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Investigations on flushing and panicle emergence in litchi under sub-humid sub-tropical plateau region of eastern India

Bikash Das*, Vishal Nath and P. Dey
Horticulture and Agro-forestry Research Programme,
ICAR Research Complex for Eastern Region, Plandu, Ranchi 834 010

ABSTRACT

Investigations were undertaken to develop an understanding of the flushing and panicle emergence process in litchi plants under sub-humid subtropical conditions of Eastern India. The intraplant variation in flushing and shoot growth pattern was found to influence the overall floriferousness of the litchi plants. All the shoots with second flush emerging during August and the third flush emerging during November were found to bear panicle in the month of February. A higher shoot girth and larger number of leaves per unit shoot length in the second flush was found to be crucial for flower bud differentiation. Cessation of growth of second flush before the emergence of third flush was found to result in panicle emergence. The carbohydrate content of previous season flush appeared to be contributing towards the emergence of third flush and ultimately the panicle as the content was found to decrease during the third flushing. The phenol content of all the flushes was found to increase during the initiation of new flushes. Observations on changes in content soluble proteins, total free amino acids, proline, phenylalanine, alanine, tryptophane and iso-leucine during different flushings have also been recorded.

Key words: Litchi, flushing, shoot growth, panicle emergence

INTRODUCTION

Litchi (*Litchi chinensis* Sonn.), a subtropical evergreen tree adapted to the areas of cool dry winters and warm wet summers (Menzel, 7) is grown for its excellent fruit quality, characteristic pleasant flavour and attractive colour. However, it has not yet attended the status of a major crop due to the problem of low and irregular bearing habit. Floral initiation, the first step in the reproductive cycle holds the key in the productivity of litchi plants in warm subtropical region (Das *et al.*, 2). Environmental conditions during winter are very critical for litchi production, because vegetative growth in the one to two months prior to panicle emergence completely eliminates flowering (Menzel *et al.*, 9). The relationship between flowering and vegetative flushing activity in winter is well established in litchi, however, most of the studies do not indicate the reasons for failure of floral initiation. In litchi, floral initiation takes place only after the shoots have undergone a period of vegetative dormancy (Menzel, 7). In general litchi plants produce three flushes after fruit harvest till panicle emergence. Menzel and Simpson (8) reported that the main period of vegetative flushing in high yielding litchi trees occurred after harvest from late summer and ceased 4-6 weeks before panicle emergence.

Changes in different phytohormones have been reported to influence floral initiation process in litchi (Liang *et al.*, 5). However, information on changes in other biochemical constituents in shoot like carbohydrates, phenols, soluble protein and amino acids in relation to flushing and panicle initiation would help in developing a proper understanding of the panicle initiation process in litchi.

The Chotanagpur plateau region is of strategic importance in terms of litchi production due to the early maturity of the fruits. However, meager amount information is available on flushing and pattern of panicle emergence in litchi plants under these conditions. Keeping this in view, the present investigations were undertaken on litchi cultivar Shahi under sub-humid sub-tropical plateau region of eastern India.

MATERIALS AND METHODS

The experiments were carried out at HARP, Ranchi during 2002- 2003. Observations were recorded from 18 years old plants of cultivar Shahi planted at a spacing of 10m x 10m. For studies on intra-plant variation in flushing and panicle emergence, 100 healthy shoots each in 10 different plants were tagged and observations on flushing pattern and panicle emergence were recorded. Observation on growth of each flush (length and diameter) was recorded at weekly interval. Observation was initiated during last week of July till emergence of panicle (2nd week of February). For studies on biochemical changes associated with flushing and panicle emergence, 25 shoots with new flush were selected from each plant and the sample was replicated thrice. Observation on

*Corresponding author: E-mail: bikash41271@yahoo.com

content of total carbohydrates, total soluble proteins, total free amino acids and individual amino acids like L-Proline, L-Phenylalanine, DL-Alanine, DL-Tryptophane and DL-iso-Leucine were estimated from each flush of the shoot.

The total carbohydrate content was estimated colorimetrically by using anthrone reagent after acid hydrolysis of the carbohydrate in to reducing sugars (Mahadevan and Sridhar, 6). The total phenol content was estimated colorimetrically using Folin-Ciocalteu reagent for oxidation of phenol (Mahadevan and Sridhar, 6). The total soluble protein content was estimated colorimetrically using Folin-Ciocalteau reagent (Mahadevan and Sridhar, 6). The total free amino acids was estimated colorimetrically using ninhydrin reagent (Mahadevan and Sridhar, 6). Quantitative estimation of different amino acids was done after their chromatographic separation (paper chromatography) and detection using ninhydrin spray (Mahadevan and Sridhar, 6). The ninhydrin positive spots were eluted in a mixture of ethanol and copper sulphate (80:20 v/v) and the absorbance was measured at 550 nm in a colorimeter. The data were subjected to test of significance.

RESULTS AND DISCUSSION

Five different shoot growth patterns were observed in the litchi trees (table 1). Earlier, Rai *et al.* (12) had reported that litchi trees produce three flushes between fruit harvest to panicle emergence in the next year. However, time of emergence of different flushes has a profound influence on the floriferousness of the shoot. Shukla and Bajpai (13) observed vegetative flushing in litchi cvs. Calcutta and Rose Scented during July to October. During the present investigation, the panicle emergence took place during the second week of February. Earlier, Menzel *et al.* (19) under Florida conditions have reported heaviest flowering in cultivar Brewstar in shoots, which were vegetatively dormant for two months before panicle emergence. The shoots having the second flush emerging during August and the third during November were found to be most floriferous in the present investigation.

Shoot vigor has also been found to have a profound influence on panicle formation. Nakata (10) had shown strong negative correlation between flowering and extent of vegetative growth. In the present investigation, the vegetative shoots were longer during first and second flush than that in the flowering shoots. Similarly, Chen *et al.* (1) had reported significant affect of shoot length on panicle emergence (no panicles were formed from shoots with a flush growth <0.2 cm and when the flush growth was >10 cm, the leaves grew continuously through the winter). However, both first and second flushes of flowering shoot attended higher shoot diameter than that in case of vegetative shoot. In case of flowering shoots, 69.6% of the shoots had a first flush girth more than 0.8 cm, whereas, in case of non-flowering shoots 58.3% of shoots had a first flush diameter of more than 0.8 cm. Similarly, in case of 2nd flush, 47.8% of the shoots had a diameter of more than 0.65 cm in case of flowering shoots whereas, only 17 % of the 2nd flush of non-flowering shoots had a diameter of more than 0.65 cm. A higher shoot girth is an indication of higher cambial activity, which is favoured by a higher value of auxin:gibberellin ratio in the shoot. Earlier, Liang *et al.* (5) have reported higher level of IAA in the shoot promote flower bud initiation in litchi. Hence, the higher value of auxin:gibberellin ratio might have promoted the flower bud differentiation in the shoots.

Presence of leaves on the shoot is essential for differentiation and development of flower buds. Although not much of work has been carried out on this aspect in litchi, studies on mango, a terminal bearing crop like litchi, support the existence of a floral stimulus continuously synthesized in leaves during inductive temperatures (Singh, 14). During the present

Table 1. Pattern of emergence of different flushes in litchi cv. Shahi.

Flushing pattern	Per cent of total No. of shoots	Per cent of bearing panicle
No 2nd flush and 3rd flush emerging during 1st to 31st December	6.0	55.55
2nd flush emerging during 20th to 31st August and 3rd flush emerging during 1st to 30th November	30.0	100.00
2nd flush emerging during 20th to 31st August and 3rd flush emerging during 1st to 31st December	8.0	66.66
2nd flush emerging during 1st to 20th September and 3rd flush emerging during 1st to 31st December	28.0	55.00
2nd flush emerging after 20th September and 3rd flush emerging during 1st to 31st December	28.0	66.00

Fig.1. diame

investigations, in case of flowering shoots, the average number of leaves was 7.53 and 7.07 in first and second flushes respectively, whereas in case of non-flowering shoots, the average number of leaves was 7.25 and 3.83 on first and second flush respectively. In case of flowering shoots, 46.5% of first flush had more than 8 leaves, whereas it was only 33.33% in case of non-flowering shoots. Similarly, 60.75% of second flush of flowering shoots had more than 8 leaves, whereas it was only 8.75% in case of non-flowering shoots. The insignificant difference in number of leaves between first flush of flowering and non-flowering shoots and significant difference in case of second flush of flowering and non-flowering shoot indicate the essentiality of the second flush for inducing flower bud differentiation in litchi.

The data on weekly shoot growth pattern of different flushes are being averaged in case of flowering and non-flowering shoots and the average value are depicted in Fig. 1-2. In case of flowering shoots, the second flush took place during third week of August whereas, in case of vegetative shoots, the second flush was initiated during the last week of July. However, the rapid increase in shoot diameter of second flush was observed during the second week of September in case of vegetative shoots. With respect to shoot length, two distinctly different growth patterns were observed between flowering and non-flowering shoots. In case of flowering shoots, there was a complete cessation of shoot elongation of second flush for about six weeks before the initiation of third flush whereas in case of vegetative shoots the duration of growth cessation before the initiation of third flush was only two weeks. Menzel (7) reported that in litchi, floral initiation takes place only after the shoots have undergone a period of vegetative dormancy. Hence, the lack of growth cessation between two flushes might have resulted into the failure in flower bud differentiation in the present study.

The different morphological changes taking place in the plant is accompanied by changes in different biochemical composition in the tissue (Table 2). Different phytohormones have been found to be associated with floral differentiation in litchi. The carbohydrate content in the shoots is an indication of shoot maturity. Carbohydrates are translocated from different parts of the plant for construction of new tissues. In the present investigation, the content of carbohydrate in first flush and second flush increased during the emergence of each new flush. On the

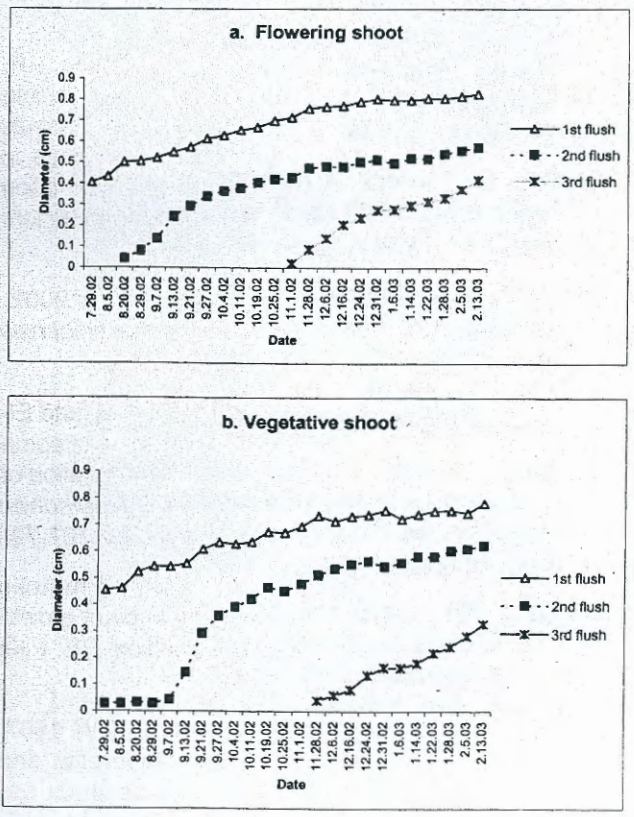

Fig.1. Flushing and shoot growth pattern in terms of shoot diameter.

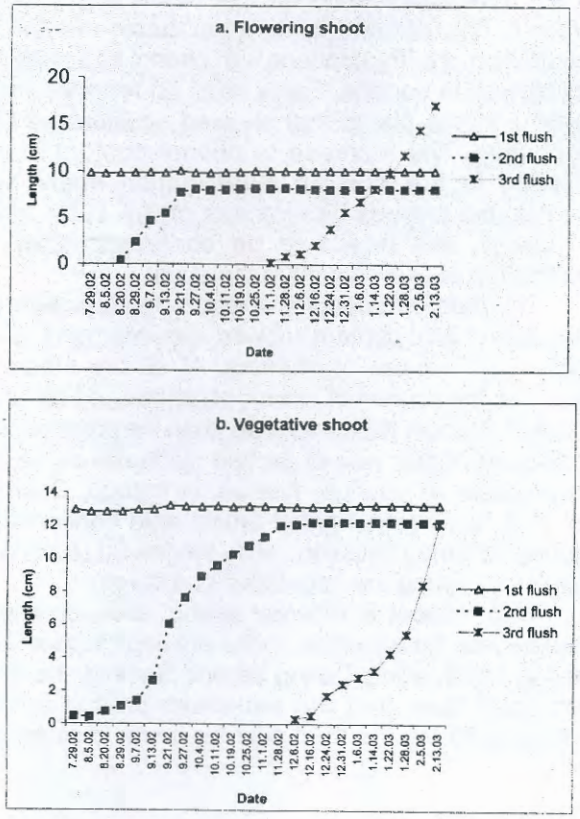

Fig. 2. Flushing and shoot growth pattern in terms of shoot length.

Table 2. Biochemical changes associated with flushing and panicle emergence in litchi cultivar Shahi.

Biochemical constituent	Stage of flushing									
	1st flush		2nd flush			3rd flush				
	Previous season flush	1st stage	Previous season flush	1st stage	2nd stage	Previous season flush	1st stage	2nd stage	3rd stage	C.D. at 5%
Carbohydrate (%)	9.26	4.92	9.54	6.23	5.61	6.71	6.32	7.21	4.87	1.114
Total phenols (mg/100g)	0.36	0.24	0.54	0.50	0.29	0.61	0.57	0.5	0.29	0.355
Total soluble protein (%)	0.18	0.29	0.19	0.28	0.36	0.14	0.19	0.23	0.34	0.118
Total free amino acids (mg/g)	0.86	1.28	0.38	0.62	0.85	0.68	0.64	0.79	1.07	0.214
L-Proline (mg/100g)	0.82	0.34	0.19	0.18	0.65	0.22	0.92	0.28	0.29	0.168
L-Phenylalanine (mg/100g)	0.16	0.31	0.29	0.52	0.21	0.85	0.51	0.37	0.18	0.131
DL-Alanine (mg/100g)	0.00	0.19	0.52	0.55	0.24	0.37	0.39	0.29	0.28	0.089
DL-Tryptophane (mg/100g)	0.16	0.65	0.43	0.36	0.58	0.41	0.12	0.23	0.24	0.139

contrary, the carbohydrate content of the previous season flush remained same during second flushing and decreased during the emergence of the third flush. The reduced carbohydrate in the previous season flush might have contributed towards the emergence of the third flush.

The phenol content of all the flushes increased during the initiation of new flushes. However, at all the stages of flushing, the phenolic content of younger flush was lower than the previous flush. Kefeli and Kutacek (4) reported that formation of IAA from L-Tryptophane is accelerated under polyphenol polyphenolase system. They have also mentioned that IAA is easily formed from L-Tryptophane in a rather basic medium by incubation of L-Tryptophane with phenol as established by biotest. In banana, Fayek *et al.* (3) reported higher phenol in the plants that showed accelerated floral formation. The increase in phenol content in new flushes in the present investigation might have contributed towards biosynthesis of IAA in the shoot. However, this needs to be confirmed after the estimation of IAA content in the shoot.

The data on changes in total soluble protein and free amino acid content showed opposite trend to that observed in case of phenols. At all the stages of flushing, the content of soluble proteins and free amino acids in younger flush was lower than the previous flush indicating higher rate of protein synthesis as well as degradation in younger flushes. In mango, Osuna *et al.* (11) had found highest amino acid concentration during flowering initiation, while the lowest levels were observed during the vegetative bud stage.

With respect to different amino acids, content of proline was the maximum in the previous season flush during first flushing. During second flushing, the newly emerged flush had the maximum proline content whereas during the third flushing it was maximum in first flush. The amino acid, tryptophane is the precursor of auxins. The content of tryptophane showed opposite trend to that obtained in case of proline. The newly emerging flushes had higher content of tryptophane than the previous flushes during the first and second second flushing. During the third flushing, the previous season flush had significantly higher tryptophane content than the other flushes.

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