

TEMPERATURE, pH AND GENOTYPE INTERACTIONS AFFECTING POLLEN GERMINATION AND TUBE GROWTH IN *CARICA PAPAYA* L.

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Abstract

A study was made to investigate the temperature and pH at which maximum germination of pollen and growth of pollen tube take place in *Carica papaya*. Maximum germination and pollen tube growth were obtained at 27°C and pH 6.5. However, the differences among various levels of temperature and pH were statistically nonsignificant.

To study the effect of genotype and the effects of temperature and pH over a wider range, 3 x 3 factorial experiments under three temperatures were planned in completely random design. Three dioecious male plants of papaya represented the genotypes. Effects of these factors were highly significant both for germination percentage and pollen tube growth. All the first degree interactions and the second degree interaction for both the variables were found to be highly significant as well.

Introduction

The available reports on the *in vitro* germination of *Carica papaya* pollen indicated that variation exists for the optimal concentration of sucrose in the medium within this species (Kwack, 1965; Chitale & Deshpande, 1970; Eng & Rao, 1968; Sharma & Bajpai, 1969; Nafees & Vahidy, 1973). These conflicting reports may be because of the interaction between strain and nutrient requirements as this type of interaction has been found in other plant species (Vasil, 1960; Pfahler, 1968). The germination percentage and tube growth were affected by pH of the medium as well. (Kwack, 1965) The effect of temperature on the germination of papaya pollen has not been reported, however, Mekako (1972) found significant differences among replications and suspected that this was because of the fluctuations in laboratory temperature.

The present investigation was made to study the effects of temperature and pH in narrow and broad ranges on pollen germination and tube growth in *C. papaya*. The significance of the interactions among these factors and genotype was also evaluated.

Materials and Methods

Four levels of temperature, 21, 24, 27 and 30°C and four levels of pH, 4.5, 5.5, 6.5 and 7.5 were used. To study the effect of genotype and the effects of temperature and pH over a wider range three experiments (for three levels of temperature, viz; 17, 27 and 37°C) were planned. These were 3 x 3 factorial experiments in completely randomized design. The three levels of pH of culture medium were 4.0, 6.0 and 8.0. Pollen was collected just after anthesis from dioecious male plants representing three genotypes. Culture medium used was same as described by Brewbaker & Kwack (1963)

TABLE 1. Planned comparisons to test the difference in temperature.

Comparisons	Pollen germination	Pollen tube growth
17°C Vs. 27°C.		
Mean difference	65.22	1,244.83 microns
St. error of differences	4.47	107.54
t-value	14.59***	11.58***
17°C Vs. 37°C.		
Mean difference	44.50	260.11 microns
St. error of differences	7.79	91.00
t-value	5.71***	2.86 n.s.
27°C Vs. 37°C.		
Mean difference	20.72	984.72 microns
St. error of differences	9.02	129.17
t-value	2.30*	7.62***

n.s. non significant.

*significant at 0.05 level of probability.

***significant at 0.001 level of probability.

supplemented with 5% sucrose since this concentration was found to be the best for pollen germination in *C. papaya* (Nafees & Vahidy, 1973). After incubation period of 24 hours, the pollen was fixed in McClintock's fixative. The fixed suspension was diluted with an equal volume of absolute alcohol just before the preparation of slides. The preparations were stained by Lacto-propiono-orcein (Dyer, 1963).

TABLE 2. Combined analysis of variance of three experiments.

Source of Variation	DF	MS	
		Germination	Tube length
Temperature (T)	2	20,134.50	7760,837.02
pH	2	325.50***	69,516.52***
Genotype (G)	2	1,104.67***	21,840.07***
T X pH	4	122.33***	124,404.86***
T X G	4	404.67***	119,874.83***
pH X G	4	329.96***	39,149.41***
T X pH X G.	8	776.90***	97,052.03***
Error	27	1.35	7.44
Total	53		

**Significant at 0.001 level of probability.

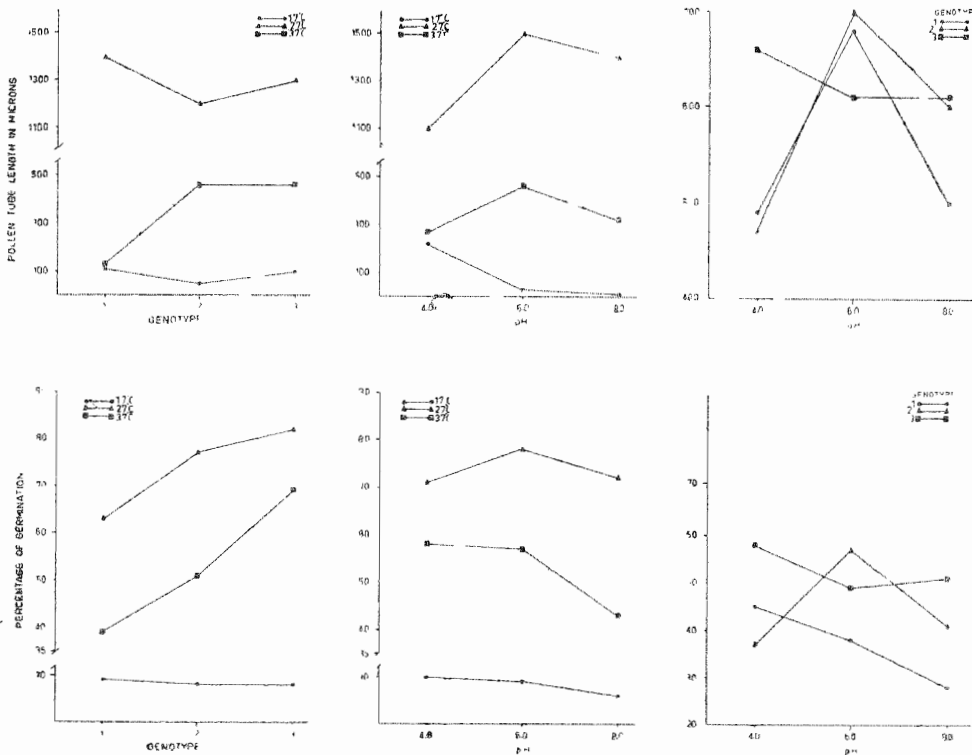


Fig. 1. Graphic presentation of temperature, pH and genotype interactions affecting pollen germination and tube growth.

The counts on pollen grains were made in ten randomly selected fields of microscope. About 300 pollen grains per treatment combination per replication were counted. To obtain the length of pollen tubes, twenty randomly selected tubes were measured in each treatment combination.

Results and Discussion

In most of the plant species maximum pollen germination has been reported in a range of 20 to 30°C (King & Johnston, 1958; Teare *et al.*, 1970). In the present studies, maximum germination and tube growth in papaya pollen were observed at 27°C and pH 6.5. The differences among various levels of pH and temperature studied were, however, statistically nonsignificant. The optimum pH in the present investigation was different from those of the previous studies (Kwack, 1965; Mekako, 1972).

Since three independent experiments (for three temperatures) were pooled to conduct the analysis of variance, therefore, the effect of temperature was studied through three planned comparisons. The results are shown in Table 1.

The germination percentage and tube growth were poor at 17°C and most of the pollen grains produced only small protuberances at this temperature. The tubes showed various deformities at 37°C, e.g., bursting of tips, dwarfing and blunting of tubes. Some showed broadening or swelling of the distal portions, while some were twisted. Mekako (1972) suspected that fluctuations in laboratory temperature ($25 \pm 3^\circ\text{C}$) during the course of the experiment produced significant differences among the replications. In the light of the present studies, it is probable that significance in replications obtained by Mekako was due to either the effect of genotype (within a species) or an interaction of genotype and pH. Highly significant differences were found among the three genotypes both for pollen germination percentage and tube length. These results are in agreement to those obtained by Pfahler (1971) with maize pollen grains. He showed that genotype of maize pollen grain is capable of altering both its *in vitro* germination and fertilization ability.

A significant interaction between pH and species of genus *Carica* has been reported (Mekako, 1972). In the present study a significant interaction was obtained at a lower level *i.e.*, between pH and genotypes within *C. papaya* (Table 2). Genotype x temperature interaction was found to be highly significant as well. Straley & Melton (1970) obtained similar significant interaction in alfalfa.

Johri & Vasil (1961) mentioned that the influence of pH on growth and metabolism of plants has been proved beyond doubt, but the opinions are so conflicting that it is difficult to decide whether pH at all influences the germination of pollen. The present study indicated that conflicting reports are due to the interactions of factors that influence pollen germination and tube growth. The significant second degree interaction further supported this view. It is inferred that temperature, pH and genotype not only influence the germination and pollen tube growth independently, but there are significant interactions among these factors as well. Various interactions among the factors are graphically presented in Fig. 1.

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