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Effect of plant age and stress on flowering in litchi *(Litchi chinensis)*

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ABSTRACT

The experiment was conducted on eight year-old litchi (*Litchi chinensis* Sonn.) cv. Shahi at ICAR-NRC on Litchi, Muzaffrapur, Bihar during 2017-18. The results showed that trees started opening of flowers (male, hermaphrodite functionally female and hermaphrodite functionally male) on 4, 11 and 16 March 2017, and 11, 17 and 24 March 2018 respectively, whereas, in 15 year-old trees, anthesis of male, hermaphrodite functionally female and hermaphrodite functionally male was earlier on 1, 7 and 13 March 2017, and 7, 14 and 20 March 2018, respectively. Similarly, eight-year-old plant of Longia started opening of flowers (male, hermaphrodite functionally female and hermaphrodite functionally male) on 19, 27 and 30 March 2017, and 22, 30 March 2018 and 1 April 2018, respectively and 15 year-old trees started opening of flowers on 14, 21 and 25 March 2017 and 18, 25 and 29 March 2018, respectively. The eight year old Kasba plants located near road side were recorded with anthesis of flowers (male, female and hermaphrodite male flowers) on 12, 17 and 23 March 2017, and 16, 20 and 24 March 2018, respectively, whereas, 15-year old Kasba plant located at the centre of the field started opening of flowers on 15, 19 and 22 March 2017 and 20, 24 and 27 March 2018, respectively.

Key Words: Anthesis, Cultivars, Female flowers, Hermaphrodite flowers, Male flowers

Litchi (*Litchi chinensis* Sonn.), a popular member of family Sapindaceae, is an evergreen subtropical fruit tree. Mycorrhizal association is very strong in litchi and its inoculation in citrus increased the content of P and Zn (Ortas, 2017). The age of plants have great role in fruit production. Litchi produces three types of flowers [male (M1), hermaphrodite functionally female (F) and hermaphrodite functionally male (M2)] which open in succession. The pollen grain of M2 flowers are more viable and source of pollen grains significantly affect fruit set and success of hybrid fruits (Lal *et al.*, 2019a and b). The development and opening of flowers depend on age of plants. The old plants of the same cultivars commence early development and opening of flowers, while young ones produce late flowers and fruiting. Many types of stresses are known to induce flowering in litchi. These include high or low light intensity, UV light, high or low temperature, poor nutrition, nitrogen deficiency, drought, root pruning, growth retardant (Pandey *et al.*, 2017) and mechanical stimulation. Stress induces carbohydrate accumulation (Holland *et al.*, 2016; Shahryar and Maali-Amiri, 2016). Carbohydrates are important nutrients and energy sources in plant tissues. As a developmental stage, flowering can be regarded as the transition from the vegetative to the reproductive phase. An increase in carbohydrate levels in apical bud is associated with floral transition in plants (Bernier *et al.*, 1993). In litchi fruit tree, the importance of carbohydrates in flowering has been emphasized (Kumar *et al.*, 2017) by the fact that female flowers and regularity of flowering is improved by girdling. The plants located in stressed area where frequent movement of automobiles and human talk encounter near plants or facing stress by other means also induce early flowering in litchi. Keeping in view, an experiment was conducted to find out the effect of age of plant and stress on flowering in litchi.

MATERIALS AND METHODS

Three cultivars of litchi (Shahi, Longia and Kasba) were selected for observation. The two different age group of plants, viz. 8-year and 15-year-were selected. Different ages (8 and 15 year-old) of Longia and Shahi cultivars were selected at the centre of the field. Eight-

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year-old plants of Kasba located at the corner of the field were selected which stressed by human being, vehicles movement and others, and 15-year old tree of Kasba located at the centre of the field were selected which free from such stress. The observations on opening of flowers were recorded in all three cultivars during 2017 and 2018.

RESULTS AND DISCUSSION

The result revealed that-eight-year-old plants of Shahi started opening of flowers (male, hermaphrodite functionally female and hermaphrodite functionally male) on 4, 11 and 16 March 2017 respectively, whereas in fifteen-year-old trees, anthesis of male, hermaphrodite functionally female and hermaphrodite functionally male was earlier on 1, 7 and 13 March 2017, respectively. Similarly, eight-year-old plants of Longia started opening of male, hermaphrodite functionally female and hermaphrodite functionally male flowers on 19, 27 and 30 March 2017, respectively and fifteen-year-old plants started opening of flowers on 14, 21 and 25 March 2017, respectively. During second year, eight-year-old plants of Shahi started opening of flowers (male, hermaphrodite functionally female and hermaphrodite functionally male) on 11, 17 and 24 March 2018 respectively, whereas in fifteen-year-old trees, anthesis of male, hermaphrodite functionally female and hermaphrodite functionally male flower was earlier on 7, 14 and 20 March 2018, respectively. Similarly, eight-year-old plants of Longia started opening of male, hermaphrodite functionally female and hermaphrodite functionally male flowers on 22, 30 March 2018 and 1 April 2018, respectively and fifteen-year-old trees started opening of flowers on 18, 25 and 29 March 2018, respectively. The eight-year-old plants of Kasba located near road side were recorded with anthesis of flower (male, hermaphrodite functionally female and hermaphrodite functionally male flowers) on 12, 17 and 23 March 2017, whereas fifteen-year-old trees of Kasba located at the centre of the field started opening of flowers on 15, 19 and 22 March 2017, respectively. In the second year eight-year-old Kasba showed precocity in flowering where opening of flowers started on 16, 20 and 24 March 2018 while fifteen-year-old tree located at centre of the field showed late opening of flower on 20, 24 and 27 March 2018, respectively.

A fifteen-year-old plants of Shahi commenced anthesis (M1 flowers) on 1 March 2017 and eight-year-old plant started anthesis three days later on 4 March 2017. Similarly, M2 flower was opened on 13 March 2017 in fifteen-year-old plants whereas it was opened three days later on 16 March 2017 in eight-year-old plants. The similar case was also observed in the second year where fifteen-year-old plant of Shahi started anthesis on 7 March 2018 and eight-year-old plants commenced anthesis four days later on 11 March 2018. The fifteen-year-old trees of Shahi commenced anthesis 3-4 days earlier as compare to eight-year-old plant of Shahi. The same trends of anthesis was also observed in Longia litchi where fifteen-year-old plants started anthesis on 14 March 2017 and eight-year-old plants started anthesis five days later on 19 March 2017.

Similarly in second year, fifteen-year-old plants started anthesis on 18 March 2018 and eight-year-old plants started four days later on 22 March 2018. The fifteen-year-old plant of Longia commenced anthesis 4-5 days earlier as compare to eight-year-old plant of Longia and both the cultivars were located in the centre of field. The female flowers opened and M2 flowers (Hermaphrodite male flowers) were unopened in eight-year-old plants of Longia and in fifteen-year-old trees

Table 1. Effect of age of plants on anthesis in litchi cvs. Shahi and Longia

Anthesis of flowers	Age of Shahi				Age of Longia			
	2017		2018		2017		2018	
	15 Years	8 Years	15 Years	8 Years	15 Years	8 Years	15 Years	8 Years
Male (M1)	01.03.17	04.03.17	07.03.18	11.03.18	14.03.17	19.03.17	18.03.18	22.03.18
Female (F)	07.03.17	11.03.17	14.03.18	17.03.18	21.03.17	27.03.17	25.03.18	30.03.18
Male (M2)	13.03.17	16.03.17	20.03.18	24.03.18	25.03.17	30.03.17	29.03.18	01.04.18

Table 2. Effect of stress caused by location of the plant on anthesis in litchi cv. Kasba

Anthesis of flowers	Plant located in centre of field (15 Years)		Plant located at road side (8 Years)	
	2017	2018	2017	2018
Male (M1)	15.03.17	20.03.18	12.03.17	16.03.18
Female (F)	19.03.17	24.03.18	17.03.17	20.03.18
Male (M2)	22.03.17	27.03.18	23.03.17	24.03.18

of Longia, female flowers were opened 4-5 days earlier where stigma became brown and M2 flowers were also opened.

The fifteen-year-old trees of Kasba located at centre of the field started anthesis on 15 March 2017 and eight-year-old plants located at roadside commenced anthesis three days earlier on 12 March 2017. Similarly in the second year, fifteen-year-old plants started anthesis on 20 March 2018 and eight-year-old plants four days earlier on 16 March 2018. The fifteen-year-old trees of Kasba commenced anthesis 3-4 days later as compare to eight-year-old plants. The results indicated that older plants start reproductive cycle earlier as compare to young ones. The older plants of Shahi and Longia started anthesis 3-4 and 4-5 days earlier, respectively as compare the younger ones when plants were located at the centre in the field. But fifteen-year-old trees of Kasba started anthesis 3-4 days later as compare to eight-year-old plants when the locations of the plants were different. The eight-year-old plants of Kasba started anthesis 3-4 days earlier when located the roadside / near road and this is clear from Fig 2 that M2 flowers are still opening in fifteen-year-old trees of Kasba and in eight-year-old plant of Kasba, M2 flowers were completely dropped off and bified ovary started to grow.

This result indicated that young plants can enter into reproductive cycle when plants were stressed. The stresses may be due to water scarcity, human intervention (Human talks, noise, vehicle movement etc.) and other things which passes near to the plants. It is clear from the observations that older plants always may not enter into reproductive cycle earlier as compare to younger ones, the other factors are also responsible for such behaviour of the plants. However, these types of behavior are easily seen in annual / seasonal plants like mustard. Mustard plants which are located near the road / bunds enter into reproductive cycle earlier as compare to the plants located at the centre in the same field because of stress received by plants. The stress induces carbohydrate accumulation (Holland *et al.*, 2016; Shahryar and Maali-Amiri, 2016).

Many woody plants need stressful conditions to initiate or promote flowering (Zhou *et al.*, 2014; Shen *et al.*, 2016) and hormonal level of roots determines tolerance in trifoliate orange seedlings (Gao *et al.*, 2018). Flowering is positively correlated with carbohydrate level in the leaf, phloem, and xylem of litchi and Avvorhoa carambola (Wu *et al.*, 2013; Yang *et al.*, 2014). Soluble sugar and starch are carbohydrates that have conventionally been viewed as resources for respiration and metabolic intermediates as well as

Fig. 1: A: Eight-year-old plants of Longia where female flowers are opened and M2 flowers are unopened, B: Fifteen-year-old trees where female flowers are 4-5 days old to open indicating browning of stigma and M2 flowers are opened

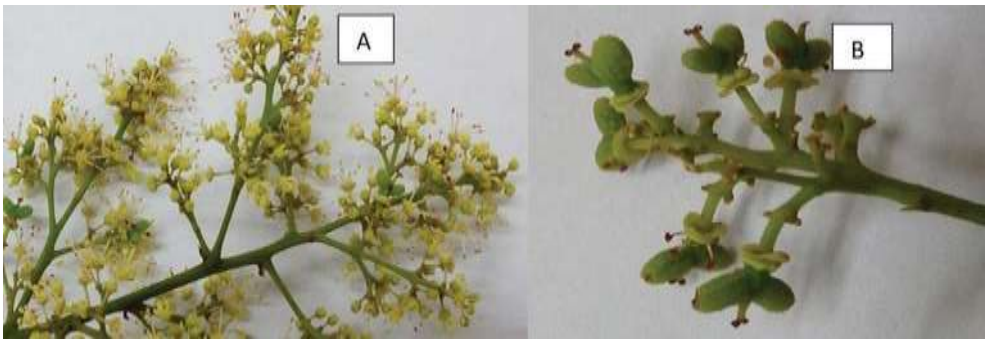

Fig. 2: A: Fifteen-year-old trees of Kasba where M2 flowers are still opening, B: Eight-year-old plant where M2 flowers are dropped off and bified ovary started to grow up

structural components (Sheen *et al*., 1999). Sugars are signaling molecules that control gene expression and developmental processes in plants (Jang and Sheen, 1997; Wang *et al*., 2008). Carbohydrates play an important role in the flowering of litchi (Litchi chinensis Sonn.) (Menzel *et al*., 1995; Chen *et al*., 2004; Yang *et al*., 2014), Zantedeschia (Kozlowska *et al*., 2007), strawberry (Fragaria × ananassa Duch.) (Eshghi *et al*., 2007), and Oncidium orchid (Wang *et al*., 2008).

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