International Journal of Chemical Studies

P-ISSN2349–8528
E-ISSN 2321–4902
IJCS 2016; 4(2): 110-113

Received: 20-12-2015
Accepted: 27-01-2016

Bhaskaran M
Department of Seed Science and Technology Tamil, Nadu Agricultural University, Coimbatore, Tamil Nadu, India

Ranjeet Kumar Jha
Department of Seed Science and Technology Tamil, Nadu Agricultural University, Coimbatore, Tamil Nadu, India

Correspondence
Bhaskaran M
Department of Seed Science and Technology Tamil, Nadu Agricultural University, Coimbatore, Tamil Nadu, India

Studies on seed development and maturation of Marigold *Tagetes* erecta L.

Bhaskaran M and Ranjeet Kumar Jha

Abstract
Studies were undertaken to assess physiological maturity of seeds in marigold after flower bud initiation. Physiological maturity was assessed by harvesting flower heads after flowering at weekly intervals and were designated as S_1, S_2, S_3, S_4, S_5, S_6 and S_7 representing 7^{th}, 14^{th}, 21^{st}, 28^{th}, 35^{th}, 42^{nd} and 49^{th} days after budding. Results revealed that flower heads harvested at 42 days after flower bud initiation were found to exhibit maximum seed filling, higher germination %, higher 100 seed weight, increased dry matter accumulation and enhanced seedling vigour. Moisture content in seeds of flower heads harvested at 42 days after flowering was found to be around 24.96 per cent.

Keywords: Studies on seed, maturation, *Tagetes* erecta L

Introduction
Marigold (*Tagetus erecta* L.) is one of the major flower crops exploited commercially belonging to the family Asteraceae. Marigold is a short duration flower crop producing wide spectrum of attractively coloured flowers with varying shapes, size and keeping quality which attracted the attention of flower growers. It is put to many uses like cut flower, garden displays, garlands, bouquets and for worship. The aromatic oil extracted from *Tagetus minuta* which is being traded as Tagetus oil is a fly repellant and has also got larvicidal property. Besides, marigold is identified as an alternate source of carotenoid pigments. The principal pigment present in the flower is xanthophyll, particularly lutein, accounting for 80-90 per cent and is present in the form of esters of palmitic and myristic acids (Alam *et al*., 1968) [2].
Inadequate supply of high quality seeds accounts for majority of yield loss in marigold and it remains as one of the major constraints in limiting the flower cultivation. Research reports revealed that 10-20 per cent of yield could be increased by the use of quality seed alone (Chandginam *et al.* 1987) [3]. Maturity status of seeds at harvest is one of the most important factors that can influence the quality of seeds (Demir *et al*., 2008) [4]. Harvesting too early may lead to not only reduced yield and but also poor quality because of the partial development of essential structures of seeds. Delayed harvesting may increase the risk of shattering and decrease the quality of seeds due to ageing. Hence this study was taken to optimize the time of harvest in marigold with a view to obtain good quality seeds.

Materials and Methods
Seed crop of marigold was raised and about 2000 flower buds were tagged soon after emerging. One hundred and sixty flower heads were harvested at weekly intervals and were designated as S_1, S_2, S_3, S_4, S_5, S_6 and S_7 representing 7^{th}, 14^{th}, 21^{st}, 28^{th}, 35^{th}, 42^{nd} and 49^{th} days after budding, respectively. Observations viz., **f**resh and dry weight of flowers, moisture content of flowers, fresh and dry weight of seeds, moisture content of seeds, seed number per flower, 100 seed weight (dry), germination percentage, root length, shoot length dry matter production and vigour index.

Results and Discussion
Seed development is the period between fertilization and maximum fresh weight accumulation and seed maturation begins at the end of seed development and continues till harvest (Mehta *et al*., 1993) [8]. In seed production, the time of harvest is a critical factor determining the seed yield and quality. Unevenness in the performance of a seed lot is due to the differential maturation of seeds and the environmental interaction which affects the seed development.

Studying the pattern of seed development and maturation may enable us to understand the critical period of development in which failure to apply nutrients and irrigation may produce irreversible changes leading to loss of seed quality.

In the present study, fresh weight of flower increased gradually up to 28 days after initiation of flower buds and started decreasing thereafter as supported by Natarajan (2000) [11]. This might be due to loss in moisture content of the developing seeds. The loss in moisture content of matured flower is referred as one of the inherent phase of seed development (Jerlin, 1999) [6]. Dry weight of the flower also followed the same trend as that of fresh weight of the flower. The moisture content of the flower during initial stage was 82.09 per cent and decreased gradually to 37.69 per cent at 42 days after initiation of flower bud. The decrease in moisture content with the advancement in maturity stage might be due to desiccation and dehydration of seed (Miyajima, 1997) [10] or replacement of osmotic potential by starch and other large molecule with low hydration capacity (Milthorpe and Moorthy, 1979) [9].

The fresh weight of the seed increased with advancement of seed development and maturation period and attained maximum of 1.66 g at 21 days after flower bud initiation and then it started to decline. This could be attributed to the steady accumulation of dry matter during seed maturation. Seed development is a period between fertilization and accumulation of maximum fresh weight of seed (Abdul-Baki and Anderson, 1973 a) [1]. Harrington (1972) had referred fresh weight of seed as one of the important factor which determine the quality of seed. Seed attains physiological maturity when it reaches maximum dry weight (Harrington, 1972). Delouche (1973) reported that physiological maturity of seed was assessed by dry weight of developing seed. In the present study, maximum dry weight of seed (0.56 g) was recorded on 42 days after flower bud initiation. This indicated that large amount of reserve food went on accumulating in seed till 42 days after anthesis.

Moisture content of developing seed increased up to 14 days after flower bud initiation and decreased to 24.96 per cent at 42 days after flower bud initiation. This might be due to desiccation and dehydration as drying is the normal terminal event in the development of seed, which pass into a metabolically quiescent state and form a development to a germinative mode of metabolism. In the present investigation, increase in total number of seeds was observed from 14 days after flower bud initiation and was found maximum on 42 days after flower bud initiation as also reported by Natarajan (2000) in marigold and Selvakumari (2005) [12] in china aster. The reason attributed for this might be that number of seeds was reported to be directly proportional to the flower size and weight.

In the present study, increase in number of filled seed and decreasing trend in number of ill filled seed was recorded from 14 days of flower bud initiation to maximum at 42 days after flower bud initiation and decreased thereafter, the reason may be accumulation of dry matter in seed during development and maturation stage. Hundred seed weight (dry) of developing seed increased and attained maximum at 42 days after flower bud initiation and decreased thereafter. This might be due to increased deposition of reserve food material in seed during development and maturation stages. The decrease in dry weight may be due to escape of fluid and gaseous form of nutrients and volatile substances present in seed during maturation by oxidation and volatilization (Harrrington 1973) [5].

The developing seed started to germinate from 21 days after flower bud initiation and increased to maximum (97 %) on 42 days after flower bud initiation. The increasing trend in germination during the development stage which attained maximum on 42 days after flower bud initiation might be attributed to the maximum dry matter content and associated decrease in seed moisture. The declining trend of germination in the matured hybrid marigold seed beyond 42 days after bud initiation might be due to the development of inhibitors, probably ABA, following dehydration of seed during that period (Loveys *et al*., 1975) [7]. The root and shoot length of the seedling increased as the seed matured and reached maximum at 42 days after anthesis. This might be due to maximum dry matter accumulation of the seed which might have provided more energy in the growth process (Tupper, 1969) [13]. The dry matter production of seedling could be taken as manifestation of the physiological efficiency dependent of seed vigour (Heydecker, 1972). In this study, the seed attained higher dry matter production on 42 days after flower bud initiation. The quantum increase in dry matter production towards the attainment of physiological maturity was maximum as much as the seed at physiological maturity. Vigour is the inherent ability of seed to survive, germinate and produce seedling capable of doing well under wide range of conditions. The computed vigour index value was maximum at 42 days after floral bud initiation, coinciding with higher germination and seedling length Since the vigour index was the product of these two parameters, it was the highest at 42 days after floral bud initiation. From this study, it is inferred that the physiological maturity of marigold seeds was attained on 42 days after flower bud initiation, where the dry matter, germination and vigour were maximum and the moisture content was minimum.

Table 1: Mean flower fresh weight (g), flower dry weight (g), flower moisture content (%), seed fresh weight (g), seed dry weight (g) and seed moisture content (%) recorded at different stages of maturity in hybrid marigold

Stages of maturation	Fresh weight of flower (g)	Dry weight of flower (g)	Moisture content of Flower (%)		Fresh weight of Seed (g)	Dry weight of seed (g)	Seed moisture Content (%)	
S1	0.62	0.10	82.09	(65.18)	-	-		-
S_2	7.08	1.17	83.55	(66.31)	0.74	0.16	79.04	(62.85)
S_3	10.87	1.67	84.69	(67.24)	1.66	0.29	82.19	(65.17)
S_4	11.09	1.75	83.27	(66.09)	1.16	0.34	69.70	(56.65)
S_5	6.72	1.58	76.45	(61.09)	0.89	0.42	51.3 0	(45.74)
S_6	1.98	1.14	37.69	(37.85)	0.75	0.56	24.96	(29.91)
S_7	1.16	1.01	12.27	(20.45)	0.59	0.46	22.11	(27.94)
Mean	5.64	1.20	65.71	(54.89)	0.96	0.37	54.88	(41.18)

Figures in parenthesis indicate arcsine value							
	SEd	0.691	0.154	3.376	0.042	0.034	12.146
CD (P=0.05)		1.482	0.331	7.242	0.091	0.073	26.053
S_1=	First week after flower bud initiation		S_4 =	Fourth week after flower bud initiation	S_7 =	Seventh week after flower bud initiation	
S2=	Second week after flower bud initiation		S_5 =	Fifth week after flower bud initiation			
S_3=	Third week after flower bud initiation		S_6 =	sixth week after flower bud initiation			

Table 2: Total seed flower^{-1}, Filled seed flower^{-1}, Ill filled seed flower^{-1} and 100 seed weight (g) recorded at different stages of maturity in hybrid marigold

Stages of maturation	**Total seed flower^{-1}**	**Filled seed flower^{-1}**	**Ill filled seed flower^{-1}**	**100 seed weight (g)**
S1	-	-	-	-
S2	196	48	148	0.086
S3	228	95	133	0.150
S4	251	205	46	0.310
S5	261	232	29	0.360
S6	270	254	16	0.390
S7	270	249	21	0.320
Mean	**246**	**180.5**	**65.5**	**0.270**
SEd		6.621	6.097	4.455	0.008
CD (P=0.05)		14.202	13.079	9.557	0.017
S_1	= First week after flower bud initiation		S_4 =	Fourth week after flower bud initiation	S_7 =	Seventh week after flower bud initiation
S2	= Second week after flower bud initiation		S_5 =	Fifth week after flower bud initiation		

Table 3: Mean germination (%), root length (cm), shoot length (cm), drymatter production (g seedling^{-10}) and vigour index as measured at different stages of maturity in hybrid marigold

Stages of maturation	**Germination (%)**	**Root length (cm)**	**Shoot length (cm)**	**Drymatter production (g seedling^{-10})**	**Vigour index**
S1	-	-	-	-	-
S2	-	-	-	-	-
S3	15	3.08	2.71	0.002	83
	(21.48)				
S4	19	6.80	5.73	0.008	261
	(24.63)				
S5	90	7.35	6.85	0.023	1279
	(71.65)				
S6	97	11.13	7.97	0.033	1855
	(83.00)				
S7	91	8.40	5.67	0.019	1281
	(75.00)				
Mean	**62**	**7.77**	**5.78**	**0.017**	**952**
	(55.22)				
SEd	5.993	0.738	0.414	0.002	75.158
CD (P=0.05)	12.464	1.536	0.861	0.004	156.302
S_1=	First week after flower bud initiation	S_4 =	Fourth week after flower bud initiation	S_7 = Seventh week after flower bud initiation	
S_2=	Second week after flower bud initiation	S_5 =	Fifth week after flower bud initiation		
S_3=	Third week after flower bud initiation	S_6 =	sixth week after flower bud initiation		

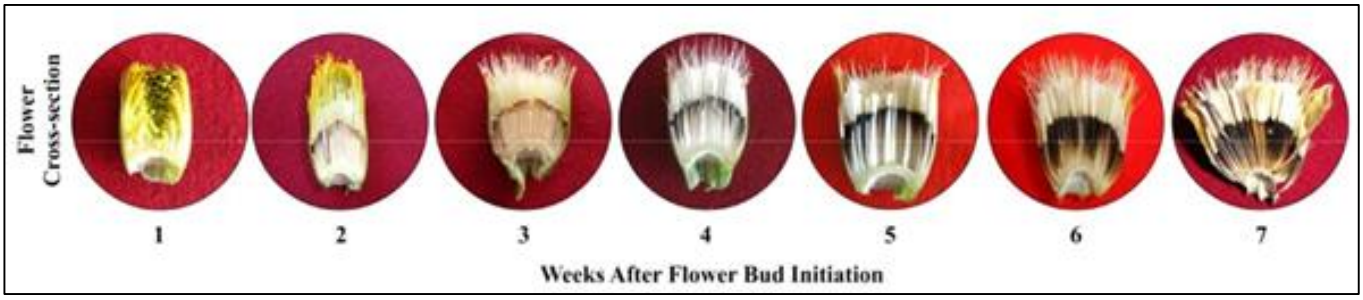

Fig 1: Stages of seed development and maturation in marigold

References

1. Abdul-Baki AA, JE Baker. Are changes in cellular organelles and membranes related to vigour loss in seeds? Seed Sci. & Technol. 1973; 11:89-125.
2. Alam AV, IR Cough, CR Creger. Fatty acid composition of the xanthophyll esters of *Tagetes erecta* petals. Lipids. 1968; 3:183.
3. Chandginam P, K Choudhury, R Singh. Farm University status of wheat production. Seed and Farms, 1987; 39-40.
4. Demir I, AM Ashirov, K Mavi. Effect of seed production environment and time of harvest on tomato (*Lycopersicon esculentum*) seedling growth. Res. J Seed. Sci. 2008; 1:1-10.
5. Harrrington JK. Biochemical basis of seed longevity. Seed Sci. and Technol. 1973: 1:453-461.
6. Jerlin R. Seed Technological studies in Pungam (*Pongamia pinnata*), Ph.D Thesis, Tamil Nadu Agricultural University, Coimbatore, 1999.
7. Loveys BR, CJ Brien, PE Kriedemann. Biosynthesis of abscisic acid under osmotic stress. Studies based on a dual labeling technique. Physiol. Plant. 1975; 33:166-170.
8. Mehta CJ, MS Kuhad, IS Sheoran, AS Nandwal. Studies on seed development and germination in chickpea cultivars. Seed Res. 1993; 21(2):89-91.
9. Milthorpe FL, J Moorthy. An introduction to crop physiology. Cambridge Univ. Press. 1979, 174.
10. Miyajima D. Zinnia seeds harvest time affects germination and plant growth, Hort. Sci. 1997; 32(4):687-689.
11. Natarajan K. Seed technological studies in marigold (*Tagetes erecta* L.) cv. African giant. M.Sc (Ag) Thesis, Tamil Nadu Agricultural University, Coimbatore, 2000.
12. Selvakumari A. Seed technological studies in china aster (*Callistephus chinensis*) cv. Poornima. M.Sc. (Ag.) Thesis, Tamil Nadu Agricultural University, Coimbatore, 2005.
13. Tupper CR. Physical characteristic of cotton seed related to seedling vigour and design parameters for seed selection. Ph.D. Thesis, Texas A and M Univ. College Station Univ., Microfilms, Ann & Arbor. Mich. (Diss ; Abst. No. 1969; 70:9727.