Research Article

Precocious Flowering and Dwarf NRCL-29-A New Genetic Stock of Litchi (*Litchi Chinensis* Sonn.)

Narayan Lal[1]*, Awtar Singh[2], AK Gupta[1], ES Marboh[1], Abhay Kumar[1] and Vishal Nath[1]

[1]ICAR-National Research Centre on Litchi, Muzaffarpur, Bihar
[2]Division of Fruits and Horticultural Technology, ICAR-IARI, New Delhi

Abstract

Experiment was conducted at ICAR-NRC on Litchi Muzaffarpur to assess the precocity of flowering in 82 promising variants/genetic stocks planted in the field in 2014 and out of them, one variant/genetic stock has shown good promise with dwarf and precocious flowering. This genetic stock commenced first flowering and fruiting in 2017 on 3 year onward of planting and showed regular bearing. The peel was good source of anthocyanin (94.62 mg/100 g).

***Correspondence**
Author: Narayan Lal
Email: narayanlal.lal7@gmail.com

Keywords: Genetic stock, Dwarf, Precocious flowering, Panicle, Anthocyanin

Introduction

The litchi (*Litchi chinensis* Sonn.), one of the most important evergreen subtropical fruits of India originated in southern China, possibly northern Vietnam and seems to have been cultivated since 1500 B. C., by the people of Malayan descent where it has been cultivated for more than 2,300 years [1]. The litchi reached Burma by the end of 17th century and was introduced in India about 100 years later. The litchi is one of the most environmentally sensitive fruit tree and probably due to this reason its cultivation is restricted to few a countries in the world and in few states in India and mainly fluctuation in temperature significantly affect fruit retention [2]. Besides China and India, litchi is grown successfully in West Indies, Brazil, Honduras, Hawaii, Madagascar, Southern Japan, Spain, Mexico, North-eastern Australia, Southern United States, Israel, Thailand, New Zealand, Mauritius, Taiwan, Burma, Bangladesh and Nepal [3]. The major litchi producing states in India are Bihar (Muzaffarpur, East Champaran, Samastipur, Vaisali, and Bhagalpur), Uttarakhand (Udhamsingh Nagar, Dehradun, Pithauragarh, Nainital, Haridwar), West Bengal (Murshidabad, 24-Paraganas), Assam (Kamrup, Sonitpur, Bongaigaon), Punjab (Gurdaspur, Pathankot, Ropar, Hoshiarpur), Uttar Pradesh (Saharanpur, Muzaffarnagar, Meerut, Kushinagar), Jharkhand (Gumla, Ranchi, Lohardaga) and Tripura (East and Central). The harvesting period of litchi fruits is quite short and extends from May to June in the northern parts of the country. In India, its commercial cultivation was restricted to the Northern subtropical parts of the country, particularly the foothills of Himalayas from Tripura to Jammu and Kashmir and Gangetic plains. The possibilities of production of litchi during December–January in the southern have been explored that can make availability of litchi fruit during off season.

The foothills of the Himalayas, *i.e*. Terai belt, free from frost, offer good scope for plantation of litchi. Litchi can be cultivated up to an altitude of 1000 m above mean sea level. In these foothills, fruits mature late in the season. Recently, it is reported that litchi is also performing well in Southern parts of India when difference of temperature was less than 4 °C and humidity difference of about 6.5% during June-August [4]. These non-traditional areas of Southern India particularly in places above 800-900 m altitude includes Kerala (Wynad, Iduki), Karnataka (Kodagu, Chikamangaloor), Tamil Nadu (Shevaroy Hills, Lower Pulneys and Gudalur), Andhra Pradesh (Vizag), Odisha (Raigarh), Chhatishgarh (Ambikapur), Maharashtra (Thane) and Gujarat. The litchi fruit consists of about 55-85% pulp, 6-27% seed and 10-28% peel which varies depending upon cultivar and climatic conditions under which it is grown. Litchi peel is good source of anthocyanin ranged from 17.7-107 mg/100g) which have antioxidant properties [5]. The sugar content of litchi fruits varies from 10 - 21 % depending on cultivar. Litchi is good source of ascorbic acid ranging from 14 to 47 mg/100g of pulp [6]. Total by product in litchi is found to the tune of 19.85 to 59.54 % in different genotypes fractioning with 6.96 to 22.58 % seed and 12.89 to 36.96 % pericarp. Litchi pericarp and seed are good source of total phenolics with 7.5 - 62.2 mg GAE/g and 23.01 – 85.57 mg GAE/g, respectively [7]. Litchi has been introduced in India a long back and its genetic base is narrow and exhibit lower genetic diversity. To widen genetic diversity, genetic enhancement programme was started at ICAR-National Research Centre on Litchi (NRCL), Muzaffarpur.

Materials and Methods

An experiment was conducted at ICAR-NRC on Litchi Muzaffarpur in 2008 by planting more than 600 open-pollinated seedling population and 82 promising variants/genetic stocks were identified and vegetatively propagated, and planted in the field for further evaluation in 2014 and out of them, one variant/genetic stock has shown good promise with dwarf and precocious flowering in 2017. Therefore, present study deals with phonological events of new litchi variant/genetic stock NRCL-29 growing in the field at ICAR-NRC on Litchi, Muzaffarpur, Bihar. It lies between26°5'64"N latitude and 85°26'64"E longitude and an altitude of 210 meters above the mean sea level. The region is characterized by humid subtropical climate with temperature varying from 30°C to 43°C during summer and 5°C to 10°C during winter along with dry and hot summer and cold winter until heavy rainfall during rainy season. The onset of monsoon usually occurs in the second or third week of June and continues in appreciable amount up to mid of September. Frost can be expected from last week of December to first week of February with occasional light rains during winter. Data of panicle, flowers and fruits were collected on

Results and Discussion

Phenological data on genetic stock NRCL-29 was periodically collected on emergence and growth of panicle, flower bud development, panicle growth, opening of flowers, floral morphology, fruit growth and ripening. The plant was of medium vigor and dwarf in height (2 m) with slightly rough trunk girth. It had spreading tree growth habit, medium branching density with irregular pattern. The young leaf was of yellowish colour whereas mature leaf was light green. The number of leaflet was 6-8 and its arrangement was opposite. The length of rachis, petiole leaflet length and width were 10 cm, 13.45 cm and 4.23 cm, respectively. The shape of leaf was elliptic with acute apex and base was cuneate. Leaflet curvature was upper side from mid portion of leaf. The emergence of panicle depends on the temperature and age of the plants. The high temperature accelerates the emergence of panicle while low temperature slows down the panicle emergence and enhances emergence period. The inflorescence is a panicle comprised of many primary and secondary dichasia along with hundreds of flowers. The phonological phases are presented in **Figure 1** and **Table 1**.

The position of panicle was terminal with 4-5 panicles per shoot. The length and width of inflorescence was 25 cm and 10 cm, respectively. The profuse flowers were produced in a panicle (M_1-470, F-270 and M_2-1350 flowers). Flower opening commenced in the second weeks of March (Figure 1I). The flowers wereborn in large number in panicle and panicle develops in several clusters. Each cluster bore hundreds to thousands of small yellowish- white pedicillate fragrant flowers. Three types of flowers are shown in **Figure 2**:

Male Flower (M_1): This type off lower was pure male without pistil and appeared first in the second weeks of March. However, it was started to open from 13March and continued to till 18 March. Flower disc colour was yellow. At full grown stage, bud length and diameter was 1.64 mm and 1.79 mm, respectively. Flower length and diameter was 7.18 mm and 4.02 mm possessed 6-8 anthers. Each male flower consisted of 4-lobed cup shaped calyx and corolla was absent. Anther length and diameter was 1.11 mm and 0.54 mm, respectively.

Hermaphrodite Functionally Female (F): It started to bloom from 17 March and continued till 25 March. The length and diameter of female flowers were7.43 and 3.30 mm, respectively and length of stigma and stamenwere4.17 and 2.06 mm, respectively. The stigma was surrounded by 6-8 stamens but heterostyly condition existed due to short length of stamens. The gynocecium was bicarpillary, placed on a fleshy disc. The style was erect and was present between the ovaries lobes which remained attached with it for a longer time. Stigma was bifid which bends down and became receptive between 6 AM to 12 PM and remained receptive for 2-3 days, afterwards stigma became grey and finally dark brown.

Hermaphrodite Functionally Male Flower (M_2):These types of flower were of third phase which started opening on 24 March and continued till 1April. Both pistil and stamens were present in this flower but pistil was rudimentary and remained non-functional. These flowers were similar to M_1 flowers except rudimentary pistil. In this flower, the filaments of the anthers were shorter than in normal male flowers. Rudimentary ovules were present inside the pistillode. The style was short and the stigmatic lobes remained unopened.

Litchi is pollinated mainly by honey bee [8] and success of fruit set which determine final yield depends on the source of pollen grain [9-10]. The fruit length and diameter increased faster till 50 days after anthesis (DAA) and afterward it became slow till 60 DAA. From 60 DAA onwards, the growth rate was almost static (**Figure 3**). Fruit weight increased from 25 to 65 DAA and pulp weight slowly increased from 35 to 55 DAA. Pulp weight increased rapidly from 55 DAA and seed weight slowly increased from 25 to 60 DAA. Similarly, peel weight started to increase from 25 to 55 DAA and afterwards, peel weight started to decrease (**Figure 4**). The fruits were ready to harvest

during last weeks of May. The length of fruit was 31.50 mm and width 24.23 mm. The colour of mature fruit was red and attractive. The peel was good source of anthocyanin (94.62 mg/100 g) and TSS was 15.84 °Brix.

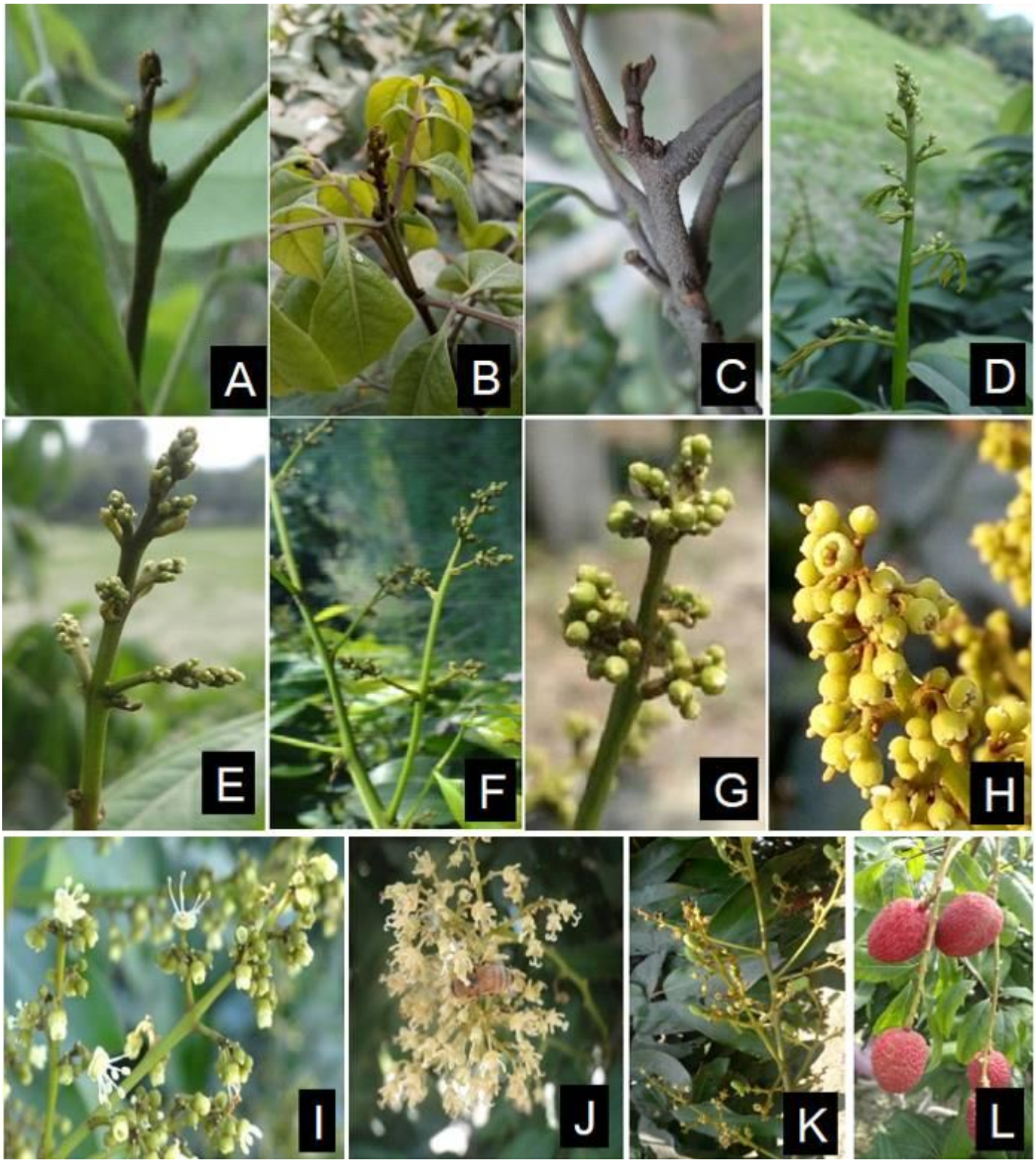

Figure 1 A-L: Pheno-phases of litchi genetic stock NRCL-29. **A.** Bud at rest with no sign of growth; **B.** First indication of bud development with bud beginning to swell; **C.** Elongation of primary branch of panicle; **D**. Appearance of secondary branches; **E.** Elongation of secondary branches of panicle; **F.** Elongation of tertiary branches and/*or* appearance of floral clusters; **G**. Swelling of floral buds; **H.** Protrusion of stigmas from female flowers; **I.** First flower opening; **J**. Peak flowering; **K.** End of flowering**; L.** Mature fruits

Table 1 Phenological phases and their active period

Pheno-phases	Active period
Panicle emergence	4-12 February
Appearance of primary branch	9-18 February
Elongation of primary branch	9-21 February
Elongation of secondary branches	21-28 February
Swelling of floral bud	27 February- 7 March
Protrusion of stigma from female flowers	8-12 March
Opening of male flowers (M_1)	13-18 March
Opening of female flower (F)	17-25 March
Opening of last male flower (M_2)	24 March-1 April

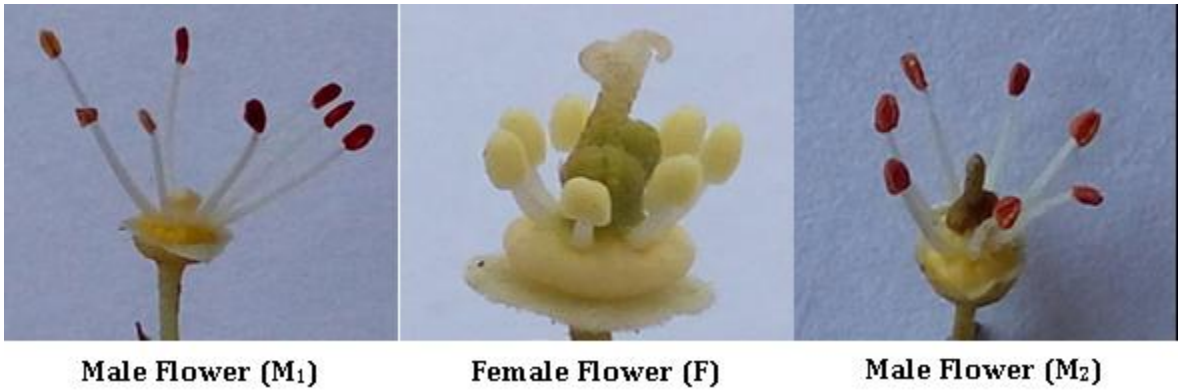

Figure 2 Types of flowers in a single panicle of genetic stock NRCL-29

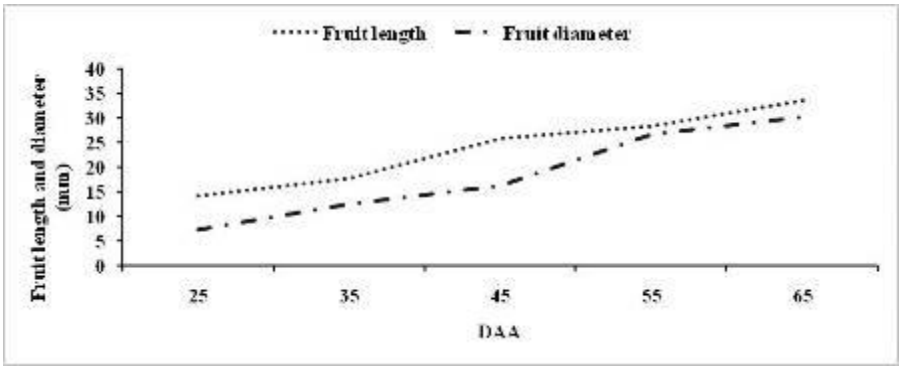

Figure 3 Changes in length and diameter of fruit of genetic stock NRCL-29

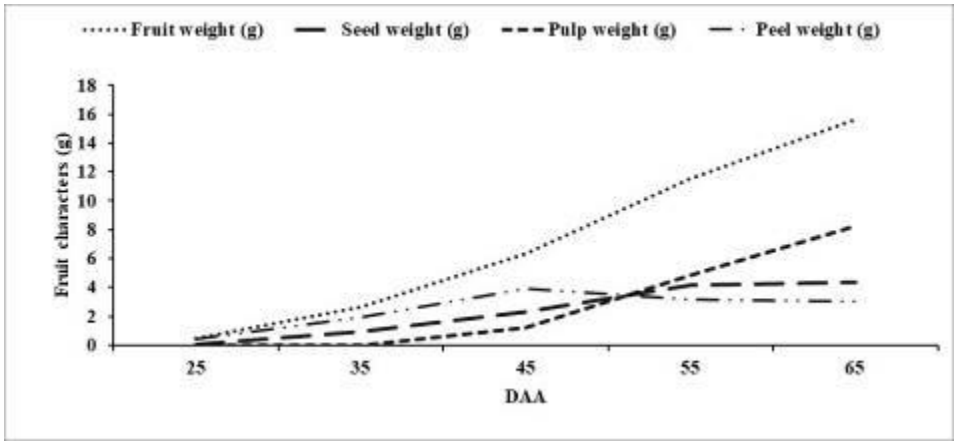

Figure 4 Changes in fruit, seed, pulp and peel weight of genetic stock NRCL-29

In the first year 2017, fruit weight and yield was 10-12 g and 2.1 kg per plant, respectively. In 2018, fruit weight and yield was 14.23-16.35 g and4.86 kg per plant, respectively and in 2019, fruit weight and yield was improved to

15.68 g and 6.45 kg per plant. Plants commenced regular flowering and fruiting. Seeing the performance of this genetic stock, it can be inferred that this stock can be used in future genetic enhancement programmes of litchi and also for the utilization as by-products also.

Conclusion

It is concluded that the new genetic stock NRCL-29 is precocious in flowering which started flowering and fruiting from 3rd years onward after planting and it is regular bearing in nature. It will help to litchi grower to get early and regular income from the litchi field. However, any cultivars of litchi does not follow regular pattern of flowering during young stages but NRCL-29 showed continuous of flowering for three years which is good sign to boost litchi production in the country. Its peel is thin and good source of anthocyanin which can be used in pharmaceutical way as antioxidant capacity. Thus, this genetic stock NRCL-29 may be tested in multi location trials and can be released as variety of litchi.

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Publication History
Received 01.11.2019
Revised 24.11.2019
Accepted 25.11.2019
Online 30.11.2019