Available online at www.ijpab.com

DOI: http://dx.doi.org/10.18782/2320-7051.5799

ISSN: 2320 – 7051

Int. J. Pure App. Biosci. **6 (1):** 1069-1075 (2018)

Research Article

International Journal of Pure & Applied Bioscience

OPEN ACCESS

Studies on Pollen Viability in Accessions of Jackfruit during 2014-15 and 2015-16

Shafeeq Bawoor[1*], Prakash Patil[2], A. Rekha[3], K. S. Shivashankara[2] T. R. Guruprasad[3] and V. Devappa[1]

[1]Ph.D Scholar, [2]Project Co-ordinator (Fruits), [1]Prof. & Head, Dept. Plant Pathology, [2]Principal Scientist, Division of Plant Physiology and Biochemistry, [2]Principal Scientist, Division of Fruit Crops,
[1]University of Horticulture Sciences Bagalkot, College of Horticulture, Bangalore-560 065
[2]Research conducted at ICAR-Indian Institute of Horticultural Research (IIHR), Hessarghatta, Bengalore
[3]ADRE, RHREC, GKVK, Bengaluru – 65

*Corresponding Author E-mail: shafeeqfsc@gmail.com

Received: 28.09.2017 | Revised: 25.10.2017 | Accepted: 1.11.2017

ABSTRACT

Jackfruit yield is affected due to sudden cold snap during flowering phase. The response of pollen viability to low temperature regimes was studies to determine the suitable condition hence, the study was carried out on pollen viability studies in different accessions of jackfruit at the PGRI laboratory ICAR-Indian Institute of Horticultural Research (IIHR), Hessaraghatta Lake Post, Bangalore-89.During 2014-15 and 2015-16, the pollen viability were recorded with four different chemicals viz., A); Control (distilled water), B);10% sucrose solution, C); 10% sucrose solution+20ppm boric acid and D); 10% sucrose solution+200 ppm $Ca(No_3)_2$+200 ppm $MgSo_4$+100 ppm $K(No_3)_2$+100 ppm boric acidwere tried at 28.5 °C (ambient temperature). Among the four different chemical treatment the maximum pollen viability were recorded the treatment D) 32.24 per cent followed by the chemical treatment C)29.70 per cent, B) 27.12 per cent and the minimum pollen viability were recorded in the treatment A) 22.72 per cent. During 2014-15 and 2015-16, the pollen viability also studied with different timing hour's intervals viz., 2hr, 4hr, 6hr and 8hr among the different time interval 6hr with respect to different chemicals followed by 4hr, 8hr time intervals and minimum pollen viability were found 2hr timing. Among the accessions the accessions A-7, A-6 and A-5 were recorded maximum pollen viability whereas the minimum pollen viability were recorded in the accession A-4 with respect to different chemicals treatments and different timing intervals during both the year of study.

Key words: *In-vitro germination, Pollen viability, Artocarphus heterophyllus L. Temperature, Flowering, Fruit setting*

INTRODUCTION

Jackfruit (*Artocarpus heterophyllus* L.) belongs to the family Moraceae, It has been reported that it is tetraploid with a somatic chromosome number of 56 (2n=4x=56)[1,3]. The jackfruit tree is monoecious, having male and female inflorescence or spikes on the same tree. The male and female spikes are borne separately on short, stout stems that sprout from older branches and the trunk.

Cite this article: Bawoor, S., Patil, P., Rekha, A., Shivashankara, K. S., Guruprasad, T. R. and Devappa, V., Studies on Pollen Viability in Accessions of Jackfruit during 2014-15 and 2015-16, *Int. J. Pure App. Biosci.* **6(1):** 1069-1075 (2018). doi: http://dx.doi.org/10.18782/2320-7051.5799

The male flowers which was maximum anthesis flowering are more pollen germinability by Newstrom*et*[8] and which can greater contribution for crossing of the variety. At the beginning, male inflorescences were light green with a smooth surface, becoming yellowish and rough when anthers appear[11]. They were cylindrical or barrel-shaped, 8-11 cm long and 3-5 cm wide at the time of maximum pollen presentation. At the maximum pollen presentation, the male inflorescences were densely covered with minute white milky flowers. Each male inflorescences of flower had a 500 stamen with a 2.5-4.5 mm long filament and a bilocular anther containing four pollen sacs. After longitudinal dehiscence, the Male inflorescences occur mainly on the terminal shoots and branches of the tree's crown and also in the main stem. At the beginning, male inflorescences were light green with a smooth surface, becoming whitish yellow and rough when anthers appear. After longitudinal dehiscence, theyellow anthers became ashy-greycolour and black mould fruiting bodies often appeared on the surface of the male inflorescences and gradually turn black due to the appearance of fruiting bodies of the black mould before they dropped off. The pollen viability Understanding of various factors influencing pollen germination and tube growth are a prerequisite for the success of hybridization program[2,7]. Viable pollen will help in giving successful result for plant breeders in breeding programme which requires huge expenditure of time as well as money. Some of the factors which influence pollen germination and tube growth in plants are carbohydrate (sugar), boron, calcium, enzymes, plant hormones, magnesium, potassium, agar, pH and certain physical factors such as temperature and light. The requirements are species specific[5]. So far, no pollen viability and pollen germination and tube elongation studies on Nepenthes khasiana are known to have been published. Since, pollen grains are the microspores which give rise to male gametes and which takes important role in fertilization, the objective of this chapter was to study the pollen viability studies on different accessions of jackfruit. This investigation could provide information to explore important aspects of plant reproduction.

MATERIAL AND METHODS

The present investigation on 'pollen viability studies on different accessions of jackfruitduring 2014-15 and 2015-16' was carried out at the PGRI laboratory ICAR-Indian Institute of Horticultural Research (IIHR), Hessaraghatta Lake Post, Bangalore-560089.The materials and methods used, techniques adopted and observation recorded during the course of the investigations are furnished in this chapter. The five male flowers were selected and tagged a day before anthesis to study pollen viability. The next day, the freshly dehisced flowers with pollen were brought to the lab and the pollen separated and studied under a magnifying glass. Meanwhile, different chemical treatments were prepared to study pollen viability and these treatments kept for varied hours (2, 4, 6 and 8hr hours) at ambient temperature.

A) Control (distilled water)

B) 10% sucrose solution

C) 10% sucrose solution+20 ppm, boric acid

D) 10% sucrose solution+200 ppm $Ca(No_3)_2$+200 ppm $MgSo_4$+100 ppm $K(No_3)_2$+100 ppm boric acid The freshly dehisced pollen grains were dusted on a drop of solution on grooved slides and thoroughly mixed by using a needle. The moist Petri dishes containing these slides were kept at 28.5^{o}C for 8 hr, which was found essential for initiating pollen germination. The germinated and non-germinated pollen grains were counted for 10 accessions covering not less than 200 grains. The number of stained (viable) and no stained viable (non-viable) pollens was recorded and the values expressed in percentage. The experimental design was completely randomized design (CBD) 10 accessions and 3 replications). For statistical analysis purposes, the germination percentage and viability data of the pollen grains was

submitted to arcsine square root transformation xX/100 (Sorkheh & Amini 2010). The pollen grains were then submitted to ANOVA using the F-test, in which measurements were compared by means of the Scott-Knott test ($p<0.05$). Analysis was carried out using the SAS Program (SAS, 2010).

RESULTS AND DISCUSSION

The observations on per cent pollen viability at ambient temperature of different jackfruit accessions are presented in Table 1 and 2. During 2014-15 and 2015-16, their respective of different jackfruit accessions maximum pollen viability was observed in as a control (Distilled water) with 8 hr of incubation period at 28.5°C temperature. The accession A-1 (25.66 %) and (23.66 %) recorded maximum pollen viability whereas, accessions A-7 (25.55 %), A-6 (24.17 %), A-5 (22.01 %) and A-7 (23.08 %), A-7 (21.79 %), A-6 (21.8 %), (20.49 %) respectively, which were on par with each other and minimum pollen viability was noticed in A-3 (15.74 %) and (14.51 %) respectively at 6 hr of incubation period. During 4 hr significantly maximum pollen viability (23.39 %) and (21.33 %) respectively were observed in accession A-7 which was at par with accessions A-6 (22.34 %), A-1 (21.83 %) and A6 (20.81 %), A-1 (20.63 %), A-5 (18.15 %), A-8 (17.86) whereas, the minimum pollen viability was observed in accession A-3 (13.12 %) and A-10 (12.18 %) respectively. During 2014-15 and 2015-16 the maximum pollen viability were observed in accession A-1 (17.27 %) and A-4 (15.55 %) respectively which was on par with accessions A-7 (17.26 %), A-6 (16.85 %), A-8 (16.55 %), A-5 (15.85 %) and A-6 (15.46 %), A-5 (15.45 %), A-7 (15.38 %), A-8 (15.35 %), A-1 (14.92 %), A-9 (14.39 %) respectively, the minimum pollen viability was observed in accession A-3 (11.99 %) and A-3 (11.53 %) at 8 hr of incubation period, respectively. During 2 hr of the pollen viability showed significantly maximum pollen viability was recorded in accessions A-8 (16.19 %) and A-6 (14.67 %) respectively whereas, accessions A-1 (16.11 %), A-6 (15.75 %), A-7 (15.11 %) and A-8 (13.93 %), A-1 (13.78 %), A-7 (13.64 %), A-5 (13.53 %) respectively which were on par with each other and minimum pollen viability was noticed in accession A-10 (9.47 %) and (9.14 %) respectively. During 2014-15 and 2015-16 the data revealed that, irrespective of different jackfruit accessions maximum pollen viability was observed in as a 10% sucrose solution with 8 hr of incubation period at 28.5°C temperature accession A-2 (35.45 %) and (34.72 %) recorded maximum pollen viability whereas, accessions A-5 (33.20 %), A-6 (32.96 %), A-4 (32.92 %), A-3 (32.56 %), A-7 (29.26 %) and A-3 (33.32 %), A-6 (32.96 %), A-5 (32.82 %), A-1 (32.36 %), A-4 (31.94 %) respectively on par with each other and minimum pollen viability was noticed in A-10 (24.25 %) and (25.50 %) at 6 hr of incubation period. During 4 hr the significantly maximum pollen viability (30.56 %) and (30.17 %) was observed in accession A-2 which was at par with accessions A-1 (29.31 %), A-4 (28.87 %), A-3 (27.13 %) and A-4 (28.31 %), A-1 (28.11 %) respectively whereas, the minimum pollen viability was observed in accession A-9 (20.66 %) and (20.37 respectively). The maximum pollen viability were observed in accession A-7 (22.59 %) and A-1 (21.91 %) respectively which was on par with accessions A-1 (22.43 %), A-6 (21.10 %) and A-7 (21.84 %), A-6 (20.37 %) respectively whereas, the minimum pollen viability was observed in accession A-3 (14.35 %) and A-10 (14.46 %) respectively at 8 hr of incubation period. During 2 hr the significantly maximum pollen viability was recorded in accession A-7 (23.70%) and (23.28 %) respectively whereas, accessions A-6 (22.59 %), A-8 (21.69 %), A-2 (21.10 %), A-3 (20.55 %), A-5 (20.46 %), A-4 (19.29 %) and A-6 (21.48 %), A-2 (20.33 %), A-8 (20.14 %), A-3 (19.93 %), A-5 (19.70 %) respectively which were on par with each other and the minimum pollen viability was noticed in accession A-10 (15.91 %) and (15.59 %) respectively. During 2014-15 and 2015-16 the data revealed that, irrespective of different jackfruit accessions maximum pollen viability was observed in as a 10% sucrose solution+20ppm boric acid with 8 hr of

incubation period at 28.5°C temperature accession A-1 (53.27 %) and (52.48 %) respectively recorded higher pollen viability whereas, lowest pollen viability was noticed in A-10 (31.10 %) and A-4 (30.81 %) respectively at 6 hr of incubation period. During 4 hr the pollen viability showed significantly maximum pollen viability (35.64 %) and (34.58 %) was observed in accession A-2 and A-1 respectively, which was at par with accessions A-7 (34.49 %), A-8 (32.69 %) and A-8 (32.84 %), A7 (32.26 %) whereas, the minimum pollen viability was observed in accession A-3 (25.12 %) and A-4 (24.29 %) respectively. The maximum pollen viability were observed in accession A-2 (29.53 %) and (29.89 %) respectively, which was on par with accessions A-1 (28.74 %), A-4 (27.34 %), A-7 (26.44 %) and A-4 (28.26 %), A-2 (27.76 %) respectively whereas, the minimum pollen viability was observed in accession A-9 (19.90 %) and (20.08 %) respectively at 8 hr of incubation period. During 2 hr the significantly maximum pollen viability was recorded in accession A-7, A-8 (24.53%) and A-8 (22.51 %) whereas, accessions A-1 (24.14 %), A-6 (21.74 %), A-10 (15.55 %) and A-7 (22.37 %), A-6 (20.82 %), A-5 (20.07 %) respectively which were on par with each other and minimum pollen viability was noticed in accession A-10 (15.55 %) and A-3 (15.35 %) respectively. During 2014-15 and 2015-16 the data revealed that, irrespective of different jackfruit accessions maximum pollen viability was observed in as a 10% sucrose solution+200ppm $Ca(No_3)_2$+200ppm MgSo4+100ppm $K(No_3)_2$+100ppm boric acid with 8 hr of incubation period at 28.5°C temperature accession. The Maximum pollen viability were, observed in accession A-1 (53.21 %) and A-8 (52.39 %) respectively which was on par with accessions A-7 (50.21 %) and A-1 (51.35 %), A-7 (50.21 %) respectively and the lowest pollen viability was noticed in A-10 (33.73 %) and (30.36 %) respectively, at 6 hr of incubation period. During 4 hr the significantly maximum pollen viability was observed in accession A-7 (42.15 %) and A??accession number (44.08 %) respectively, which was at or on par with accessions A-8 (39.85 %), A-1 (38.39 %) and A-6 (41.20 %), A-8 (40.51 %), A-1 (40.24 %) respectively, whereas, the minimum pollen viability was observed in accession A-4 (25.72 %) and (26.21 %). The maximum pollen viability were observed in accession A-1 (34.21 %) and A-7 (35.25 %) respectively, which was is or were on par with accessions A-7 (31.88 %), A-7 (31.36 %) and A-1 (33.33 %), A-8 (33.09 %) respectively whereas, the minimum pollen viability was observed in accession A-9 (22.97 %) and A-10 (21.11 %) respectively at 8 hr of incubation period. During 2 hr significantly maximum pollen viability was recorded in accession A-7 (34.07%) and (37.59 %) respectively whereas, accessions A-1 (32.71 %), A-6 (32.24 %), A-8 (32.10 %) and A-8 (34.58 %), A-6 (34.47 %), A-1 (33.33 %) respectively which were on par with each other and the minimum pollen viability was noticed in accession A-9 (20.47 %) and A-10 (20.77 %) respectively.

During 2014-15 and 2015-16 the experimental data on percent pollen viability of different jackfruit accessions was observed that the significant differences in pollen fertility between different timing flowers expose at 2hr, 4hr, 6hr and 8hr. Pollen fertility of accessions of jackfruit had significantly higher at 6hr followed by at 4hr and 8hr whereas, lower pollen germination was recorded at 2hr which may be due to indicates that pollen development for this cultivar is highly sensitive to for 2hr.Among ten accessions the accession A-1 and A-7 maximum pollen viability with all different chemicals during both the year of study which may be due to temperature was the most significant environmental factor that influences commercial jackfruit production by affecting the frequency, intensity, duration at the time of flowering. The results indicate that low temperatures adversely affected inflorescence development of all the accessions of jackfruit and appropriate temperature for profuse flowering of jackfruit flower bud size (*i.e.* Length and width). Among all the accessions of jackfruit obtained

maximum size of inflorescence due to its genetic makeup of the plant. Similar kinds of trend were noted by patel *et al.,* 2014 and Sukhvibul *et al.*,1999. The mean temperature 28.5 ºC at that time pollen germination and viability was maximum at all the accessions of jackfruit. During 2014-15 and 2015-16, significantly maximum per cent pollen viability was observed with 10% sucrose solution + 200 ppm $Ca(No_3)_2$ + 200 ppm $MgSo_4$+100 ppm $K(No_3)_2$+100 ppm boric acid and followed by 10% sucrose solution+20 ppm boric acid and 10% sucrose solution whereas, minimum per cent pollen viability was observed in control (Distilled water) which may be due to In-vitro germination in culture medium is a technique that simulates the conditions of the style-stigma, inducing germination and pollen tube growth. Each accession requires a specific protocol of culture medium to obtain adequate pollen grain germination. Some authors have suggested that, the culture medium should contain, in addition to carbohydrates, germination-stimulating substances, such as boric acid, calcium nitrate, potassium nitrate and magnesium sulphate, similar findings were reported by Soares *et al.,*[13], Imani *et al.,*[4]; Khan and Perveen,[6]. According to Stanley and Linskens[15], the gelling agent facilitates the incorporation of sucrose or other stimulants of germination and maintains constant relative humidity and suitable aerobic conditions for adequate pollen grain germination. In breeding programs, it is essential to collect the pollen from an appropriate stage of maturation to maintain the viability and ability to germinate when the hybridization is performed. The idea is consistent with data for several species, reinforcing the notion that the highest and lowest percentages of germinated pollen grains occur during anthesis and post-anthesis, respectively[10]. This has biological implications, as samples collected before the natural flower opening contain immature pollen, which primarily reflects a low rate of germination.

Table 1: Pollen viability studies during 2014 to 2015 in different jackfruit accessions

Accessions	A*					B*					C*					D*				
	2h	4h	6h	8h	mean	2h	4h	6h	8h	mean	2h	4h	6h	8h	Mean	2h	4h	6h	8h	mean
A1	21.95 (16.11)	25.82 (21.83)	28.18 (25.66)	22.77 (17.27)	24.68	23.56 (18.27)	30.42 (29.31)	32.35 (32.73)	26.31 (22.43)	28.16	27.23 (24.14)	33.81 (35.64)	42.87 (53.27)	29.98 (28.74)	33.47	32.35 (32.71)	35.44 (38.39)	43.06 (53.12)	33.18 (34.21)	36.01
A2	18.41 (11.23)	22.47 (16.47)	24.06 (18.72)	19.34 (12.36)	21.07	25.55 (21.10)	31.27 (30.56)	34.01 (35.45)	22.74 (16.95)	28.39	25.08 (20.71)	30.20 (29.14)	33.60 (35.26)	30.42 (29.53)	29.82	28.64 (25.75)	31.93 (31.35)	38.62 (43.65)	29.54 (27.25)	32.18
A3	18.07 (10.87)	19.94 (13.12)	21.95 (15.74)	19.05 (11.99)	19.75	24.82 (20.55)	28.86 (27.13)	31.91 (32.56)	20.53 (14.35)	26.53	21.95 (15.99)	27.95 (25.12)	32.56 (33.14)	28.41 (25.91)	27.72	26.52 (22.47)	28.86 (26.22)	36.45 (39.69)	27.25 (23.61)	29.77
A4	19.05 (11.76)	22.49 (16.18)	25.08 (19.86)	21.40 (14.70)	22.01	24.52 (19.29)	30.63 (28.87)	32.93 (32.92)	23.04 (17.03)	27.78	24.05 (18.72)	29.98 (26.97)	32.35 (32.21)	29.54 (27.34)	28.81	26.78 (22.10)	29.09 (25.72)	34.82 (35.53)	28.87 (25.37)	29.89
A5	20.82 (14.70)	24.08 (19.31)	25.82 (22.01)	21.68 (15.85)	23.10	24.84 (20.46)	27.25 (24.32)	32.35 (33.20)	22.77 (17.36)	26.80	25.08 (19.99)	29.98 (27.79)	35.03 (36.65)	26.78 (22.58)	29.22	27.94 (24.98)	30.63 (29.52)	34.82 (37.10)	29.76 (28.06)	30.79
A6	22.23 (15.75)	26.78 (22.34)	27.95 (24.17)	23.03 (16.85)	25.00	26.78 (22.59)	29.09 (26.30)	32.98 (32.96)	25.82 (21.10)	28.67	26.07 (21.74)	30.19 (28.48)	34.02 (35.21)	27.49 (23.96)	29.44	32.56 (32.34)	35.24 (31.17)	37.44 (41.26)	29.31 (26.77)	33.64
A7	21.95 (15.11)	27.71 (23.39)	29.08 (25.55)	23.56 (17.26)	25.57	27.49 (23.70)	29.09 (26.30)	32.98 (29.26)	26.78 (22.59)	28.55	27.49 (24.54)	33.18 (34.49)	39.41 (46.38)	28.64 (26.44)	32.18	33.81 (34.07)	38.23 (42.15)	42.49 (50.21)	32.56 (31.88)	36.77
A8	22.77 (16.19)	25.05 (19.43)	26.98 (22.31)	23.04 (16.55)	24.46	26.29 (21.69)	28.18 (24.63)	28.81 (25.75)	25.07 (19.86)	27.09	27.95 (24.54)	32.76 (32.69)	39.38 (44.97)	27.49 (23.79)	31.90	32.56 (32.10)	36.85 (39.85)	39.60 (45.02)	32.13 (31.36)	35.28
A9	19.66 (12.68)	21.95 (15.69)	25.08 (20.14)	21.11 (14.57)	21.95	23.50 (18.01)	25.30 (20.66)	29.31 (27.05)	22.50 (16.56)	25.15	23.52 (18.43)	27.95 (25.29)	34.22 (36.44)	24.56 (19.90)	27.56	25.78 (20.47)	29.94 (26.93)	34.01 (33.73)	27.47 (22.97)	29.30
A10	16.76 (9.47)	19.94 (13.25)	22.49 (16.67)	19.34 (12.50)	19.63	21.95 (15.91)	25.82 (21.60)	27.47 (24.25)	21.11 (14.77)	24.09	21.95 (15.55)	28.41 (25.21)	31.93 (31.10)	25.33 (20.38)	26.90	25.08 (20.56)	30.54 (29.64)	32.14 (32.35)	27.47 (24.38)	28.81
Mean	20.17	23.62	25.67	21.43	22.72	24.93	28.59	31.30	23.67	27.12	25.04	30.38	35.54	27.86	29.70	29.20	32.67	37.35	29.76	32.24
	S.Em±	CV	CD @ 1%			S.Em±	CV	CD @ 1%			S.Em±	CV	CD @ 1%			S.Em±	CV	CD @ 1%		
Accessions	0.18	4.53 %	0.70			0.25	5.10%	0.94			0.21	3.95%	0.80			0.24	4.24%	0.93		
A*	0.29		1.11			0.39		1.49			0.33		1.26			0.39		1.47		
Acc X A*	0.59		2.22			0.79		2.99			0.67		2.53			0.79		2.95		

A: Control (Distilled water), B: 10% Sucrose solution, C: 10% Sucrose solution+20ppm Boric acid and D: 10% Sucrose solution+200ppm $Ca(No_3)_2$+200ppm $MgSo_4$+100ppm $K(No_3)_2$+100ppm Boric acid.

Table 2: Pollen viability studies during 2015 to 2016 in different jackfruit accessions

Accessions	A*					B*					C*					D*				
	2h	4h	6h	8h	mean	2h	4h	6h	8h	mean	2h	4h	6h	8h	mean	2h	4h	6h	8h	mean
A1	20.24 (13.78)	25.08 (20.63)	27.01 (23.66)	21.11 (14.92)	23.36	22.77 (17.35)	29.54 (28.11)	31.93 (32.36)	25.82 (21.91)	27.51	25.79 (21.64)	33.39 (34.58)	42.68 (52.48)	29.54 (27.76)	32.85	32.56 (33.33)	36.25 (40.24)	41.92 (51.35)	32.56 (33.33)	35.82
A2	18.08 (11.02)	22.23 (16.35)	23.29 (17.89)	18.72 (11.81)	20.58	25.05 (20.33)	31.06 (30.17)	33.60 (34.72)	23.02 (17.34)	28.18	23.30 (17.54)	30.85 (29.48)	34.22 (35.46)	31.07 (29.85)	29.86	29.08 (27.24)	32.12 (32.56)	39.21 (45.99)	29.07 (27.17)	32.37
A3	17.43 (10.05)	19.34 (12.28)	21.11 (14.51)	18.72 (11.53)	19.15	24.58 (19.33)	28.64 (26.43)	32.56 (33.32)	20.83 (14.56)	26.65	21.68 (15.35)	28.64 (25.85)	32.35 (32.22)	28.17 (25.08)	27.71	27.00 (23.66)	29.76 (28.17)	36.25 (40.01)	27.01 (23.60)	30.00
A4	18.41 (11.11)	22.50 (16.30)	24.08 (18.52)	21.95 (15.55)	21.73	24.07 (18.41)	30.42 (28.31)	32.54 (31.94)	22.50 (16.19)	27.38	23.56 (17.38)	28.18 (24.29)	32.14 (30.81)	30.64 (28.26)	28.63	26.07 (21.73)	28.86 (26.21)	35.64 (38.19)	28.41 (25.46)	29.74
A5	19.96 (13.53)	23.30 (18.15)	24.84 (20.49)	21.39 (15.45)	22.37	24.33 (19.70)	27.25 (24.32)	32.14 (32.82)	22.50 (16.98)	26.56	24.84 (20.07)	29.75 (28.02)	35.03 (37.46)	27.01 (23.46)	29.16	28.62 (25.53)	31.93 (31.10)	33.81 (34.44)	30.20 (28.15)	31.14
A6	21.66 (14.67)	26.07 (20.81)	26.30 (21.18)	22.20 (15.46)	24.06	26.06 (21.48)	27.01 (22.96)	32.98 (32.96)	25.33 (20.37)	27.85	25.58 (20.82)	29.31 (26.77)	34.83 (36.42)	27.49 (23.79)	29.30	33.61 (34.47)	37.24 (41.20)	38.62 (43.83)	28.41 (25.45)	34.47
A7	21.12 (13.64)	26.74 (21.33)	27.95 (23.08)	22.50 (15.38)	24.58	27.48 (23.28)	28.87 (25.45)	31.29 (29.45)	26.54 (21.84)	28.54	26.78 (22.37)	32.77 (32.26)	39.79 (45.08)	28.64 (25.27)	32.00	34.83 (37.59)	38.23 (44.08)	41.34 (50.21)	33.61 (35.25)	37.00
A8	21.09 (13.93)	24.02 (17.86)	26.76 (21.79)	22.22 (15.35)	23.52	25.58 (20.14)	27.48 (23.01)	29.75 (26.61)	25.07 (19.44)	26.97	26.77 (22.51)	32.97 (32.84)	40.18 (46.12)	28.18 (24.72)	32.02	33.81 (34.58)	37.05 (40.51)	43.26 (52.39)	32.98 (33.09)	36.77
A9	18.41 (11.30)	21.11 (14.70)	24.58 (19.61)	20.81 (14.39)	21.23	22.47 (16.27)	25.32 (20.37)	29.31 (26.65)	22.23 (15.94)	24.83	24.32 (18.31)	29.09 (25.44)	35.45 (36.22)	25.56 (20.08)	28.60	26.06 (22.26)	31.71 (31.83)	33.40 (34.90)	27.24 (24.16)	29.60
A10	16.40 (9.14)	19.05 (12.18)	21.11 (14.82)	18.73 (11.80)	18.82	21.68 (15.59)	25.58 (21.31)	28.18 (25.50)	20.83 (14.46)	24.07	21.68 (15.60)	28.41 (25.89)	32.35 (32.72)	26.06 (22.09)	27.12	25.57 (20.77)	29.07 (26.33)	31.50 (30.36)	25.82 (21.11)	29.60
Mean	19.28	19.05	24.70	20.84	21.94	24.41	28.12	31.43	23.47	26.85	24.43	30.34	35.90	28.24	29.73	29.72	33.22	37.49	29.53	32.49
	S.Em±	CV	CD @ 1%			S.Em±	CV	CD @ 1%			S.Em±	CV	CD @ 1%			S.Em±	CV	CD @ 1%		
Accessions	0.19	4.83%	0.72			0.18	3.80%	0.69			0.19	3.56%	0.72			0.20	3.46%	0.76		
A*	0.30		1.14			0.29		1.10			0.30		1.14			0.32		1.21		
Acc X A*	0.61		2.29			0.59		2.20			0.61		2.29			0.64		2.42		

A: Control (Distilled water), B: 10% Sucrose solution, C: 10% Sucrose solution+20ppm Boric acid and D: 10% Sucrose solution+200ppm $Ca(No_3)_2$+200ppm $MgSo_4$+100ppm $K(No_3)_2$+100ppm Boric acid.

CONCLUSION

From the above, foregoing discussion the ambient temperature during anthesis 28.5 ºCresulted of pollen grain which produced fruit setting. During 2014-15 and 2015-16, among the accessions the accession A-1, A-7 and A-6 were recorded maximum pollen viability and with respect to four different chemical treatment the treatment 10% sucrose solution+200 ppm $Ca(No_3)_2$+200 ppm $MgSo_4$+100 ppm $K(No_3)_2$+100 ppm boric acid then the other treatment during both the year of study.

REFERENCES

1. Darlington and Wylie, A. P., Chromosome Atlas of Flowering Plants.*George Allen and Unwin Ltd*. London. **p:** 184 (1956).
2. Farooqi, A. A. and Rao, M. M., Studied on fruit set in some sapota varieties in relation to intra and inter varietal pollination. *Mysore J. Agril. Sci.,* **10:** 28-34 (1976).
3. Habib, A. I., Cited from Samaddar, 1990, *Mysore J. Agril. Sci.,* **6:** 200 (1965).
4. Imani, A., Kazem, B., Saeed, P. and Seiyed, H.M., Storage of apple pollen and in vitro germination. *African J. Agril. Res. Victoria Island*, **6:** p. 624-629 (2011).
5. JOHRI AND VASIL, Pollen viability and Pollen germination on *Nepenthes khasiana*. Publications: Chapter number: **5: Pp.** 115-118 (1961).
6. Khan, S. A. and Perveen, A., Germination capacity of stored pollen of *Abelmoschus esculentus* L. (*Malvaceae*) and their maintenance. *Pakistan J. Botany, Karachi,* **38:** p. 233-236 (2006).
7. Kumari, A., Komal, R., Rajesh, R. and Pande, A. K., In vitro pollen germination, pollen tube growth and pollen viability in *Trichosanthes dioica* Roxb. (*Cucurbitaceae*). *The International Journal of Plant Reproductive Biology, Agra*., **1: p.** 147-151 (2009).
8. Newstrom, L. E., Frankie, G. W. and Baker, H. G., a. A new classification for plant phenology based on flowering patterns in lowland tropical rain forest tree at Selva, Costa Rica. *Biotropica,* **26:** 141-159 (1994).
9. Patel G. D., Dhaduk B.K. And Kapadiya D., Landscape gardening: A tool for

environmental moderation, *J. Environ. Res. Develop.*, **8(3A):** 689-695 (2014).

10. Prasad, P.V. V., Boote, K. J., Allen, J. R., L.H., Longevity and temperature response of pollen as affected by elevated growth temperature and carbon dioxide in peanut and grain sorghum. *Env. Experimental Botany, Oxford,* v. **70: p.** 51-57 (2011).
11. Pushpakumara, D. K. N. G., Floral and fruit morphology and phenology of *Artocarpusheterophyllus* Lam. (Moraceae), *Sri Lankan J. Agric. Sci.,* **43:** 82 – 106 (2006).
12. SAS Institute Inc. Sas/Stat user´s guide: statistics, Version 9.1.3 ed. SAS Institute, Cary. NC. USA (2010).
13. Soares, T. L., Silva, S. O., Costa, M.A.P. C., Santos-Serejo, J. A., Souza, A. S., Lino, L.S. M., Souza, E. H. and Jesus, O.N., In vitro germination and viability of pollen grains of banana diploids. Crop Breeding Applied Biotechnology **8:** 111-118 (2008)
14. Sorkheh, K. and Amini, F., Principle and procedures of multivariate statistical analysis. Tehran. *Daneshparvar Press* (2010).
15. Stanley, R. G. and Linskens, H. F., Pollen biology biochemistry management. *Berlin: Springer Verlag*, **307**p (1974).
16. Sukhvibul, N., Whiley, A.W., Smith, M. K., Suzan, Hetherington, E. and Vithanage V., Effect of temperature on inflorescence and floral development in four mango (*Mangifera indica* L.) cultivars. *Sci. Hort*., **82(1-2):** 67-82 (1999).