



Pollen viability and vigour in interspecific hybrids (*E. guineensis* x *E. oleifera*) of oil palm

(Manuscript Received: 00-00-00, Revised: 00-00-00, Accepted: 00-00-00)

Keywords: *Elaeis*, interspecific hybrids, *in vitro* germination, pollen viability, oil palm

The oil palm (*Elaeis guineensis* Jacq.), a perennial oil yielding crop, is the richest source of vegetable oil in the world and can produce 4-6 MT of palm oil (mesocarp oil) and 0.4 to 0.6 MT of palm kernel oil per ha per annum. Realizing the potential of the crop, oil palm has been identified as the crop for overcoming the vegetable oil shortage in India through its large scale cultivation (Chadha, 2006). The present area under oil palm cultivation is 2.03 lakh hectare.

Oil palm is monoecious and entomophilous perennial which produces distinct male and female flowers in separate inflorescences. Pollen viability and vigour are important for successful pollination and is generally considered to indicate the ability of the pollen grains to perform their function of delivering the sperm cells to the embryo sac following compatible pollination (Shivanna *et al.*, 1991). The viability is greatly affected by quality of the pollen resulting from genetic and environmental factors. Hence, it is important to assess the viability of pollen used in artificial pollination and in breeding experiments (Stone *et al.*, 1995) and to understand the sterility problems in hybridization programmes, fruit breeding programmes and evolutionary ecology.

Inter-specific hybridization is being followed in oil palm for introgression of various traits like dwarfness/compactness, high iodine value, high carotene and vitamin E contents *etc.* from *E. oleifera* into cultivated species *i.e.* *E. guineensis*. Hardon and Tan (1969) have reported inter- and intra-specific variations in pollen viability of oil palm. This necessitates evaluation of the viability

of pollen for carrying out success full breeding programme. Hence, the present study was aimed assessing the pollen quality from inter-specific hybrids of oil palm with respect to viability as well as *in vitro* germination.

The fastest way of analyzing pollen viability is using vital stains that react with pollen enzymes, thereby indicating the presence of intact cellular content. The 2,3,5-triphenyl tetrazolium chloride is the most commonly used tetrazolium salt for pollen viability test. Another commonly used tetrazolium salt is MTT. Both these salts were tried in the present experiment.

In vitro germination is frequently used to determine pollen viability as *in vivo* method is laborious and time consuming. *In vitro* pollen germination rates are considered the best indicator of pollen viability (Shivanna *et al.*, 1991). The present experiment was carried out to assess the pollen quality of population from two inter-specific hybrids (361Eg x 11Eo and 361Eg x 11Eo), developed with *E. guineensis* as female parent and *E. oleifera* as male parent. The population comprised of 44 and 34 palms respectively under each cross with normal D x P as control planted during 2000 and being evaluated at Directorate of Oil Palm Research, Pedavegi, Andhra Pradesh. ANOVA was done in Completely Randomised Design. Bagging of male inflorescence, processing male flowers and collection of pollen was done as per standard procedures.

Pollen germination studies

Medium, consisting of 2.5 per cent sucrose, 100ppm H₃BO₃ and 10 per cent PEG (Tandon *et al.*,

2001), was used for *in vitro* germination studies. The pollen grains were kept for incubation in the humidity chamber under 22 ± 2 °C temperature for two hours before observing at 150 x magnification under Leica microscope. The number of germinated pollen grain in each microscopic field was counted (10 fields each with about 200 pollen grains were observed per sample). A pollen grain was considered germinated when the pollen tube length is more than the diameter of the grain.

Selection of stain for viability test

Of the two stains tested, MTT performed better with high correlation of viability with *in vitro* germination. It did not stain dead or aborted pollen. TTC did not perform well for oil palm pollen, though it is considered as a vital stain for both seeds and pollen for many crop species. Thus, MTT method was used for viability assessment of pollen (new dye for oil palm). Rodriguez-Riano and Dafni (2000) reported that out of four stains tested, MTT and p-phenylenediamine showed high correlation with *in vitro* germination of fresh pollen.

Pollen quality evaluation

Results of the evaluation of pollen viability in inter-specific hybrids indicated that significant variability exist among different crosses as well as between palms within each cross. Among the population of 360Eg x 13Eo hybrid, the viability of pollen was the lowest in P- 13 (44%) and the corresponding germination was 29 per cent (Fig. 1). The highest viability was recorded in P-8 (98%) and P-25 (98%) and the corresponding germination percentages were 98 and 93. The mean viability and germination for the population of 360Eg x 13Eo hybrid was 91 and 84% respectively (Table 1).

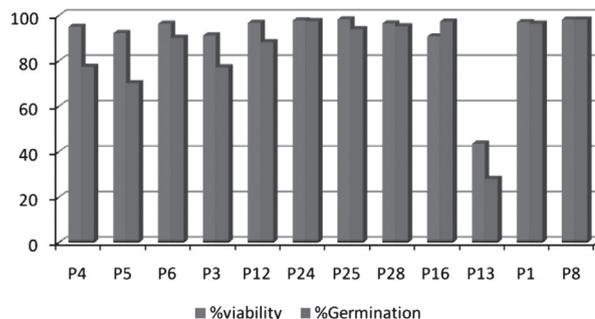


Fig. 1. Variation in pollen viability and germination among interspecific palms of 360D x 13P

In case of hybrid 361Eg x 11Eo, a reduced pollen viability was noticed. P-32 recorded the lowest viability (8%) and germination (5%). The highest value for viability was observed in P-29 followed by P-32, P-42 and P-40. The mean viability of this hybrid was 66 per cent and the mean germination was 63 per cent. The normal tenera (D x P) of *E. guineensis* used as control in the study recorded 83 per cent viability and 81 per cent germination. Hardon and Tan (1969) reported that abnormal cell divisions resulting from incomplete pairing of chromosomes are frequent in interspecific hybrids during pollen grain formation and thus pollen viability and germination are low. As a consequence of poor pollen viability and germination, the fruit set is also low in such hybrid combinations. Alvarado *et al.* (2000) reported pollen viability as low as 6 per cent in some inter-specific hybrids. Consistent yield could be obtained in oil palm especially in inter specific hybrids through use of parents with good pollen viability for breeding purpose. Arnaud (1979) reported that the pollen viability should be more than 70 per cent for use in breeding programmes and if the viability is between 40 and 70 per cent, the same may be used provided

Table 1. Variation in pollen viability and in vitro germination of inter-specific hybrids of oil palm

	Cross ID	No of palms sampled	Mean	Std. Deviation	Minimum	Maximum	F test
Viability (Percent)	360Eg*13Eo	12	91.155	15.24	44	98	*
	361Eg*11Eo	9	66.39	29.41	8	99	
	115D * 176P	2	82.54	11.24	75	91	
Germination (Percent)	360Eg*13Eo	12	84.145	20.03	28	98	NS
	361Eg*11Eo	9	62.75	30.92	5	97	
	115D * 176P	2	80.56	17.712	68	93	

*Significant at 5% level

the pollen is not stored and extra quantity is used for pollinating the female inflorescences. Moreover, the progenies should have enough quantity of viable pollen for enabling sufficient fruit set. This becomes relevant when there are less number of plants with male phase and also in monsoon season when the insect activity as well as pollen density in the air is reduced. Sharma and Tan (1990) found a decrease in fruit set in hybrid block when the adjacent *E. guineensis* field was felled for replanting, suggesting the importance of pollen quality and quantity in fruit set and yield.

The linear regression between viability and germination was found to be 0.963 (Fig. 2) which indicated that there is high correlation between the two observations and the procedures adopted for viability and germination tests are effective in assessing pollen quality.

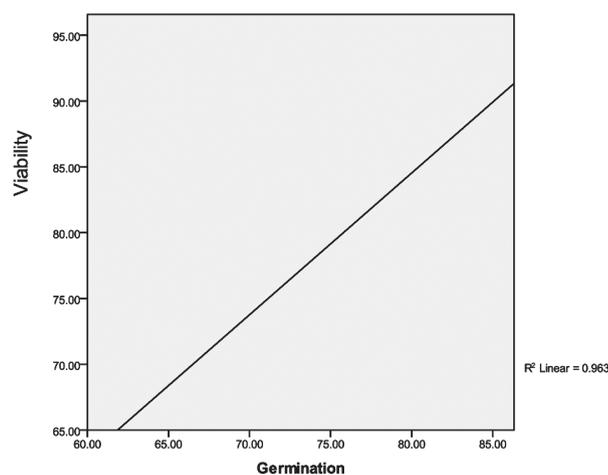


Fig. 2. Linear regression of pollen Germination Vs Viability percent

The reproductive nature in interspecific hybrid palms is of interest mainly because it indicates the yield potential and in turn quantity of oil that can be obtained. More number of parthenocarpic fruits has been reported in some interspecific hybrids, which means less quantity of extractable oil. There is possibility of high density planting upto 200 palms using interspecific hybrids. Full or partial bunch failure due to poor fruit set has been reported in inter-specific hybrids.

Evaluation of pollen viability in inter-specific crosses indicated that significant variability exist

among different crosses as well as between palms within each cross. In the 360Eg x 13Eo cross, the pollen viability was high with a mean of 91 per cent. The mean *in vitro* germination for this hybrid was 84 per cent. In case of 361Eg x 11Eo, reduced pollen viability was noticed with a mean of 66 per cent where the *in vitro* germination was 63 per cent. Thus, it was clear that 360Eg x 13Eo will be a more effective interspecific hybrid with regard to fruit set and bunch yield compared to 361Eg x 11Eo. Studies in pollen viability and germination has resulted in identification of interspecific hybrids and selection of compatible parents having sufficient pollen viability and fruit set.

Inter-specific hybridization in oil palm was taken up for introgression of various traits like dwarfness/compactness, high iodine value, high carotene and vitamin E contents *etc.* from *E. oleifera* (American oil palm) into the cultivated species *ie.* *E. guineensis* (African oil palm). Assessment of pollen viability has become imperative due to the variability observed in pollen fertility and seed set as noticed in F1 progenies. The present study revealed that significant variability exists among different crosses as well as between palms within each cross. Out of the two crosses studied, 360Eg x 13Eo had high pollen viability and *in vitro* germination, indicating that it will be more effective in development of interspecific hybrids.

References

- Alvarado, A., Bulgarelli, G. and Moya, B. 2000. Pollen germination in populations derived from a hybrid of *Elaeis guineensis* and *E.oleifera*. *ASD Oil Palm Papers* **20**:32-34.
- Arnaud, F.1979. La pollinisation assistee dans les plantations de palmiers a huile. Recolte et conditionnement du pollen. *Oleagineux* **34**(4): 175-176.
- Chadha, K.L. 2006. Progress and Potential of Oil Palm in India. Report of the Committee to reassess fresh/potential areas of Oil Palm in India. Department of Agriculture and Co-operation, Govt. of India, New Delhi. 214 p.
- Hardon J.J. and Tan G.Y. 1969. Interspecific hybrids in the genus *Elaeis*.I. Crossability, cryogenetics and fertility of F₁ hybrids of *E. guineensis* X *E. oleifera*. *Euphytica* **18**: 372-379.
- Rodriguez-Riano, T. and Dafni, A. 2000. A new procedure to assess pollen viability. *Sex Plant Reprod.* **12**: 241-244.

- Sharma, M. and Tan, Y.P. 1990. Performance of the *Elaeis oleifera* X *Elaeis guineensis* (OG) hybrids and their backcrosses. In: *Proc 1989 Int. Palm oil Dev. Conf.-Agriculture* (Ed.) Jalani, B.S. Palm Oil Res. Inst. Malaysia, Kuala Lumpur. pp. 40-43.
- Shivanna, K.R., Linkens, H.F. and Cresti, M. 1991. Pollen viability and pollen vigour. *Theor. Appl. Gen.* **81**: 34-42.
- Stone, J.L., Thomson, J.D. and Dent-Acosta, S.J. 1995. Assessment of pollen viability in hand pollination experiments: a review. *American Journal of Botany* **82**:1186-1197.
- Tandon, R., Manohara, T.N., Nijalingappa, B.H.M. and Shivanna, K.R. 2001. *Annals of Botany* **87**: 831-838.

Directorate of Oil Palm Research,
Pedavegi - 534 450, West Godavari District,
Andhra Pradesh

K. Sunilkumar
R.K. Mathur
D.S. Sparjanbabu
A.G.K. Reddy

*Corresponding Author: sunilk.icar@gmail.com