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Studies on phenology and floral biology in *Moringa oleifera* Lam

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ABSTRACT
Studies were carried out at the Department of Horticulture, Pandit Jawaharlal Nehru College of Agriculture and Research Institute Karaikal during September 2003 to December 2004 to gather information on floral biology in moringa (Moringa oleifera Lam.) cvs. PKM 1 and PKM 2. Flowering was observed throughout the year and peak flowering was recorded during April – May and September – October and peak fruiting observed during May and October for summer and rainy season. Anthesis continued throughout the day with two peak time at 9.30 am and 6.30 pm. Stigma was receptive a day prior to opening and continued upto the day of opening with maximum receptivity. Pollen grains exhibited good germination and maximum pollen tube growth was noticed in 15 per cent sucrose medium. Pollen viability per cent on acetocarmine staining method was 98 per cent in PKM 1 and 99 per cent in PKM 2. Pollen grains stored in refrigeration (3^0 C) lost viability within seven days under room temperature (25^0 – 30^0 C) within three days.

Key words : Floral biology, Moringa, Anthesis, Stigma receptivity, Pollen tube growth

INTRODUCTION

The knowledge of floral biology is a pre-requisite for embarking upon a crop breeding and hybridization programme. The success of pollination and fertilization depends upon whether the signals carried by the pollen are recognized by the receptors in the stigma, pollen viability, pollen germination, pollen production and other pollination steps. Moringa (Moringa oleifera Lam) is one of the commercial vegetable crop in India especially in South India in which time of anthesis, anther dehiscence, pollen viability and germination and stigma receptivity and fruit set studies have not been undertaken in detail. More over in this crop, even though thousands of flowers were produced per tree, but fruits are a not developed from all the flowers formed. The fruit yield can be increased if the knowledge of exact floral biology, varieties and seasonal effects were known to the growers and researchers. Therefore the present investigation was carried out on floral biology of two moringa varieties (PKM and PKM 2) in summer and rainy season which will serve as a guide to the breeder to develop efficient breeding and management researchers to maximize fruit yield.

Materials and Methods: The experimental material consisted of two varieties of moringa viz PKM 1 and PKM 2. Twenty five bearing plants in each variety were selected and marked for recording observation on duration of flowering, monthly count of total inflorescence and fruits produced during each month, anthesis time, stigma receptivity, pollen production, viability, pollen tube growth, pollination study and fruit set was carried out in summer and rainy reasons in two varieties.

RESULTS AND DISCUSSION

The results of the present study on Phenology and floral biology revealed that the moringa flowered throughout the year. There were two peaks of flowering viz October – November (rainy season) and April – May (summer season) with corresponding two fruiting peaks during October (rainy) and May (summer) in both the varieties. Continuous flowering and fruiting in moringa was reported by Pushpaganthan *et al*. (1996) and Sindhu (2002). The two periods of peak fruiting in moringa was reported by Muthuswamy (1954) and Indira and Peter (1988) in South India support the present finding (Table.1). There were two anthesis peaks ,one at 9.31 to 10. 00 am. and second around at 6.31 to 7.00 pm on the same day in both the varieties during summer and rainy season (Table.2) which was earlier reported by Jyothi *et al.* (1990) and Babu and Rajan (1996) in moringa support the present finding of two peaks rather than one peak flowering in moringa which was reported by Devar *et al*. (1981) and Subramanian *et al*. (1997).

The stigma was receptive one day prior to opening and continued with maximum receptivity 88 and 96 percent based on pollen adherence and 72 and 84 percent in PKM1 and PKM2 by controlled pollination on the day of opening and a sudden decline in receptivity there after (Table.3). This is in agreement with the findings of Devar etal (1981) and Ashish *et al*. (2003) in moringa. The results of the estimation of pollen production revealed that the average pollen count per anther in summer season was 8000 and the total pollen per flower was 38,000 in PKM1 and in PKM2 it was 8100 and 38500. In rainy season, the count was 7675 and 36500 in PKM1 and 7900 and 37250 in PKM2 respectively. Higher pollen production might have contributed to the better fruit set and higher fruit production in summer season as reported by Sindhu (2002) was in line with the present finding.

Pollen grains failed to germinate in water in the in-vitro germination studies. High pollen germination percentage and pollen tube growth was obtained in 5 to 20 percent sucrose media with highest values observed in 15 percent sucrose and thereafter a slight decline was noticed which support the findings of Sindhu(2002) in moringa that 15 percent sucrose recorded highest values (Table.4) for pollen tube growth.

In pollen storage studies under refrigerated condition, viability decline to a negligible level with in seven days and under room temperature, viability totally last with in 3 days. Refrigeration has been reported to extend the viability in cocoa (Simmons, 1976) supports the present finding in moringa.

The fruit set percentage (Table.5) was 42.00, 16.00, 32.00, 64.00 in PKM 1 and 47.20, 24.00, 36.00, 68.00 in PKM2 under natural pollination, natural selfing, natural crossing and assisted crossing respectively. Maximum fruit set was obtained in assisted crossing (64.00 and 68.00 per cent) in both the varieties. The flowers which were emasculated and bagged, did not set any fruit revealing that the entomophilous nature of the crop. The results fully agree with the findings of Devar *et al*. (1981) moringa.

Table1 : Phenlogy of flowering, fruiting in moringa CVRS. PKM1 and PKM2

Month	Total number of inflorescence per tree		No. of flowers per inflorescence		Total number of fruits produced per tree	
	PKM 1	PKM2	PKM1	PKM2	PKM1	PKM2
Rainy Season October 2003	308	227	12195	589	106	90
November 2003	240	210	9210	4812	95	78
December 2003	141	196	3362	4158	46	60
January 2004	23	55	1795	2815	31	28
February 2004	75	68	6110	3153	64	36
Summer Season March 2004	218	105	6321	7210	86	75
April 2004	285	264	10554	11246	158	158
May 2004	308	285	11026	10141	171	189
June 2004	264	245	7154	6754	141	114
July 2004	227	228	6143	5992	85	85
August 2004	246	185	5754	5027	58	64
Rainy Season September 2004	285	207	7785	4223	79	76

Table 2 : Anthesis in moringa CVRS PKM 1 and PKM2

Time	Mean number of flowers opened in an inflorescence			
	PKM 1		PKM2	
	Summer season	Rainy season	Summer season	Rainy season
8.00am to 8.30 am	09	11	08	11
8.31 to 9.00 am	10	13	10	12
9.01 to 9.30 am	11	15	10	14
9.31* to 10.00 am	14	17	13	18
10.01 to 10.30 am	7	11	8	12
10.31 to 11.00 am	5	8	6	9
11.01 to 12.00 am	5	7	4	9
11.01am to5.00 pm	Less than 2 flowers opened			
5.01 to 5.30 pm	11	14	10	10
5.31 to 6.00 pm	12	14	12	13
6.01 to 6.30 pm	13	17	12	14
6.31 * to 7.00 pm	18	21	17	20
7.01 to 7.30 pm	12	15	14	16
7.31 to 8.00 pm	10	12	11	16
8.01 to 8.30 pm	8	10	10	12
8.31 to 9.00 pm	7	9	9	11
9.01 to 9.30 pm	6	9	8	10
9.31 to10.00 pm	6	8	5	9
10.01 to11.30 pm	Less than 2 flowers opened			
11.31 to 5.00 am	No flowers opened			
5.31 to 6.30 am	5	7	6	8
6.31 to 7.30 am	6	8	7	9
7.31 to 8.00 am	8	10	7	10

* Peak time of anthesis - 9. 31 to 10. 00 am to 6. 31 to 7. 00pm

Table 3 : Stigma receptivity in moringa CVRS PKM1 and PKM2 based on pollen grain adherence and fruit set after controlled pollination.

Variety	Stage of flower	Total number of flowers observed in each variety	Pollen grain adherence		Fruit set after controlled pollination	
			No. of stigma with sticky surface	Percent	No. of stigma with sticky surface	Percent
PKM1	One day prior to opening	25	15	56	11	44
	On the day of opening	25	23	88	18	72
	One day after opening	25	4	12	01	04
PKM2	One day prior to opening	25	17	64	14	56
	On the day of opening	25	24	96	21	84
	One day after opening	25	7	16	3	18

Table4. Loss in pollen viability on storage under refrigeration and loom temperature is moringa CVRS PKM1 and PKM2.

Days of Storage	Refrigerated storage (3^0C)						Room temperature (25 – 30^o C)					
	Staining (%)		Germination (%)		Pollen tue growth (10 x 45 x) M		Staining (%)		Germination (%)		Pollen tube growth (10 x 45 x) M	
	PKM1	PKM2	PKM1	PKM2	PKM1	PKM2	PKM1	PKM2	PKM1	PKM2	PKM1	PKM2
1.	97	98	86.89	97.78	280.00	282.80	96.00	96.98	86.00	86.86	98.26	98.46
2.	90	91	80.61	81.51	245.90	248.6	55.73	56.34	18.00	20.00	-	-
3.	82	84	73.44	75.23	142.53	146.0	22.72	23.27	7.00	8.00	-	-
4.	79	78	70.75	69.85	120.70	119.6	-	-	-	-	-	-
5.	65	67	58.21	59.99	70.75	73.0	-	-	-	-	-	-
6.	60	62	53.73	55.51	44.02	45.5	-	-	-	-	-	-
7.	41	40	36.71	35.81	29.36	28.6	-	-	-	-	-	-

Table.5. Fruit set in Moringa CVRS PKM1 and PKM2 under different methods of pollination

Sl.No.	Methods of pollination	Number of flowers under observation in each variety	Fruit set (Number)		Fruit set (Per cent)		Remarks
			PKM1	PKM2	PKM1	PKM2	
1.	Flower buds merely bagged	25	10.50	11.80	42.00	47.20	Natural pollination (Open pollination)
2.	Flower buds not emasculated but bagged	25	4.00	6.00	16.00	24.00	Natural sefing (self pollination)
3.	Flower buds emasculated and kept open	25	8.00	9.00	32.00	36.00	Natural out crossing
4.	Emasculated crossed and bagged	25	16.00	17.00	64.00	68.00	Assisted crossing (Hand pollination)
5.	Emasculated and bagged	25	-	-	-	-	No pollination

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