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Quantitative Analysis of Relationships Between Panicle Size and Fruit Traits in Litchi (*Litchi chinensis* Sonn.)

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Abstract

An experiment was conducted to assess the effect of inflorescence on fruit set, yield and quality of three litchi cultivars *viz*., Rose Scented, Mandaraji and Seedless Late in 2017 and 2018 at ICAR-National Research Centre on Litchi, Muzaffarpur, Bihar. Panicle length determined fruit set in Rose Scented and Mandaraji, and panicle length and girth are important for fruit retention in Seedless Late. Results revealed that there was a strong correlation between the length and width of panicle in cultivar Rose Scented (0.989), Mandaraji (0.970) and Seedless Late (0.771). The length of panicle was highly and positively correlated with fruit set in cultivar Rose Scented (0.896), Mandaraji (0.955) and Seedless Late (0.943) and it was also positively and strongly correlated with girth of panicle in cultivar Rose Scented (0.763) and Seedless Late (0.966) and weakly correlated in Mandaraji (0.526). A strong correlation between girth of panicle with fruit set in both years was also observed in Rose Scented (0.882) and Seedless Late (0.940). A very strong correlation between girth of panicle and fruit weight was observed in Seedless Late (0.608) in both the year. The optimum girth of panicle was 4.23 mm in Mandaraji for higher fruit set. However, in Seedless Late, fruit set increased with increase in panicle length and girth. For genetic improvement in litchi, emphasis on length and girth of panicle should be given during selection of improved cultivars.

Keywords: Litchi, correlation, panicle, fruit set, improvement

1. Introduction

Litchi (*Litchi chinensis* Sonn.) is an evergreen subtropical fruit tree and important member of family Sapindaceae (Lal et al., 2017a), which has strong mycorrhizal association (Lal and Nath, 2020a). Litchi is evergreen sub-tropical fruit crops which has high nutritive and medicinal values. It is good source of Vitamin-C (Lal, 2018) and phenolics (Lal et al., 2018a). Litchi is highly specific to its climatic requirements particularly low temperature for bumper flowering and fruiting and this is the reason of its restricted cultivation in few countries and limited states in India. Litchi is highly sensitive to change in climatic condition and selective to the environmental factors (Purbey et al., 2019a). 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 seeds are good source of total phenol with 7.5-62.2 mg GAE/g and 23.01–85.57 mg GAE/g, respectively (Lal et al., 2018a). It produces inflorescence called panicle which is the fruiting body for ensuring the final yield of

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litchi and emergence and size of panicle is also influenced by phenol content in the tree (Lal et al., 2018b). Many genotypes bear loose or compact panicle which also depends on climatic condition. However, none of the litchi cultivars follow regular pattern of flowering during young stages (Lal et al., 2019d). There are three types of flower on the inflorescence in litchi: male (M1), pseudo-hermaphrodite male (M2) and pseudo-hermaphrodite female (F) flowers. Male flowers bloom first followed by an overlapping successions of female flowers with pseudo-hermaphrodite male and flowers bloom for 7-10 days and the number of flowers on a single inflorescence vary from hundreds to several thousand (Lal, 2018). Pollen grains of M2 flowers are more viable and fruit set depends on the sources of pollen grains (Lal et al., 2019a and 2019b). However, fluctuation in temperature significantly affects fruit retention influenced by borer (Lal et al., 2019c). Litchi suffers from some problems viz., fruit drop (Lal et al., 2017b and c), sun burn and fruit cracking (Lal et al., 2018c), pericarp browning (Purbey et al., 2019b). Aberrant weather influences the productivity and quality of litchi (Lal and Nath, 2020b). Fruit set varies with cultivars in fruit crops (Adhikary et al., 2019; Hada and Singh 2017). Nutrients and plant growth regulators also affected fruit set, yield and quality of fruits (Singh et al., 2016; Lal et al., 2013). Fruit set vary with cultivars grown in the same condition and nutritional condition of plants as highest fruit set (23.96%) and lowest fruit drop (13.06%) was recorded in trees fertilized with calcium nitrate+urea (Jeet et al., 2016). Indian litchi can be categorized mainly into three distinct groups: Shahi, China and Bedana groups. Each group falls many cultivars like Rose Scented, Mandaraji and Bedana comes under these three groups, respectively. These three groups are easily distinguished based on leaf, panicle and fruit characters. Panicle is fruiting body in litchi and its length and girth is very important for maximum production of litchi. The objective of this experiment was to assess the effect of panicle on fruit weight and quality of litchi.

2. Materials and Methods

2.1. Experimental site

An experiment was conducted in 2017 and 2018 in National Active Germplasm Site (NAGS) ICAR-National Research Centre on Litchi, Muzaffarpur (Bihar) located at 26°5'87" N latitude, 85°26'64" E longitude at an elevation of 210 m above msl to assess the relationship between panicle size and fruit traits in three cultivars. The soil type of the site was alluvial with sandy loam texture having calcareous in nature with pH ranging from 7.5-8.0. The temperature varied from 30°C to 43 °C in summer and 5 °C to 10 °C in winter. The region was characterized by dry and hot summer and cold winter with 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. Three cultivars of litchi namely Mandaraji, Rose Scented and Seedless Late of 10 years old were selected and experiment was laid out in randomized block design (RBD) with three replications. The uniform cultural practices were provided to each all the selected plants.

2.2. Method of data collection

For taking observations, ten shoots were tagged in each cultivar in four directions. The length width and girth of panicle were measured at fully developed stage before opening of male flowers (M1). The length and width of panicle was recorded at the longest and widest part of each panicle and express in centimeter while girth of panicle was measured at the base of shoot and expressed in millimeter. The number of fruits at harvest were counted from the tagged panicle and average number of fruit set was recorded. Total soluble solids in the fruits were recorded at room temperature using digital refractometer and were expressed in terms of ^{0}Brix. Five fruits per replication were taken from each treatment for taking the average value. The data was subjected to statistical analysis by using Analysis of variance (Burton, 1952). Critical difference values at $p<0.05$ were used to determine the significance of difference between treatment means. The correlation and regression of panicle data were analyzed by SAS software.

3. Results and Discussion

The characteristics of three cultivars are presented in Table 1. Rose Scented produced maximum length of panicle (30.89 cm) whereas Seedless Late produced least length of panicle (20.19 cm). Similarly, Rose Scented produced maximum width of panicle (20.23 cm) and Seedless Late produced the least (11.14 cm). The variations in panicle length are also reported by earlier worker (Khurshid et al., 2004). The differences might

Table 1: Panicle and quality characteristics of litchi cultivars

Cultivars	Length of panicle (cm)	Width of panicle (cm)	No. of fruit set at harvest	Girth of panicle (mm)	Fruit weight (g)	TSS (Brix)	Pulp %	Titratable acidity (%)
Rose Scented	30.89	20.23	7.71	4.96	21.27	20.05	56.45	0.35
Mandaraji	26.59	16.38	9.14	4.12	20.40	19.68	58.37	0.38
Seedless Late	20.19	11.14	5.37	4.79	21.18	19.63	74.65	0.43
SEm±	0.495	0.408	0.553	0.066	0.344	0.408	0.73	0.007
CD (p=0.05)	1.994	1.647	2.229	0.264	N/A	N/A	2.941	0.027

be due to genetic make up of the cultivars and their response to the environmental conditions. The variations in number of fruit set have been found with maximum in Mandaraji (9.14) and least in Seedless Late (5.37). The cultivars also showed variations in fruit weight with maximum in Seedless Late (23.18 g) and least in Mandaraji (20.40 g). The fruit weight in litchi cultivar depend on genetic factors (Khurshid et al., 2004; Lal, 2018), nutrition (Cronje et al., 2009) and fruit orientation (Waseem et al., 2002). The TSS content of fruit varied among cultivars with maximum in Rose Scented (20.05 Brix) and least in Seedless Late (19.63 Brix). Haq and Rab (2012) reported significantly higher TSS in Gola (22.13%) and lowest in Bedana (16.27%). The variation in total soluble solids has been reported by other workers (Waseem et al., 2002; Islam et al., 2003). Pulp is edible portion of litchi and seedless Late exhibited highest pulp (74.65%) whereas Rose Scented and Mandaraji exhibited less than 60% pulp content. The variation in pulp content was due to genotypic variation. The variation in pulp content was also reported by Khurshid et al. (2004), and Singh and Nath et al. (2012). The considerable variation in titratable acidity was found in the present study which was also reported by other workers Lal (2018), and Haq and Rab (2012).

3.1. Effect of panicle length on width

Throughout the inflorescence development period, a strong positive correlation was observed between the length and width of panicle over the times in both years in all three cultivars *viz.,* Rose Scented (0.989), Mandaraji (0.970) and Seedless Late (0.771). Lee (2006) indicated that the number of florets per inflorescence was correlated to the length of the inflorescence in 'Yu Her Pau'. Panicle width increased with the increment in length in all three cultivars of litchi. Very strong correlation between panicle length and width in Rose Scented and Mandaraji showed large size of panicle which carried maximum number of flowers and fruits resulted higher production in Rose Scented and Mandaraji as compared to Seedless Late.

3.2. Effect of panicle length on fruit set

There was a strong positive correlation between panicle length and fruit set over the times in both years in cultivar Rose Scented (0.896), Mandaraji (0.955) and Seedless Late (0.943). Chen et al. (2013) showed a strong relationship between the number of fruit set and length of the inflorescence, with optimum length about 20 cm. Panicle was fruiting body which governed the number of flowers produced and responsible for success of fruit set in litchi. Larger size of panicle carried more number of flowers which turned into maximum number of fruit. This indicated that optimum size of panicle is required for higher production of fruits in litchi. The length of panicle exerts a great impact on litchi production by affecting the behavior of pollinators in two ways; first by creating more conspicuous visual signals that attract pollinators more effectively and second by increasing the number of flowers that pollinators probe in a single visit, thus increasing the probability of accumulating or depositing pollen. Pollinator attraction is dependent only on the number of flowers open at a given time and not on the total number of flowers produced. However, larger panicle carried maximum number of female flowers which results into more number of fruit set. Suetsugu et al. (2015) found positive correlation between the proportion of flowers developing into fruit and the number of flowers per inflorescence. Adhikary et al. (2019) reported that fruit set directly correlated with lower sex ratio in ber. The variation in fruit set is entirely based on the genetic makeup of cultivars, pollen fertility and prevailing climatic conditions (Kumari et al., 2016). The results revealed that development of panicle length should be allowed to the maximum possible extend for higher fruit set.

3.3. Effect of panicle length on girth

A strong positive correlation between length and girth of panicle was found over the times in both years in cultivar Rose Scented (0.763) and Seedless Late (0.966) while Mandaraji showed moderate positive correlation (0.526). A very strong positive correlation between length and girth of panicle in Seedless Late (0.966) observed in our study was due to genetic make-up of the plant in having mechanism that naturally restrict the length of panicle. The maximum length of panicle in Seedless Late was 30 cm making it efficiently enough to use food material in improving the girth of panicle while in Rose Scented and Mandaraji, length of panicle were more (40 cm) (Table 2).

3.4. Effect of panicle length on fruit weight

A week positive correlation between panicle length and fruit weight was found over the times in both the year in cultivars Rose Scented (0.453) and Mandaraji (0.397) while Seedless Late showed moderate positive correlation (0.651). In Seedless Late, size of panicle was comparatively short than Rose Scented and Mandaraji which has conserved food metabolites and used in development of fruit resulted good weight of fruit.

3.5. Effect of panicle girth on fruit set

All cultivars exhibited a very strong positive correlation between girth of panicle and fruit set over times in both years *viz*., Rose Scented (0.882) and Seedless Late (0.940) while Mandaraji showed moderate positive correlation (0.568). In Mandaraji, number of fruit set was highest (13.85) when girth of panicle was about 4.23 mm while in Rose Scented and Seedless Late fruit set increases with increased in girth of panicle. Lauri et al. (1996) reported positive relationship between inflorescence development and the ability to set one or more fruit. Inflorescence size strongly determines fruit-set capacity. The ability of a flower bud to set fruit is usually expressed through the `flower quality' or `floral strength' concept. It may be applied to either individual flowers or inflorescences (May, 1970; Abbott, 1977). Higher value of auxin:gibberellin ratio promotes flower bud initiation which

Table 2: Correlation between panicle and fruit traits in different cultivars of litchi

Traits	Length of panicle	Width of panicle	No. of fruit set at harvest	Girth of panicle	Fruit weight	TSS
Rose Scented						
Length of panicle	1	.989**	.896**	.763**	.453*	-.009
Width of panicle		1	.866**	.737**	.391	-.023
Number of fruit set at harvest			1	.882**	.505*	-.064
Girth of panicle				1	.518*	.112
Fruit weight					1	.247
TSS						1
Mandaraji						
Length of panicle	1	.970**	.955**	.526**	.397**	-.109
Width of panicle		1	.965**	.565**	.450**	-.109
Number of fruit set at harvest			1	.568**	.399**	-.140
Girth of panicle				1	.358*	.063
Fruit weight					1	.090
TSS						1
Seedless Late						
Length of panicle	1	.771**	.943**	.966**	.651**	-.045
Width of panicle		1	.812**	.876**	.351	-.120
No. of fruit set at harvest			1	.940**	.565**	-.142
Girth of panicle				1	.608**	-.091
Fruit weight					1	.337
TSS						1

was associated with higher cambial activity of higher girth of panicle (Luo et al., 2005). This reflect that an adequate active xylem and pith cell capable to carry out food materials to the developing fruits is present, which results in retention of more number of fruits. The significance of fruit trees reserves in influencing fruit set has also been reported in olive (Bustan et al., 2011).

3.6. Effect of panicle girth on fruit weight and TSS

A strong positive correlation between girth of panicle and fruit weight was noted in two cultivars *viz.,* Rose Scented (0.518) and Seedless Late (0.608) while weak positive relation (0.358) was observed in Mandaraji. A very strong correlation between girth of panicle and fruit weight in Seedless Late (0.608) can be attributed to increased girth of panicle which had provided more nutrients and water to the developing fruits and resulted in higher fruit weight. However, no correlation between number of fruit set and TSS of fruit in litchi was observed.

4. Conclusion

Panicle length exerted a positive correlation with width and girth of panicle in carrying maximum number of fruits. However, in Rose Scented, length of panicle played a great role in determining fruit set. Similarly, in Mandaraji, girth of panicle played a determining role in influencing fruit set, while in Seedless Late, both length and girth of panicle were crucial for fruit set. For genetic improvement in litchi, emphasis on length and girth of panicle should be given due attention.

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6. References

Abbott, D.L., 1977. Fruit-bud formation in Cox's Orange Pippin. Annual Report for 1976. Long Ashton Research Station 167−176.

Adhikary, T., Kundu, S., Chattopadhayay, P., Ghosh, B., 2019. Flowering intensity and sex ratio of ber (*Ziziphus mauritiana* Lamk.). International Journal of Bio-resource and Stress Management 10(2), 107−112. DOI: HTTPS://DOI.ORG/10.23910/IJBSM/2019.10.2.1954.

Burton, G.W., 1952. Quantitative inheritance in grasses. Proceeding of 6th Grassland Congress 1, 27−83.

Bustan, A., Avni, A., Lavee, S., Zipori, I., Yeselson, Y., Schaffer,

A.A., Riov, J., Dag, A., 2011. Role of carbohydrate reserves in yield production of intensively cultivated oil olive (*Olea europaea* L.) trees. Tree Physiology 31, 519–530.

Chen, P.A., Roan, S.F., Lee, C.L., Chen, I.Z., 2013. The effect of temperature during inflorescence development to flowering and inflorescence length on yield of 'Yu Her Pau' litchi. Scientia Horticulturae 159, 186–189.

Cronje, R. B., Sivakumar, D., Mostert, P.G., Korsten, L.,2009. Effect of different preharvest treatment regimes on fruit quality of Litchi cultivar 'Maritius' Journal of Plant Nutrition 32, 19−29.

Hada, T.S., Singh, A.K., 2017. Evaluation of mango (*Mangifera indica* L.) cultivars for flowering, fruiting and yield attributes. International Journal of Bio-resource and Stress Management 8(4), 505−509. Doi: HTTPS://DOI.ORG/10.23910/IJBSM/2017.8.4.1811a.

Haq, IU., Rab, A., 2012. Characterization of physico-chemical attributes of litchi fruit and its relation with fruit skin cracking. The Journal of Animal & Plant Sciences 22(1), 142−147.

Islam, M. S., Ibrahim, M., Rahman, M.A., Uddin, M.A., Biswas, S.K., 2003. Studies on the fruit characteristics, bio-chemical composition and storage behavior of litchi varieties. Pakistan Journal of Biological Sciences 6, 70−72.

Jeet, A., Sharma, N.C., Chandel, J.S., 2016. Effect of nitrogen sources on yield, fruit quality and nutritional status of apple (*Malus×Domestica* Borkh.). International Journal of Bio-resource and Stress Management 7(6), 1297−1301 Doi: HTTPS://DOI.ORG/10.23910/IJBSM/2016.7.6.1745.

Khurshid, S., Ahmad, I., Anjum, M.A., 2004. Genetic diversity in different morphological characteristics of litchi (*Litchi chinensis* Sonn.), International Journal of Agricultural Biology 6, 1062−1065.

Kumari, R., Thakur, B.S., Babita, Rimpika., 2016. Performance of different guava cultivars under the subtropical condition of Himachal Pradesh. International Journal of Bio-resource and Stress Management 7(2), 326−329. DOI: 10.5958/0976 4038.2016.00046.4.

Lal, N., 2018. Genetic studies of litchi germplasm. Ph.D. Thesis, submitted to JNKVV, Jabalpur, MP.

Lal, N., Das, R.P., Verma, L.R., 2013. Effect of plant growth regulators on flowering and fruit growth of guava (*Psidium guajava* L) cv. Allahabad Safeda. Asian Journal of Horticulture 8(1), 54−56.

Lal, N., Gupta, A.K., Kushwah, N.S., Nath, V., 2017a. Sapindaceous Fruits: In: Peter KV, Editor. Horticultural Crops of High Nutritive Values. Brillion Publishing, New Delhi.

Lal, N., Gupta, A.K., Marboh, E.S., Kumar, A., Nath, V., 2019a. Effect of pollen grain sources on fruit set and retention in 'Rose Scented' litchi. Multilogic in Science 9(29), 152−156.

Lal, N., Gupta, A.K., Marboh, E.S., Kumar, A., Nath, V., 2019b. Effect of pollen grain sources on success of hybrids in 'Bedana' Litchi. International Journal of Bio-resource and Stress Management 10(3), 241−245. DOI: HTTPS://DOI.ORG/10.23910/IJBSM/2019.10.3.1990.

Lal, N., Gupta, A.K., Nath, V., 2017b. Major challenges in developing of new cultivars in litchi cultivars in litchi. Gyan Manthan 6, 124.

Lal, N., Gupta, A.K., Nath, V., 2017c. Fruit drop pattern in some litchi cultivars. Gyan Manthan 6, 132.

Lal, N., Marboh, E.S., Gupta, A.K., Kumar, A., Nath, V., 2019c. Fruit drop in litchi (*Litchi Chinensis* Linn) influenced by seed and fruit Borer. Souvenir cum abstracts: National Conference on Integrated Plant Health Management in Fruit Crops, 3-4 September, 2019, 78−80.

Lal, N., Nath, V., 2018a. Phenolics and its relation with flowering in litchi (*Litchi chinensis* Sonn). Souvenir: International Conference on Global Research Initiatives for Sustainable Agriculture & Allied Sciences during 28-30 October 2018 at Rajasthan Agricultural Research Institute, Durgapura, Jaipur, Rajasthan, India, 313.

Lal, N., Nath, V., 2020a. Effect of plant age and stress on flowering in litchi (*Litchi chinensis*). Current Horticulture 8 (1), 24−27.

Lal, N., Nath, V., 2020b. Aberrant weather influencing the productivity and quality of litchi under changing climatic condition. National Conference on Climate Conclave 2020: Scientific & Environmental Innovation and Implementation of Sustainable Development Goals, 7-8 March, 2020. Organized by SHEFWEL Society and M.P. Council of Science and Technology, Bhopal.

Lal, N., Pandey, S.K., Nath, V., 2018c. Pericarp morphology influences sun burn in different germplasm of litchi. Book of Abstract, National Conference on Intensification and Diversification in Agriculture for Livelihood and Rural Development May 28−31, 2018, DRPCAU, Pusa, Samastipur, Bihar, India, 21.

Lal, N., Pandey, S.K., Nath, V., Rangare, N.R., 2018b. Diversity in total phenol and flavonoids among litchi genotypes. International Conference on Global Research Initiatives for Sustainable Agriculture & Allied Sciences during 28-30 October 2018 at Rajasthan Agricultural Research Institute, Durgapura, Jaipur, Rajasthan (India), 311.

Lal, N., Singh, A., Gupta, A.K., Marboh, E.S., Kumar, A., Nath, V., 2019d. Precocious flowering and dwarf NRCL-29-A new genetic stock of litchi (*Litchi Chinensis* Sonn.). Chemical Science Review and Letters 8(32), 206−210.

Lauri, P.E., Terouanne, E., Lespinasse, J.M., 1996.Quantitative analysis of relationships between inflorescence size, bearing-axis size and fruit-set-An apple tree case study. Annals of Botany 77, 277−286.

Lee, S.R., 2006. Flowering and fruit set in 'Yu-Her-Pao' litchi (*Litchi chinensis* Sonn.) in Southern Taiwan. Research Bulletin of KDARES 17, 9−19.

Luo, H., Zheng, Z., Lin, S., Chen, H.B., 2005. Changes in endogenous hormones and polyamine during sexual differentiation of lychee flower. Acta Horticulturae 665, 203−208.

May, P., 1970. Physiological and horticultural aspects of flowering and fruit set. Proceedings of the 18th International Horticultural Congress 4, 211−221.

Purbey, S.K., Pongener, A., Marboh, E.S., Lal, N., 2019b. Advances in packaging of litchi fruit to maintain the quality. Current Journal of Applied Science and Technology 38(1), 1−11.

Purbey, S.K., Singh, S.K. Pongener, A., 2019a. Management of light for quality production of litchi. International Journal of Bio-resource and Stress Management 10(5), 529−538. DOI: HTTPS://DOI.ORG/10.23910/IJBSM/2019.10.5.2034

Singh, V.K., Karuna, S., Tiwari, N.K., Rao, O.P., 2016. Effect of certain nutrients on fruit set, fruit retention, physical characters and yield of ber fruit (*Zizyphus mauritiana* Lamk). cv. Banarasi Karaka. International Journal of Bio-resource and Stress Management 7, 648−652. DOI: 10.5958/0976-4038.2016.00100.7.

Singh, A., Nath, V., 2012. Variability in fruit physico-chemical characters of litchi (*Litchi chinensis* Sonn.): an index for selection of improved clones for processing and value addition. Indian Journal of Genetics & Plant Breeding 72(2), 143−147.

Suetsugu, K., Naito, R.N., Fukushima, S., Kawakita, A., Kato, M., 2015. Pollination system and the effect of inflorescence size on fruit set in the deceptive orchid *Cephalanthera falcate*. Journal of Plant Research 128(4), 585−594.

Waseem, K., Ghafoor, A., Rahman, S.U., 2002. Effect of Fruit Orientation on the Quality of Litchi (*Litchi chinenesis* Sonn) under the Agro- Climatic Conditions of Dera Ismail Khan– Pakistan. International Journal of Agriculture and Biology 4, 503−505.