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IMPACT OF CHEMICALS IN MANAGEMENT OF FRUIT CRACKING AND IMPROVING THE QUALITY IN LITCHI CV. CHINA IN FOOT HILL OF NAGALAND

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ABSTRACT

Fruit cracking and sun-burning is a major issue in litchi cultivation that accounts a significant crop loss in India (30-40%) every year. An investigation was carried out to minimize the incidence of cracking and sun-burning of litchi fruit along with quality fruits at Experimental cum Research Farm, Deptt. of Horticulture, SASRD, Nagaland University, Medziphema campus during 2015 to 2016 in cv. China on 25 years old plant. The chemicals viz., kaolin @ 1 % and 3 %, $CaCO_3$ @ 1 % and 2 %, $CaCl_2$ @ 1 % and 2 %, Boron @ 1 % and 2 % and spraying of water (Control) were applied to the bearing plant during fruit growth and development stage by comprising of nine treatments with four replications. The significant results were found by spraying boron @ 1%, $CaCl_2$ @ 2 % and $CaCO_3$ @ 1 & 2 % to minimize the augmentation of fruit cracking (2.87 to 4.21%) in litchi over control (14.90%) and eventually increased normal fruit per cent in treated plants. The calcium content in peel was found to be more in normal fruits varying between 1.71 to 2.33% as compared to cracked fruits (1.15 to 1.43%). The statistical analysis also indicated that the calcium content both in peel and aril had a positive correlation with cracking of fruits. Among the different chemicals, the plants treated with boron and calciun chloride showed maximum biomass production regarding fruit weight (24.00 to 25.10 g) and aril content (52.50 to 62.05 per cent) as well as bio-chemical attributes like TSS (14.75 to 15.55^{0}B), total sugar (7.00 to 7.55 %), reducing sugar (4.15 to 5.35 %), ascorbic acid (35.15 to 51.80 mg 100 g^{-1} pulp) and anthocyanin (49.67 to 68.31 mg 100 g^{-1} peel) content of fruit.

(Key words: Litchi, cv.China, cracking, yield, quality)

INTRODUCTION

Litchi (*Litchi chinensis* Sonn.) is an evergreen subtropical fruit tree and belongs to family sapindaceae. Litchi is native of South China and it reached India by the end of 17th century. India is not only the second largest producer of litchi next to China but also Indian litchis are highly acceptable in the global market for its good size and excellent quality. Bihar is the largest producer of litchi in India followed by West Bengal. The litchi orchardists face a huge crop loss (in India 30-40%) in every year due to fruit cracking and sun burning in different years (Ghosh and Mitra, 2000). Many workers have observed that sun burning and fruit cracking are promoted by high temperature (above 38^0 C) with hot winds, low humidity (below 60 %), low soil moisture resume (above 60 % ASM depletion), hormonal imbalance, deficiency of micronutrients and a varietal character. Moreover, because of high rainfall in hilly topography, the plants suffer from leaching loss of micronutrients abundantly and soil becomes acidic due to undecomposed organic matter in soil (Kundu, 2017). Therefore, the exogenous foliar application of growth regulators and some micronutrients are very much essential to improve the quality as well as reduce the cracking of fruits in litchi. Affected fruits had lower Ca contents in the peel and a lower pulp:peel ratio than normal fruits (Li and Huang, 1995 and Huang *et al*., 2001). Fruit cracking occurs mainly after the fruit begin to colour, coinciding with the start of rapid aril growth (Wang *et al.,* 2006). Fruit cracking in litchi is very common and becomes a great challenge in a given sub-humid and sub-tropical agro climatic condition in Nagaland. Keeping in view the commercial importance and potential of litchi in Nagaland, the research efforts had been intensified to minimize the incidents of fruit cracking and to get the fruit with superior quality.

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MATERIALS AND METHODS

The experiment was carried out on 25 years old litchi plants being maintained at Horticulture Experimental cum Research Farm, SASRD, Nagaland university, Medziphema campus during the year 2015-16.The experimental site was located in the foot hill of Nagaland at the altitude of 305 meters above mean sea level (MSL) with geographical location of 25°45'43" N latitude and 93°53'04" E. The experimental plot was situated at the subtropical and sub-humid climatic condition in foothills of Nagaland. A nutrient mixture of 100 kg FYM, 1000 g N_2, 700 g $P_{-2}O_5$ and 1000 g K_2O plant^{-1} year^{-1} were applied in two split doses. Full amount of FYM and P_2O_5 and half of N_{-2} and K_2O were given just after harvesting of fruit (End of June). Rest N_2 and K_2O were applied 15 days after fruit set (1st week of April) followed by irrigation with ring and basin method. The trees were selected randomly and death twig and unnecessary shoot were pruned before carrying out the experiment. Just after pruning operation, copper oxychloride paste was applied to the cut portions to avoid infestation by pathogen. All the chemicals were sprayed twice, first spray at 15 days after fruit set (pea stage) and second spray was given at 30 days after fruit set (marble stage) using foot sprayer. The micronutrients like calcium chloride and borax were dissolved in hot water for even dilution into water to avoid precipitation of particles. $CaCO_3$ was dissolved in harvested rain water for facilitating proper dilution of particles into water. Before foliar application, the P^H of water was also checked and neutralized using NaOH solution. A sticker agent Indtron AE (non-ionic surfactant) was dissolved in the solution of chemicals for increasing residence time of the droplets onto the leaves. The experiment was laid out in a Randomized Block Design (RBD) with nine treatments and four replications. The various treatments were as follows: T_1: Kaolin @ 1 %, T_2: Kaolin @ 3 %, T_3: Calcium carbonate @ 1%, T_4: Calcium carbonate @ 2 %, T_5: Calcium chloride @ 1 %, T_6: Calcium chloride @ 2 %, T_7: Boron @ 1 %, T_8: Boron @ 2 %, T_9: Control. In experiment, the fruits were categorized as normal, cracked and sun-burnt during harvesting and counted from the individual plant. Observations on various growth and yield characters were recorded as per the standard procedures. Total soluble solids (TSS) of the fruit was determined by EMRA hand refractometer (0-32°B) at 22.5^0 C with necessary correction factor. Titratable acidity of the fruit juice was determined by titrating against N/10 NaOH using phenolphthalein indicator and expressed in percentage. 2, 6-dichlorophenol indophenol dye titration method was used to estimate the ascorbic acid content of fruit and expressed as mg 100 g^{-1} of pulp. Anthocyanin content of the peel was determined by standard procedure as described by Ranganna (2001) using spectrophotometer and petroleum ether as blank by optical density at 503 nm. Total sugar, reducing sugar and non-reducing sugar were estimated using Fehling's A and B reagents with methylene blue as an indicator through copper reduction method (Anonymous, 2000). Calcium content in peel and fruit were estimated by using 0.1 N Potassium permanganate ($KMnO_4$) titration method against a standard solution made from Ammonium oxalate using methyl red inicator as described by Ranganna (2001). The data were statistically analyzed employing randomized block design in accordance with the procedure outlined by Gomez and Gomez (2012).

RESULTS AND DISCUSSION

Per cent of normal, cracked and sun-burnt fruit

The data presented in table 1 revealed that application of chemicals at different concentrations showed a significant influence to minimize the fruit cracking in litchi. The results of the investigation showed that treatments with different concentration of Kaolin, $CaCO_3$, $CaCl_2$, and Boron markedly reduced fruit cracking and sun-burnt and increased fruit set, number of fruits plant^{-1} and consequently high yield. Foliar application of Boron is most effective in controlling fruit cracking followed by $CaCO_3$. Spraying of boron @ 1 % caused the lowest per cent of fruit cracking (2.87 %) whereas, the highest per cent of cracked fruit was recorded in control (T_9) with 14.90 %. Hossain *et al.* (2014) showed boron @ 2 g l^{-1} of water to be the best in respect of minimization of fruit cracking in litchi.

The sun-burnt fruit in bunches was very nominal ranging from 0.06 to 1.62 %. Maximum sun-burnt fruit (1.62 %) was noted in T_9 (control) followed by T_2 (kaolin @ 3 %) with 0.89 % cracked fruit and T_1 (kaolin @ 1 %) with 0.53 % cracked fruit. Most of the treatments were found to be free from sun-burnt fruit mainly noted in T_3 ($CaCO_3$ @ 1 %), T_4 ($CaCO_3$ @ 2 %) and T_7 (Boron @ 1 %). A significant reduction of sunscald damage by application of $CaCO_3$ was also noticed in Murcott tangor fruit by Meng *et al.* (2013).

Calcium content in normal, cracked and sun burnt fruits

The data summarized in table 1 revealed that the calcium content of normal, cracked and sunburnt fruits differed significantly due to spraying of micronutrients. The fruits sprayed with Boron @ 2 % (T_8) has more calcium content (2.33 %) while, the controlled trees has the lowest calcium content (1.71 %) in peel of normal fruits. However, in general we see that the normal fruits significantly have more calcium content (1.71 % to 2.33 % in peel) compared to the cracked (1.15 % to 1.43 % in peel) and sun burnt (1.69 % to 2.04 % in peel) fruits. Li and Huang (1995) reported that there is a strong correlation between cracking and total calcium concentration in different tissues, with less calcium present in the skin of cracked fruits. Huang *et al.* (2001) reported that contents of the pectin-bound calcium in various parts of the pericarp were higher in the cracking resistant variety Huaizhi than in the cracking susceptible Nuomici variety. Haq and Rab (2012) showed the increment of fruit skin calcium content and skin tensile strength by foliar application of $CaCl_2$ @ 3 % and boron @ 1.5 % .

Yield and yield attributing characters

The plants sprayed with Boron @ 1 % (T_7) caused to enhance the fruit retention (45.57 %) followed by 44.30 % in T_6 ($CaCl_2$ @ 2 %) and 43.04 % with T_5 ($CaCl_2$ @ 1 %) compared with 28.09 % in control. Higher retention of fruits resulted in higher yield as a consequences. Rightly application of $CaCl_2$ @ 2 % (T_6) gave maximum yield of 35.90 kg plant^{-1} followed by 29.22 kg plant^{-1} in T_7 (Boron 1 %) and 27.40 kg plant^{-1} in T_8 (Boron @ 2 %) compared with 14.36 kg plant^{-1} in control (water spray). Meshram *et al.* (2017) also found that soil application of boron @ 1.5 kg ha^{-1} significantly enhanced the growth and yield attributing characters in soybean. Application of micronutrients like calcium and boron, maintaining the optimum soil moisture regimes during fruit growth and development resulted increased fruit yields mainly due to increased fruit size and fruit weight. These findings are in complete agreement with earlier findings of Hasan and Chattopadhyay (1993) who sprayed on 12 years old litchi trees cv. Bombai with the chemicals viz., GA_3, NAA, 2,4-D, borax, $ZnSO_4$ and $AgNO_3$ during full bloom and twice subsequently at 2-weekly intervals and got maximum yield, fruit weight and size of over controls with borax at 0.5 %.

Fruit morphological characters

The data presented in table 2 showed the significant variation in different fruit morphological characters among the treatments. However, the impact of $CaCl_2$ @ 2 % and Boron @ 1 % were more pronounced in terms of yield and yield attributes compared with the other chemicals. Maximum fruit weight (25.10 g) was recorded by application of $CaCl_2$ @ 2 % followed by Boron @ 1 % with 24.50 g. The lowest fruit weight (20.66 g) was recorded in control. The highest aril recovery percentage (58.61 %) and lower tubercle density on skin of fruit (26.33 cm^2) were noticed in the plants sprayed with Boron @ 1 % (T_7). Haq and Rab (2012) showed the influence of foliar application of $CaCl_2$ @ 3 % and boron @ 1.5 % increased fruit weight in litchi plant.

Bio-chemical composition of fruits

The different chemicals used in these experiments also influenced the biochemical composition of fruits. The harvested fruits from treated plants showed a variation in TSS from 12.90 to 15.55 ^{0}B, 5.75 to 7.55 % in total sugar and 3.30 to 5.35 % in reducing sugar, 0.448 to 0.636 % in acidity and 27.75 to 51.80 mg 100 g^{-1} of pulp in ascorbic acid. An inquisition of data presented in table 3 revealed that application of boron @ 1 % (T_7) recorded the highest TSS (15.55^0 B), total sugar (7.55 %), and ascorbic acid (51.80 mg 100 g^{-1} of pulp) contents in fruits whereas, in control TSS 12.90^{0}B, total sugar 6.20 % and ascorbic acid 27.75 mg 100 g^{-1} of pulp. The plants treated with micronutrients had proved more effective in increasing TSS, sugar and Vit-C content of fruits that are in complete agreements with earlier findings of Haq *et al.* (2013), who addressed that foliar application of calcium (1-3 %) either alone or in combination with borax (0.5 to 1.5 %) improved the TSS, total sugars, reducing sugars and specific gravity in Bedana litchi over control. A decrease in fruit acidity (0.448 % fresh weight) by treatment with borax and increase in ascorbic acid content (51.80 mg) are in agreement with earlier findings by Babu and Singh (2002), who noticed the less cracked fruits along with improved quality fruit in litchi by applying boron at 0.3 %. The declining in acidity due to boron spray might have either been fastly converted into sugars and their derivatives by the reaction involving reversal glycolytic pathway or might be respiration or both which was reported by Ruffiner *et al.* (1975). The anthocyanin content of fruit peel in litchi varied from 42.39 to 68.31 mg 100 g^{-1} peel. There was a progressive increment in anthocyanin content in peel by spraying of boron @ 2 % that is also corroborated with the early findings of Sarkar and Ghosh (2009), who revealed that application of boron @ 0.50 % improved skin colour and anthocyanin content in litchi peel. Fruits from boron treated trees showed the higher concentration of TSS and anthocyanin than in control plant in sweet cherry (Wojcik and Wojcik, 2006). The present investigation revealed that boron @ 1 % significantly resulted in more number of normal fruits, reduced fruit cracking and better quality of the fruits besides increasing the crop yield.

Table 1. Effect of chemicals on percentage of normal, cracked and sun-burnt fruit with calcium content in peel and pulp of litchi cv. China

Treatments	Normal fruit			Cracked fruit			Sun-burnt fruit		
	Normal fruit (%)	Ca content (% dry wt.)		Cracking (%)	Ca content (% dry wt.)		Burning (%)	Ca content (% dry wt.)	
		Peel	Pulp		Peel	Pulp		Peel	Pulp
T_1: kaolin @1%	88.03 (69.76)*	1.83	0.29	11.43 (66.02)	1.15	0.17	0.54 (4.22)	1.83	0.18
T_2: kaolin @ 3%	91.65 (73.44)	1.87	0.33	7.46 (15.85)	1.23	0.19	0.89 (5.43)	1.73	0.20
T_3: $CaCO_3$@ 1%	95.87 (78.41)	2.10	0.31	4.13 (11.68)	1.24	0.18	0.00 (0.00)	1.79	0.21
T_4:$CaCO_3$@ 2%	96.72 (79.62)	2.15	0.35	3.28 (10.43)	1.27	0.20	0.00 (0.00)	1.93	0.24
T_5: $CaCl_2$ @ 1%	92.82 (74.60)	2.02	0.31	7.03 (15.37)	1.37	0.18	0.15 (0.00)	1.84	0.21
T_6: $CaCl_2$ @ 2%	95.67 (78.02)	2.18	0.40	4.21 (11.83)	1.43	0.22	0.12 (1.98)	2.04	0.25
T_7:Boron @ 1%	97.13 (80.34)	1.89	0.34	2.87 (9.74)	1.25	0.17	0.00 (0.00)	1.81	0.22
T_8:Boron @ 2%	93.10 (74.84)	2.33	0.39	6.84 (15.14)	1.31	0.22	0.06 (1.37)	2.01	0.24
T_9: Control	83.48 (66.02)	1.71	0.21	14.90 (22.70)	1.21	0.20	1.62 (7.31)	1.69	0.20
SE (m) ±	0.73	0.28	0.02	0.36	0.04	0.01	0.03	0.07	0.02
CD at 5 %	2.12	0.90	0.06	1.05	0.11	NS	0.09	0.20	NS

Data of normal, cracked & burnt fruit percentage calculated in angular transform value of parenthesis

Table 2. Effect of chemicals on different fruit morphological attributes in litchi cv. China

Treatments	Fruit retention (%)	Yield plant^{-1} (kg)	Fruit weight (g)	Aril recovery (%)	Tubercle density (cm^2)
T_1: kaolin @1%	37.66 (37.84)	25.36	23.33	51.73	30.00
T_2: kaolin @ 3%	37.75 (37.90)	25.66	23.69	55.19	28.60
T_3: $CaCO_3$ @ 1%	34.35 (35.86)	18.92	22.50	51.03	30.33
T_4: $CaCO_3$ @ 2%	36.26 (37.01)	23.08	21.62	39.48	30.66
T_5: $CaCl_2$ @ 1%	43.04 (40.99)	26.76	24.19	52.50	26.60
T_6: $CaCl_2$ @ 2%	44.30 (41.72)	35.90	25.10	62.05	24.33
T_7: Boron @ 1%	45.57 (42.45)	29.22	24.50	58.61	26.33
T_8: Boron @ 2%	40.96 (39.78)	27.40	24.00	53.13	26.33
T_9: Control	28.09 (31.99)	14.36	20.66	34.91	32.66
SE (m) ±	0.92	0.73	0.35	0.71	0.85
CD at 5 %	2.66	2.13	1.01	2.10	2.47

Table 3. Effect of chemicals on bio-chemical composition of litchi fruits cv. China

Treatments	TSS (^{0}Brix)	Total sugar (% fresh weight)	Reducing sugar (% fresh weight)	Non reducing sugar (% fresh weight)	Titratable acidity (% fresh weight)	Ascorbic acid (mg 100 g^{-1} of pulp)	Anthocyanin (mg 100 g^{-1} peel)
T_1:kaolin @1%	14.10	6.90	4.40	2.37	0.608	29.70	61.45
T_2: kaolin @ 3%	14.30	6.57	4.35	2.10	0.544	33.30	63.37
T_3:$CaCO_3$ @ 1%	14.70	7.40	4.55	2.80	0.544	33.00	47.63
T_4:$CaCO_3$ @ 2%	13.30	6.60	3.30	3.13	0.636	29.60	46.19
T_5:$CaCl_2$@ 1%	14.75	7.00	4.50	2.30	0.576	35.15	57.42
T_6: $CaCl_2$ @ 2%	14.95	5.75	4.15	2.89	0.544	37.00	49.67
T_7: Boron @ 1%	15.55	7.55	4.50	1.32	0.512	51.80	63.17
T_8: Boron @ 2%	14.80	6.75	5.35	1.32	0.448	37.00	68.31
T_9: Control	12.90	6.20	4.00	2.10	0.732	27.75	42.39
SE (m) ±	0.14	0.06	0.15	0.09	0.02	0.37	0.49
CD at 5 %	0.42	0.18	0.43	0.26	0.05	1.08	1.43

REFERENCES

Anonymous, 2000. Official Methods of Analysis (17th Edition). Association of Official of Analytical Chemists. P.O. Box 540, Washington, D.C. USA.

Babu, N. and A. R. Singh, 2002. Effect of micro-nutrients spray on fruit cracking and fruit maturity in litchi. Indian Agri. **46** (3/4):203-207.

Ghosh, S. P. and S. K. Mitra, 2000. Status report on Genetic Resources of Litchi in Thailand, India and Myanmar. IPGRI Report. 56.

Gomez, K. A. and A. A. Gomez, 2012. Statistical procedure for Agricultural Research. 2nd Ed. Ar. Emm. International, Delhi. ISBN: 978-81-265-2395-5.

Hasan, M. A. and P. K. Chattopadhyay, 1993. Effect of chemicals in controlling fruit drop of litchi cv. Bombai. Prog. Hort. **22** (1-4): 18-22.

Haq, I. and A. Rab, 2012. Foliar application of calcium chloride and borax calcium on fruit skin strength and cracking incidence in litchi (*Litchi chinensis* Sonn.). African J. Biotec. **11** (10): 2445-2453.

Haq, I., A. Rab and M. Sajid, 2013. Foliar application of Calcium Chloride and Borax enhance the fruit quality of litchi cultivars. J. Animal & Plant Sci. **23** (5): 1385-1390.

Hossain, M. M., M. S. Hossain and M. M. Islam, 2014. Fruit setting, cracking and quality of litchi (*Litchi chinensis* Sonn.) as influenced by foliar spray of different nutrient solutions during fruit growth and development. International J. Agri. Tech. **10** (3):717-73.

Huang, X. M., J. G. Li, H. C. Wang, H. B. Huang and F. F. Gao, 2001. The relationship between fruit cracking and calcium in litchi pericarp. Acta Hort. **58**: 209–15.

Li, J. G. and H. B. Huang, 1995. Physico-chemical properties and peel morphology in relation to fruit-cracking susceptibility in litchi fruit. J. South China Agri. Univ. **16**: 84–89.

Kundu, M. C., 2017. Nature of acidity in some soils of red and lateritic belt in West Bengal. J. Soils & Crops. **27** (1): 39-44.

Meng, S. T., C. L. Tan and T. C. Pai, 2013. Comparison of bags, calcium carbonate and shade protection in 'Murcott' tangor fruit. Hort. Tech. **23** (5): 659-667.

Meshram, D., P. C. Pagar, V. S. Khawale, V. Raut and R. Khade, 2017. Effect of sulphur and boron on growth, yield and economics of soybean. J. Soils & Crops. **27** (2): 120-123.

Ranganna, S. 2001. Handbook of analysis and quality control for fruit and vegetable products, Tata Mcgraw Hill Publishing Co. Ltd. New Delhi, India.

Ruffiner, H. P., W. Hoblet and D. Rast, 1975. Glucogenesis in the ripening berries of *Vitis vinifera*. Vitis. **13**: 314-328.

Sarkar, A. and B. Ghosh, 2009. Effect of foliar application of micronutrients on retention, yield and quality of fruit in litchi cv. Bombai. Envir. and Ecol. **27** (1): 89-91.

Wang, S. J. E., K. I. Theron, J. Ackerman and S. J. S. Marais, 2006. Harvest and post-harvest apple fruit quality following applications of kaolin particle film in South African orchards. Scientia Hort. **107** (3):271-276.

Wojcik, P. and M. Wojcik, 2006. Effect of boron fertilization on sweet cherry tree yield and fruit quality. J. Plant Nutrition. **29** (10): 1755-1766.

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