	588	620	50	10.518
			Seed characteristics			
Pod to seed recovery (%)	-	70 (56.80)	78 (62.07)	91 (72.55)	86 (68.08)	2.364
Fresh weight of seed pod^{-1} (mg)	-	0.0103	0.0376	0.0679	0.0592	0.0004
Dry weight of seed pod^{-1} (mg)	-	0.0072	0.0200	0.0502	0.0480	0.001
Fresh weight of 100 seed (mg)	-	4.6	6.6	8.3	8.0	0.316
Dry weight of 100 seed (mg)	-	2.0	3.1	4.7	3.8	0.233
Seed moisture content (%)	-	60.5	47.2	26.5	20.2	4.257
			Seed quality characteristics			
Germination (%)	-	-	-	96 (79.96)	15 (23.78)	4.837
Abnormal seedlings (%)	-	-	-	1	1	0.629
Dead seeds (%)	-	-	-	3	4	0.889
Root length (cm)	-	-	-	0.82	0.59	0.016
Shoot length (cm)	-	-	-	2.01	1.50	0.101
Drymatter production (mg 20 seedlings^{-1})	-	-	-	2.0	1.5	0.198
Vigour index	-	-	-	278	35	12.585
			Visual observation			
Colour of pod	-	Green	Greenish yellow	Yellowish brown	Brown	-
Colour of seed	-	White	Yellowish brown	Dark brown	Blackish brown	-

(Figures in parentheses indicate arc sine values)

to the elimination of certain amount of nutrients along with the higher rate of moisture elimination. Author expressed that the fluid and gaseous forms of nutrients and volatile substances present in the pod would escape from the seed during maturation causing reduction in the dry weight of pod and seed by oxidation and volatilization[20].

Germination capacity is the prime indicator of seed quality[23] as the final produce will become seed, only on gaining capacity for regeneration. The seeds of the present study observed that seeds were capable of germination to an extent of 5 per cent on 20 DAA and it increased with advances in maturity and reached the maximum of 96 per cent at 25 DAA which coincided well with the accumulation of the maximum fresh and dry weight at a given situation and this was also in accordance with[24,25] in field crops,[7,8,9,10] in flower crops.

Woodstock and Combs[26] coined root length and shoot length as a measure of seedling vigour as they reveal the performance of the seed under given environmental conditions. The root and shoot growth of the present study increased with advances in maturation[27] and were the maximum at 25 DAA, which was in coincidence with stages of dry weight of pod / seed and seed germination. The seedling

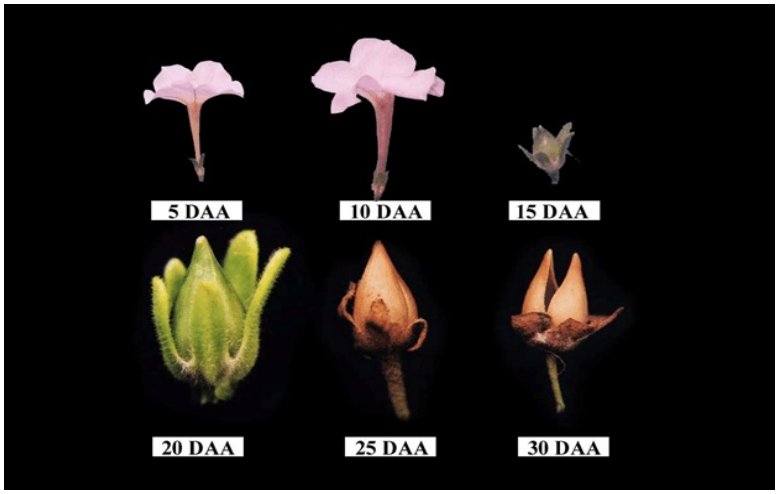

Plate 1:

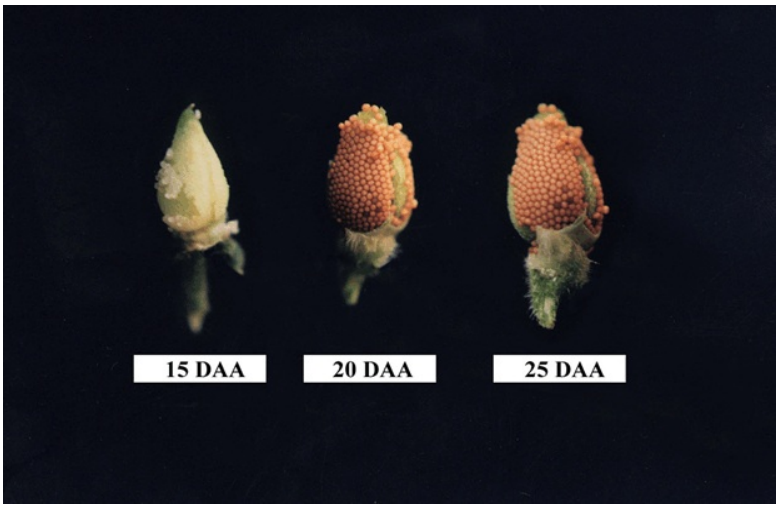

Plate 2:

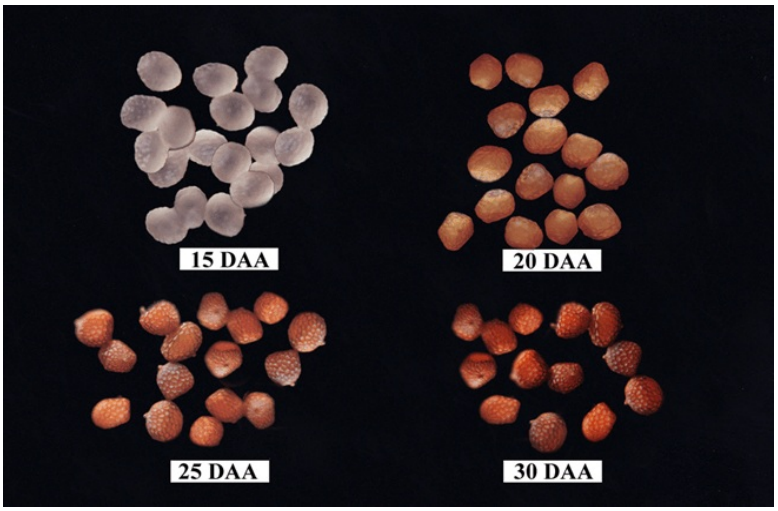

Plate 3:

drymatter which is another parameter for the measurement of seed vigour was also in increasing order due to accumulation of higher quantum of fresh and dry weight in pod and seed as the maturation stage advances upto 25 DAA. Thereafter the drymatter production decreased slightly which was claimed to be due to the development of inbuilt mechanism that involved in the disorganization of cell organelles in the few days after physiological maturity as per[28]. Vigour as the inherent ability of the seed to survive well under wide range of conditions[29]. The computed vigour index values of the present study was maximum at 25 DAA which coincide well with fresh weight, germination, seedling vigour characters which were all claimed to be the indices of seed maturation.

Seed colour also as the visual index of seed maturation both with pod and seed[30,31]. In the present study also similar observation were made, where the pod colour changes from green to greenish yellow to yellowish brown to brown, where the yellowish brown colour coincide with the 25 DAA the predicted day of maturation in conjunction with physical and physiological status of seed. The colour change could also observe in seed where the white seed turn to yellowish brown to dark brown and then to blackish brown in colour with maturation (Plate 2 and 3). Hithertoo the dark brown colour coincide with the physiological maturity stage of seed and it coincide with 25 DAA, the observed duration for seed development and maturation.

Carlson[32] expressed that the phytosynthates moved into the developing ovule through extensive network of vascular tissue located throughout the open integument and this vascular system of the integumentary was destroyed as the seed mature, which coincided with the turning of seed coat colour. In cumbu[33] and in carrot[34] also observed similar coincidence and recommended 40, 36, and 49 as the days for maturation after anthesis respectively. Thus the present study on seed development and maturation revealed that

- Seeds attained physiological maturation at 25 DAA
- The physical indices for maturity were maximisation of fresh and dry weight of pod and seed and pod length
- The visual indices for maturation was turning of pod to yellowish brown colour and the seed to dark brown.
- The moisture content of the seed at the time of maturation was 26.5 per cent while the dryweight was 2.0 mg
- The seed attained germinability 20 days after anthesis while the maximization of 96 per cent coincided with 25 DAA the days of physiological maturation
- The delayed harvest of pod after 2 to 3 days of physiological maturation leads to shattering of seeds to a tune of 100 per cent.

ACKNOWLEDGMENT

The suggestions and the guidance rendered by Dr.M.Vijayakumar, Professor and Head, and Dr. Arumugam, Assistant Professor (Farm manager), Department of Floriculture and Landscaping, Tamil Nadu Agricultural University, Coimbatore during the course of the study is acknowledged with gratitude.

REFERENCES

1. Panchal, A., S. Mahapatra, M. Ramesh, N. Mookerji, P. Krishnakumar, S. Sharma and K. Gopinath, 2003. Say it flowers. The New Indian Express. 27th January., pp: 12.
2. Jerlin, R., P. Srimathi and K. Vanangamudi, 2001. Seed physiological maturity and maturity indices. In: Recent techniques and participatory approaches on quality seed production. (Eds. K.Vanangamudi, A. Bharathi, P. Natesan, R. Jerlin, T.M. Thiagarajan and S. Kannaiyan), Department of Seed Science and Technology, Tamil Nadu Agricultural University, Coimbatore. Pp123-126.
3. ISTA, 1999. International Rules for Seed Testing. Seed Sci. & Technol. (Supplement Rules), 27: 25-30.
4. Abdul-Baki, A.A. and J.D. Anderson, 1973. Vigour determination in soybean seed by multiple criteria. Crop Sci., 13: 630-633.
5. Gomez, K.A. and A.A.Gomez, 1984. Statistical procedures for agricultural research of legumes seeds of different density. Agriculture, 41: 47-56.
6. Delouche, J.C., 1973. Seed maturation. In: Seed Production Manual. NSC and Rockfeller foundation, pp: 162-165.
7. Arunachalam, M., K. Sivasubramanian, K. Angamuthu and C.P. Thiagarajan, 1995. Studies on fruit and seed maturation in balsam genotypes. The Orissa J. Hort., 23(1&2): 54-58.
8. Natarajan, K., 2000. Seed technological studies in marigold cv. African giant. M.Sc. (Ag.) Thesis, Tamil Nadu Agricultural University, Coimbatore.
9. Sathiyanarayanan, G., 2000. Seed technological studies in phlox cv. Globe mix. M.Sc. (Ag.) Thesis, Tamil Nadu Agricultural University, Coimbatore.
10. Vijayan, R., 2002.Seed hardening and conditioning in zinnia and gaillardia. M.Sc. (Ag.) Thesis, Tamil Nadu Agricultural University, Coimbatore
11. Kolhe, A.K. and V.M. Chavan, 1964. Development of fruits, yielding capacity and influence of fruit maturity on the vegetative and reproductive

behaviour of Okra. Indian J. Agric. Sci., 37(3): 155-166.
12. Manohar, M.S. and S.C.P. Sachan, 1974. Pod development and germination studies in pea (Pisum sativum L.). Veg. Sci., 1: 22-30.
13. Mayer, A.M., 1973. The control of the initial stages of germination. Some biochemical investigations. Seed Sci. & Technol., 1: 51-72.
14. Manohar, M.S., 1970. Seed development and germination studies on lablab. Indian J.Hort., 27(1&2): 86-92.
15. Sabir-Ahamed, A., 1989. Studies on the production of quality seed and storage in soybean (Glycine max (L.) Merrill.). M.Sc. (Ag.) Thesis, Tamil Nadu Agricultural University, Coimbatore.
16. Milthorpe F.L. and J. Moorty, 1979. An introduction to crop physiology, Cambridge Univ, Press, Cambridge, pp: 174.
17. Kharb, R.P.S., B.P.S. Lather and D.P. Deswal, 1993. Studies on physiological maturity in early pigeonpea. Seed res., 2191): 45-48.
18. Harakumar, C., 1997. Seed technological studies in Gymnema sylvistre. M.Sc. (Ag.) Thesis, Tamil Nadu Agricultural University, Coimbatore.
19. Gopal, A., 1997. Studies on certain seed technological aspects of palmrosa. M.Sc. (Ag.) Thesis, Tamil Nadu Agricultural University, Coimbatore.
20. Harrrington, J.K., 1973. Biochemical basis of seed longevity. Seed Sci. & Technol., 1: 453-461.
21. Paramasivam, V., 1990. Studies in development, maturation, quality and storability of pea seeds. M.Sc. (Ag.) Tehsis. Tamil Nadu Agricultural University, Coimbatore.
22. Revathi, R., 2001. Seed production, testing and storage studies in Phllanthus niruri. M.Sc. (Ag.) Thesis, Tamil Nadu Agricultural University, Coimbatore.
23. Khan, A.A., 1977. The physiology and biochemistry of seed dormancy and germination. Elsevier Scientific Publications Co., Amsterdam. pp: 77-175.
24. Karivaratharaju, T.V., 1974. Studying seed maturation aspects to fix maximum physiological maturity to achieve maximum vigour and dry weight. Annual Progress Report, 1973-74. Tamil Nadu Agricultural University, Coimbatore.
25. Vanangamudi, K., 1977. Seed maturation and seed production techniques in CBS 156 hybrid cotton. M.Sc. (Ag.) Thesis, Tamil Nadu Agricultural University, Coimbatore.
26. Woodstock, L.W. and M.F. Combs, 1964. A comparison of some possible indices of seedling vigour in corn. Proc. Assoc. Off. Seed Anal., 54: 50-60.
27. Burries, J.S., O.T. Edje and A.K. Wahab, 1973. Effect of seed size on seedling performance in soybean-II seedling growth and photosynthesis and field performance. Crop Sci., 13: 207-210.
28. Mathews, S., 1973. The effect of time of harvest on the viability and pre-emergence mortality of pea (Pisum sativum L.) seeds in soil. Ann. Appl. Biol., 73(2): 211-219.
29. Heydecker, W., 1972. Vigour. In: Viability of seeds (ed. E.H. Roberts), chapman and Hall London, pp: 209-252.
30. Srimathi, P., 1997. Research focus on seed collection, processing and storage of Amla (Emblica officinalis), Jamun, Jamun (Syzygium cuminii) and Ber (Zizyphus mauritiana). Ph.D. Thesis, Tamil Nadu Agricultural University, Coimbatore.
31. Parameswari, K., 1999. Seed technological studies in tamarind (Tamarindus indica Linn.) M.Sc. (Ag.) Thesis, Tamil Nadu Agricultural University, Coimbatore.
32. Carlson, J.B., 1973. Morphology. In: Soybeans improvement, production and uses (ed. B.E. Caldwell), American Society of Agronomy, Wis.
33. Vanangamudi, K. 1982. Studies on seed production and storage in bajra. Ph.D. Thesis, Tamil Nadu Agricultural University, Coimbatore.
34. Sundaralingam, K., 1995. Seed technological studies in carrot. M.Sc. (Ag.) Thesis, Tamil Nadu Agricultural University, Coimbatore.