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The phenology of flowering in *Citrullus lanatus* (Thumb.) Mansf. in southwestern Nigeria

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ABSTRACT

An optimal fruit set in water-melon is highly dependent on the appropriate timing of pollination. This study was conducted in two cropping seasons, to determine the most suitable and appropriate time of pollination of water-melon. Water-melon was sown at the rate of 2 seeds per hole at a spacing of 2 x 2 m. At floral induction, flower buds were tagged to monitor the number of male to female flower ratio, sequence of flower development and pollen rating from 5.00 to 19.00 hrs. The result of the study showed that, there were 50 - 100 males to 1 female flower. Flowers opened at a relatively fast rate in the morning till mid-day and closed gradually in the evening. Also, the pollen rating was highest between 6.00 and 11.00 hrs and subsequently declined steadily as the flower closed up at 18.00 hrs. The best period for pollination to obtain optimum fruit set in water-melon was therefore at stages 3 - 6 in this study which fell within 7.00 and 12.00 hrs.

Keyword: Floral development, phenology, pollen rating, water-melon.

INTRODUCTION

Water-melon (*Citrullus lanatus* (Thumb) Mansf.) belongs to the family Cucubitaceae (Schippers 2000; Ojeifo et al., 2007). It is an aggressive annual herb and an important edible creeping fruit vegetable and is rich in vegetable protein, fats and vitamins (Gills, 1988; Fayemi, 1999; Davis et al., 2008). The pulp of the matured fruit is a valuable alternative to portable water in the desert since the fruit contains more than 90% water and is rich in potassium, and free in cholesterol (Rehn and Espig, 1999; Kendall, 2001; FAOSTAT, 2001; Ojeifo et al., 2007). Further, Rehn and Espig (1999) and Ojeifo et al. (2007) reported that 100 g of water-melon fresh fruit contained 6 mg Ca, 6 g carbohydrate, 0.2 crude fibre, and 0.5 g crude protein, 100 kj Energy, 0.1 g fat, 0.2 mg Fe, 9 mg P, 93 g Water and a wide range of vitamins. The fruit has great export potential (Rehn and Espig, 1991; Schippers, 2000) to locations where its cultivation is not favorable, particularly due to weather.

Flowering in a crop marks a transition from the vegetative phase to the reproductive phase (Turck et al., 2008; Saupe, 2009). Flowering is a process in which the shoot apex transforms to floral apex (Ausin et al., 2005), and its subsequent development into open blossom (Attridge, 1990). Flowers are monoecious or andromonecious (Salman-minkov et al., 2008) and vary in shape, size and colour. In some plants, male and female flowers may be found on different parts of the crop plant (Asiegbu, 1982; MSU, 2010), and the male flowers tend to open before the female (Akoroda et al., 1990).

Water-melon does well in temperatures of about 30 ^{0}C. When the temperature is more than 30 ^{0}C, the crop will grow well, but the pistils in the flowers may not retain the necessary moisture level for effective pollination (Schippers, 2000). According to the same report, flower setting is also impeded

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by high relative humidity because the pollens are not sufficiently freed. At blossom the flowers are mainly pollinated by Bees, although it can be pollinated by other agents such as insects, birds and wind (Adams et al., 1988; Shippers, 2000). Water-melon is cross pollinated; however, self pollination is possible when carried out by hand and the best time to do this is just before the female flower opens (Schippers, 2000). The different varieties and sub-species of *Citrullus lanatus* can easily hybridize since it is a cross pollinated species (Schippers, 2000). This hybridization with sweet water-melon can be avoided by ensuring that, no seed (egusi) melon is within at least 200 m of sweet water-melon plot/farm.

When pollination is successful, it will lead to fruit set. However, floral abortion is preponderant due to lack of synchronization of pollinators, at the peak of pollen integrity. Thus, the study therefore was designed to provide information on the floral behavior and to determine when intervention can be made using pollinators like bees for optimal fruit set in water-melon crop.

MATERIALS AND METHODS

This study was carried out for two cropping seasons at the Teaching and Research farm of Delta State University, Asaba Campus, Asaba, Nigeria. The location lies on 06 49^{1E} and $^{0}6$ 14^{1N} of the equator with an elevation of 97.6 m above the sea level. The soils were collected 0-15 cm, depth separately, bulked, mixed and air- dried under room temperature for 2 weeks and pulverized to pass 2 mm sieve, and later subjected to physico-chemical analysis.

Water-melon (Charleston grey variety) was sown on September 8, 2007 and replanted on September 17, 2008 in a 20 x 20 m (400 m^2) area, at a standard spacing of 2 x 2m. The seed were sown at the rate of 2 seeds per hole. The water-melon plants were staked on platforms constructed with bamboo at a height of 0.5 - 1.0 m, to minimize interference with soil pests.

Dry and rotted poultry droppings (organic manure) were applied at the rate of 1 kg/m^2 of land area. The fields were weeded and fallen plants re-staked as necessary. At the induction of flowering, flower buds were tagged to monitor the male to female flowers and floral behavior with respect to shape as influenced by time of the day and sex location on vines. The sex expressions of the water-melon vines were represented as ratios while relative floral openings were illustrated with diagrams, pollen ratings were presented on a histogram.

RESULTS AND DISCUSSION

Flowering was produced 4 weeks after sowing (WAS) for the male and at 7WAS for the female. A similar observation was reported by Akoroda et al. (1990), on *Telferia occidentalis* male and female flowers. The male flowers were found on the younger vines while the female flowers developed on the older vines. This observation agrees with the findings of *Asiegbu* (1982), who reported that female flowers of *Telferia occidentalis were* found on the older branches while the male flowers were found on the young branches often at the terminal part of the inflorescence.

At 8 and 9 WAS, a sex ratio of 50 – 100:1, with a mean of 75 males to 1 female flower was observed per plant. The higher number of male to female flowers agrees with the findings of Purseglove (1999), who reported more male flowers to female flowers in melon plants.

Stages of flower opening that produced corresponding shapes of flower were observed as illustrated in Figure 1. The flowers opened at a relatively fast rate in the morning till mid-day and closed gradually in the evening. The sequence of flower opening suggests that, the water-melon flower is photoperiodic. It indicates that flowers begin to open at stage 2 and close at stage 10 in the same day, corresponding to 6.00 to 17.00 hrs respectively (Figure 1). The floral behavior of water-melon indicates that it opens gradually: it is ¼ open in stage 2, half opens in stage 3 and ¾ opening in stage 4 and full open in stages 5 and 6. This corresponds to 7.00 to 12.00 hrs. The flower closes gradually till stage 9 and finally closed at stage 10. Pollen rating carried out between 6.00 to 19.00 hrs showed that the pollen was highest in the early hours of the day, declined substantially by mid-day and was very low in the evenings from 14.00 hrs (Figure 2).

In most ecological zones, pollination mostly by insect are carried out in the mornings and in the evening, when the weather is relatively cool. This also coincides with the period of minimal noise in the environment. Also, in the morning coincides with period that flower produces aroma/scent often noticed in the early hours of 6.00 to 11.00 hrs. This period coincides with the

period of full flower opening and also the period of high pollen count as indicated in the study. From this study, it is evident, that it is most appropriate to carryout manual pollination or encourages insect pollination in the morning hours when the flowers are fully open and when the pollen count is very high. This will ensure greater success in the pollination operation that would lead to better fruit set. This suggestion agrees with those of other workers (Adams et al., 1988; Purseglove, 1999), that insects' pollination especially by honeybees is most suitable for water-melon plants especially, when the pistillate flowers are pollinated immediately after anthesis.

Table 1 shows the pre-planting soil physico-chemical properties. pH 1:1 water, % organic carbon and % total N were 5.2, 2.68 and 0.80 respectively. Exchangeable cations and soil texture were also determined.

Conclusion

In any ecological zone, with minimum disturbance, the morning period coincides with high incidence of pollinating insects, particularly bees which are well known for this operation. The best period for pollination to obtain optimum fruit set in water-melon in the study area is between 7.00 – 12.00 hrs.

Table 1: Pre-planting soil physico-chemical properties.

Soil properties	Values
pH 1:1 water	5.2
% organic carbon	2.68
% total N	0.80
Exchangeable cations	
Ca++cmol kg-^{1}	6.80
Mg mgkg-^{1}	5.96
K cmol kg-^{1}	0.51
Na cmol kg-^{1}	0.11
% base saturation	97.40
Soil texture	
% sand	20
% silt	38
% clay	42

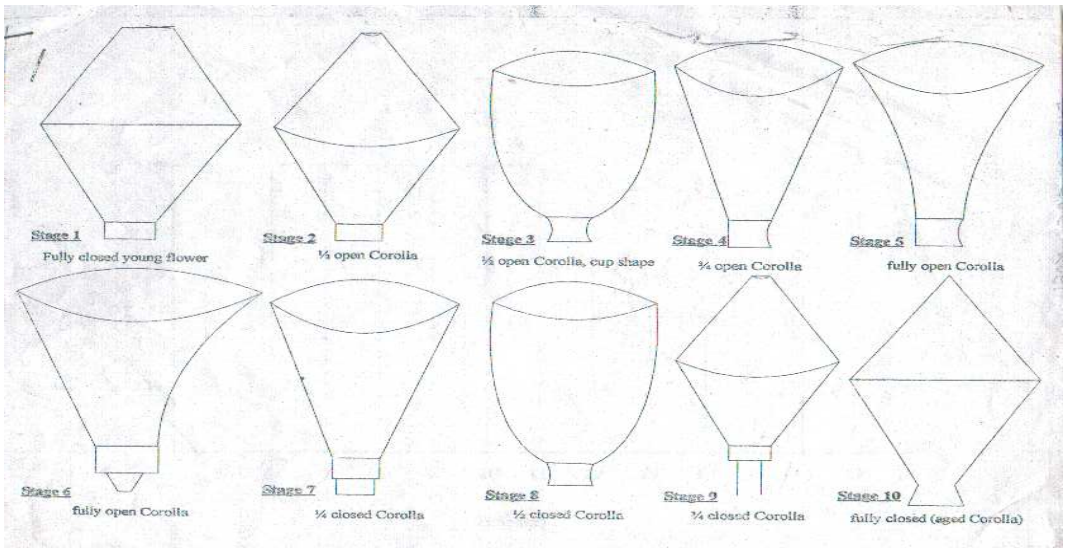

Figure 1: Stages of watermelon flower opening.

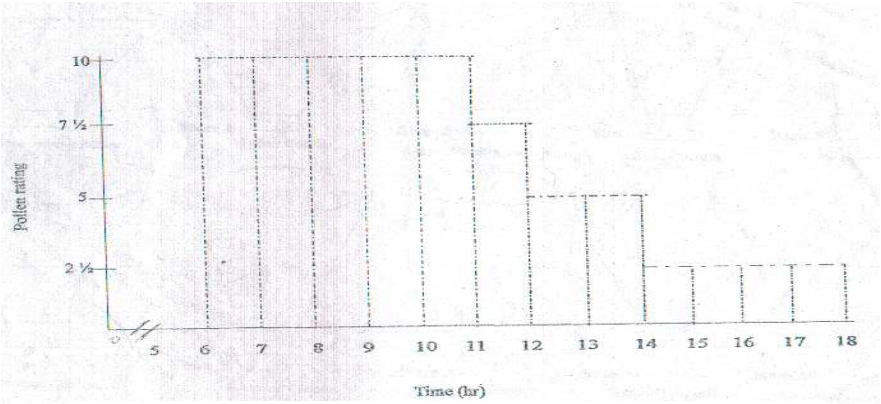

Figure 2 : Pollen rating (1-10) of watermelon over day length (hr).

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