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Fruit Setting, Cracking and Quality of Litchi (*Litchi Chinensisi Sonn.)* as Influenced by Foliar Spray of Different Nutrient Solutions During Fruit Growth and Development

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Abstract The study was conducted in order to examine the effects of foliar application of different chemical solutions on fruit setting, cracking and quality of litchi. The study was carried out at the Germplasm Centre of Fruit Tree Improvement Program (FTIP), Bangladesh Agricultural University, Mymensingh. The experiment comprised two factors viz., varieties (China-3 and Mongolbari) and ten pre harvest treatments [Control (T_0), magic growth 0.5, 1.0 and 2.0 ml/L water (T_1, T_2 and T_3, respectively), boron 1.0, 2.0 and 3.0 g/L water (T_4, T_5 and T_6, respectively) and zinc 1.0, 2.0 and 3.0 g/L water (T_7, T_8 and T_9, respectively)]. The experiment was laid out in a three replicated randomized complete block design. The result showed that variety China-3 exhibited the highest percentage of fruit setting at 20, 40 and 60 days after fruit setting (DAFS)(63.84, 47.69 and 39.17%, respectively), normal fruits (72.03%) and maximum total soluble solids (TSS) (21.23 ^{0}Brix), total sugar (14.20%), reducing sugar (10.58%) content, pulp pH (4.54) and sugar/acid ratio (52.66). While Mongolbari variety showed the highest percentage of fruit dropping at 20, 40 and 60 DAFS (41.16, 58.81 and 67.41%, respectively), cracking (11.21%), defected fruits (31.50%) and maximum non reducing sugar (3.66%), vitamin C (30.32 mg/100g) and titratable acidity (0.58%) content. Almost all the parameters studied were found to be influenced by different foliar application treatments. The highest percentage of fruit setting at 20 and 40 DAFS (74.52 and 56.75, respectively) were found from T_5 and 51.24% was found from T_2 at 60 DAFS. The highest normal fruits (81.67%) and maximum total sugar (15.14%), reducing sugar (11.14%) content, pulp pH (5.18) and sugar/acid ratio (62.56) were found in T_5 treated fruits. TSS (21.55, 21.85 and 21.99 ^{0}Brix) were found superior in T_2, T_5 and T_8 treated fruits, respectively. The highest percentage of fruit dropping at 20, 40 and 60 DAFS (48.83, 68.00 and 76.27%, respectively), cracking (14.50%), defected fruits (39.17%) and maximum vitamin C (33.51 mg/100g) and titratable acid (0.73%) content were found from control. The maximum non reducing sugar (4.22%) was obtained from T_7 treated fruits. The maximum normal fruits (86.67%), total sugar (16.17%), reducing sugar (12.10%) content, pulp pH (5.72) and sugar/acid ratio (71.93) were recorded from China-3 provided with T_5. From the above findings it could be concluded that China-3 variety and treatment T_2, T_5 and T_8 were found to be the best in respect of percent fruit setting, dropping, cracking, normal and defected fruits and biochemical compositions considering under the climatic conditions of Mymensingh.

Keywords: Magic growth, boron, zinc foliar spray, litchi (*Litchi chinensis* Sonn.)

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Introduction

Litchi (*Litchi chinensis* Sonn.) is one of the most popular subtropical edible fruits of the Sapindaceae family. It is widely known as litchi and regionally as 'lichi', 'lichee', 'laichi', 'leechee' or 'lychee'. It is originated from China, where it has been cultivated for over 3000 years and was introduced to Myanmar and Indian subcontinent including Bangladesh about 100 years later (Mitra, 2004). The leading litchi growing countries of the world are China, Myanmar, Taiwan, Thailand, Vietnam, Indonesia, India, Pakistan, the Philippines, West Indies, USA, Brazil, Israel, Mauritius, Madagascar, South Africa and Australia (Menzel and Simpson, 1986; Tindall, 1994). Litchi is considered as the queen of the fruits due to its excellent quality, juicy fruit, slightly sour and sweetly taste, characteristic pleasant flavor and for attractive color and nutritional value. It comes to the market in the months of May-June when the market is full of other fresh fruits. In spite of the availability of different types of fruit in the market, the demand for fresh litchi is always very high due to its unique taste, flavor and color. The food value of litchi mainly lies in its sugar and acid contents which again vary due to cultivars and climate.

The sugar content in different cultivars ranges from 6.74 to 18.86 percent, besides sugar, litchi contains 0.7% protein, 0.3% fat, 0.7% minerals (particularly calcium and phosphorus) and vitamin C 40-60 mg/100g pulp (Bose and Mitra, 1990; Scanlan, 1995). In Bangladesh, litchi is mainly grown in greater Pabna, Dinajpur, Rajshahi, Rangpur, Kustia, Jessore, Magura, Meherpur, Mymensingh and Chittagonj districts. Bangladesh produces 55.3 thousand mt litchi fruit per annum from 1608.50 ha of land (BBS, 2009).The drop of fruit is thought to be due to failure of fertilization, embryo abortion, internal nutrition and hormonal imbalance and external factors like high temperature, low humidity and strong winds (Menzel *et al*., 1986). It is postulated that the high incidence of fruit abscission in litchi could be a physiological rather than a genetic problem (Fivaz and Robbertse, 1995). Skin-cracking of developing fruit can be serious problem in litchi which is promoted by high temperature, low humidity and low soil moisture (Kanwar *et al*., 1972; Kanwar and Nijjar, 1975). Inadequate moisture during the early period of fruit growth results in the skin becoming hard and inelastic (sun-burnt), and it may crack when subjected to increased internal pressure as a result of rapid aril growth following irrigation (Menzel, 1984). In general, cultivars, which have relatively thin skin, few tubercles per unit area and rounded to flat in shape, are less prone to crack (Kanwar *et al*., 1972). Spraying with a solution containing zinc compounds significantly increased the zinc levels in the leaves and fruit peel and significantly lowered fruit cracking rate. Water stress reduced the zinc

accumulation in fruit peel especially during rapid aril growth and thus increased the fruit cracking rate. China-3 and Mongolbari are popular litchi varieties in Bangladesh but they have serious fruit dropping and cracking problem, which reduce total litchi production. Therefore, it is very urgent to overcome these problems in litchi. Magic growth, a newly developed nutrient solution mixture has been successfully reduced fruit drop in mango. In this experiment, the efficacy of magic growth and other micronutrients will be examined to overcome the aforesaid problem in litchi cultivation in Bangladesh.

Materials and methods

The study was conducted at the Germplasm Centre of Fruit Tree Improvement Program (FTIP), Bangladesh Agricultural University, Mymensingh during the period from February, 2011 to June, 2011 to investigate the effects of foliar application of different nutrients on fruit setting, cracking and quality of litchi. The two factor (variety and pre harvest treatment) experiment was laid out in a randomized complete block design with three replications. Each plant was divided into 10 units where 10 treatments were allocated at random. Thus, there were 60 ($2 \times 10 \times 3$) treatments altogether in the experiment. It consists of two varieties of litchi; V_1 = China-3, V_2 = Mongolbari. Three litchi trees of each variety China-3 and Mongolbari were used as experimental plants. Boron (B) as boric acid (H_3BO_3), zinc (Zn) as zinc sulphate ($ZnSO_4$), magic growth and a garden hand sprayer were supplied from GPC. Composition of magic growth was 12% N, 10% P_2O_5, 6% K_2O and trace amount of S, Zn & Ca. (Arif, 2011). The treatments were randomly assigned to the selected branches. Each treatment replicates three times. When the fruits were full matured then base of each branch was broken by hand. After harvesting fruit branches were packed in polythin bag. When all fruits were harvested and pack then all the samples were stored at -20^0 C in Fruit Research Laboratory Dept. of Horticulture BAU for quality assessment. The parameters such as percent fruit setting, percent fruit dropping, percent fruit cracking, percent normal and defected fruits, TSS, total sugar, reducing sugar, non-reducing sugar, vitamin C, titratable acidity content, pulp pH and sugar/acid ratio were determined. The physico-chemical parameters were measured according to the methods described by Ranganna (1979). The treated fruits were keenly observed at 20 days interval during the entire period of study. Ten fruits in each replication of each treatment were used for destructive sampling to investigate postharvest parameters.To evaluate fruit setting, fruit dropping and fruit cracking from each treatment, fruits of the selected branches were counted before spraying. The second counting was done 20 days after foliar spray (DAFS) and third counting was done 20 DAFS of second counting and so

on. Finally, the percentage of fruit setting, fruit dropping and fruit cracking were determined. Percentage of normal (Fully mature, fresh and without any injury) and defected fruits (Insect infested, under size, cracked, dry and rotten) were also determined. After harvest, fruits were kept in the field laboratory under room temperature (25 ± 2 °C) until fruit become attain marketable condition; the required number of days was counted. TSS content of litchi pulp was determined by using a handheld Abbe's Refractometer. Temperature corrections were made by using a temperature correction chart described by Ranganna (1979). Total sugar content of litchi pulp was determined calorimetrically by the method of Jayaraman (1981). Extraction of sugar from litchi pulp was done by following the method of Loomis and Shull (1937). Reducing sugar content of litchi pulp was determined according to the method of Miller (1972), where dinitrosalicylic acid was used for the development of color. Non reducing sugar content of litchi pulp was calculated by using the following formula: %non-reducing sugar = % total sugar - % reducing sugar Vitamin C content of fruit pulp was estimated by using 2, 6- dichlorophenol indophenols visual titration method as described by Plummer (1971). The titratable acidity of litchi pulp was determined by method of Ranganna (1979).

Statistical analysis

The data obtained from the experiment on various parameters were statistically analyzed in the MSTAT program. The mean values for all parameters were calculated and analysis of variances for the characters was accomplished by *F* variance test. Comparison of means was tested by the least significant difference test at 5% and 1% levels of probability (Gomez and Gomez, 1984).

Results and discussions

Percent fruit setting at 20, 40 and 60 days after foliar spray (DAFS)

Significant differences were observed between the litchi varieties in respect of percent fruit setting at 20 DAFS. The higher fruit setting (63.84%) was recorded in China-3. On the other hand, the lower percentage of fruit setting (58.84) was found in Mongolbari (Table 1). The variations among the different foliar application treatments in terms of percent fruit setting at 20 DAFS were significant. Fruit setting at 20 DAFS ranged from 51.17 to 74.52%. The highest fruit setting (74.52%) was found in T_5 (2.0g B/L water), followed by magic growth T_2 (71.13%) and the lowest (51.17%) was recorded in control

(T_0) (Table 2). Sharma and Roy (1987) reported that fruit set occurred within 1-8 days of flowering.

Significant variations were observed between the tested varieties in respect of percent fruit setting at 40 DAFS. Higher fruit setting (47.69%) was recorded in China-3. Lower fruit setting (41.20%) was obtained in Mongolbari (Table 1). The variations among the different foliar application treatments in terms of percent fruit setting at 40 DAFS were significant. Fruit setting at 40 DAFS ranged from 31.84-56.75%. The highest fruit setting (56.75%) was found in B (2.0g/L water) which was statistically similar with magic growth (1.0 ml/L water) (56.21%) and the lowest (31.84%) was control (Table 2).

Significant variation was found from the percent fruit setting at 60 DAFS between the tested varieties. Higher fruit setting (39.17%) was recorded in China-3. Lower fruit setting was obtained in Mongolbari (31.87%) (Table 1). The effect of different foliar application treatments on the percent fruit setting at 60 DAFS were found significant. Fruit setting at 60 DAFS ranged from 23.90-51.24%.The highest fruit setting (51.24%) was recorded in T_2 treatment. Probably this is happened as because litchi plants received more food through foliar application of T_2 treatment combination, followed by T_5 (45.48%). The lowest number (23.90%) of fruit setting was found in control (T_0) (Table 2). These results were found similar to the observation of Rajput and Ram (1979), who reported that three spraying of Zn and B at 0.1 and 0.4%, respectively caused improvement flowering, fruit set, fruit relation and fruit quality of mango.

Percent fruit dropping at 20, 49 and 60 days after foliar spray (DAFS)

Wide variation was observed between the varieties in respect of percent fruit dropping at 20 DAFS. The higher dropping (41.16%) was recorded in Mongolbari. The lower percentage of fruit dropping was found in China-3 (36.16%). The variations among the different foliar application treatments in terms of percent fruit dropping at 20 DAFS were significant. Fruit dropping at 20 DAFS ranged from 25.48 to 48.83. The highest fruits dropping (48.83%) was recorded from the control, followed by T_9 (46.95%) whereas, the lowest fruits dropping (25.48%) was observed in T_5, followed by (28.87%) with T_2 (Fig. 1). Chadha and Singh (1965); Singh (1968) found increased fruit dropping during the rapid development of ovary at the initial stage.

A significant variation was observed between the tested varieties in respect of percent fruit dropping at 40 DAFS. Higher fruit dropping (58.81%) was recorded in Mongolbari. Lower fruit dropping was obtained in China-3 (52.24%). The foliar application treatments were exerted significant variation on percent fruit dropping at 40 DAFS.Fruit dropping at 40 DAFS ranged from

43.25 to 68.00%.The highest fruit dropping (68.00%) was found in control, followed by T_9 (65.33%) and the lowest (43.25%) was recorded in T_5, which was statistically similar with T_2 (43.79%) (Fig. 1).

Significant variation was observed between the tested varieties in respect of percent fruit dropping at 60 DAFS. Higher fruit dropping (67.41%) was recorded in Mongolbari. Lower fruit dropping was obtained in China-3 (60.91%).The variations among the different foliar application treatments in terms of percent fruit dropping at 60 DAFS were significant. Fruit dropping at 60 DAFS ranged from 48.76 to 76.27%. The highest fruit dropping (76.27%) was found in T_0, followed by T_9 (74.51%) and the lowest (48.76%) was recorded in T_2, followed by T_5 (53.22%) (Fig. 1). Jawanda and Singh (1961) gained experience on the fruits set and extent of fruits drop and reported that on an average only 0.4 percent fruit per panicle was obtained during the harvesting time.

Percent fruit cracking

The varietal difference had significant variation in cracking of percent fruits per plant in litchi. The higher cracking of fruits (11.21%) was found in Mongolbari whereas, the lower cracking of fruits (9.19%) was found in China-3 (Table 1). On the other hand, different foliar application treatments had the significant effect on percent fruit cracking in litchi. Fruit cracking ranged from 4.88 to 14.50%.Maximum number of cracked fruits (14.50%) was found in T_0, followed by T_7 (13.26%). Again the lowest number of cracked fruits (4.88%) was obtained with T_5 followed by T_2 (6.40%) (Fig. 2).

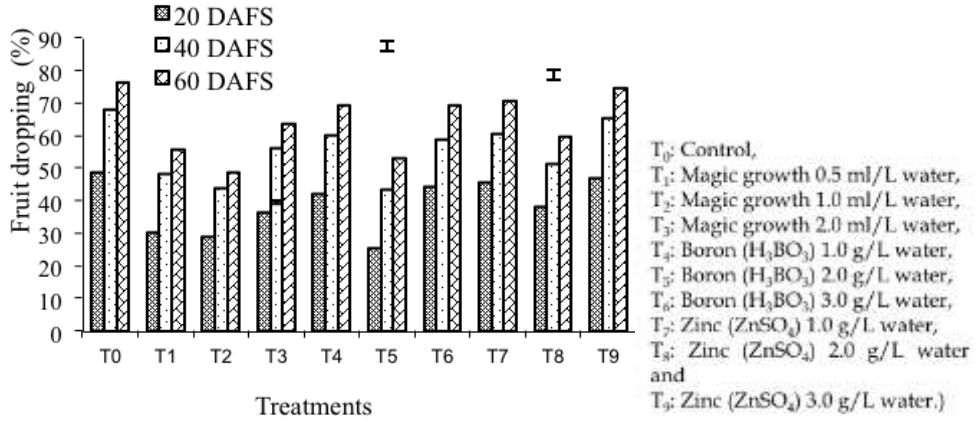

Fig. 1. Effects of foliar application on fruit dropping at different DAFS of litchi. Vertical bars represent LSD at 1% level of significance.

Percent normal and defected fruits

A wide variation was observed between the varieties in respect of percent normal and defected fruits. The higher normal fruits (72.03%) and lower defected fruits (27.97%) were recorded in China-3 and the lower normal fruits (68.50%) and higher defected fruits (31.50%) were recorded in Mongolbari (Table 1). Highly significant variations were also observed among the different treatments in terms of percent normal and defected fruits. Normal and defected fruits ranged from 60.83 to 81.67% and 18.33 to 39.17%, respectively. The maximum normal fruits (81.67%) and minimum defected fruits (18.33%) were recorded from the T_5 treatment, followed by T_2 (78.00%) and (22.00%), respectively, whereas, the minimum normal fruits (60.83%) and maximum defected fruits (39.17%) were recorded from the T_0 treatment, followed by T_6 (61.50%) and (38.50%), respectively (Fig. 3 and Table 2, respectively).

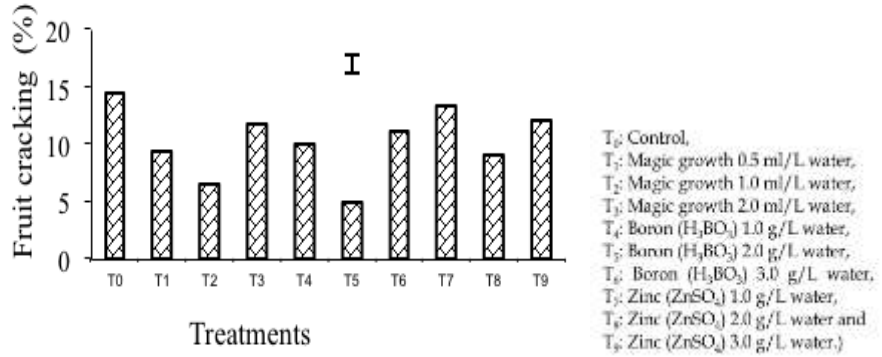

Fig. 2. Effects of foliar application treatments on fruit cracking (%) of litchi. Vertical bar represent LSD at 1% level of significance.

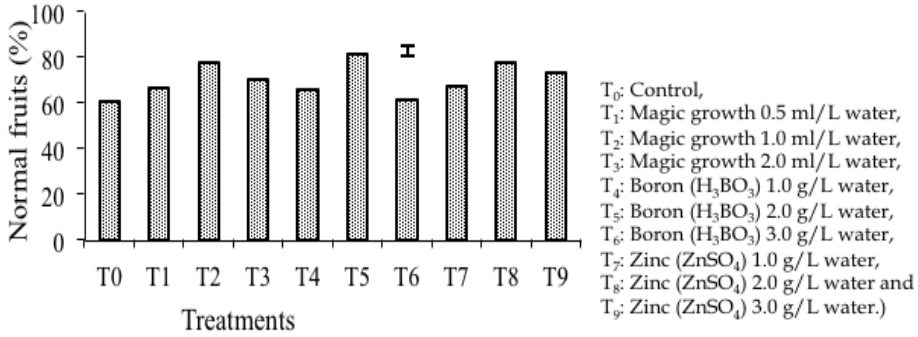

Fig. 3. Effects of foliar application treatments on normal fruits (%) of litchi. Vertical bar represent LSD at 1% level of significance.

Total soluble solids (TSS)

Total soluble solids content of two litchi varieties were measured at ripe stage and presented in Table 3. It was observed that, the varietal difference in relation to total soluble solids (TSS) contents was significant. China-3 contained the higher TSS (21.23 ^{0}Brix) and the lower (19.48 ^{0}Brix) was found in Mongolbari (Table 3). The various foliar application treatments used in the present investigation exerted significant variation.

Table 1. Effect of varietal differences on percent fruit setting, fruit cracking and defected fruits of litchi

Variety	Fruit setting (%) at			Fruit cracking (%)	Defected fruits (%)
	20 DAFS	40 DAFS	60 DAFS		
China-3	63.84	47.69	39.17	9.19	27.97
Mongolbari	58.84	41.20	31.87	11.21	31.50
$LSD_{0.05}$	0.48	1.09	0.39	0.17	1.25
$LSD_{0.01}$	0.65	1.46	0.53	0.23	1.67
Level of significance	**	**	**	**	**

Table 2. Effect of different foliar application treatments on percent fruit setting and defected fruits of litchi

Treatments	Fruit setting (%) at			Defected fruits (%)
	20 DAFS	40 DAFS	60 DAFS	
T_0 (Control)	51.17	31.84	23.90	39.17
T_1(Magic growth 0.5 ml/L	69.88	51.89	44.10	33.5
T_2(Magic growth 1.0 ml/L	71.13	56.21	51.24	22.00
T_3(Magic growth 2.0 ml/L	63.83	43.74	36.25	30.00
T_4 (H_3BO_3 1.0 g/L water)	58.07	39.97	30.62	34.17
T_5(H_3BO_3 2.0 g/L water)	74.52	56.75	45.48	18.33
T_6(H_3BO_3 3.0 g/L water)	55.63	40.95	29.45	38.50
T_7($ZnSO_4$ 1.0 g/L water)	54.44	39.64	29.17	32.50
T_8($ZnSO_4$ 2.0 g/L water)	61.70	48.79	40.40	22.17
T_9($ZnSO_4$ 3.0 g/L water)	53.05	34.67	24.66	27.00
$LSD_{0.05}$	1.08	2.44	0.88	2.79
$LSD_{0.01}$	1.44	3.27	1.19	3.74
Level of significance	**	**	**	**

Total soluble solids (TSS)

Total soluble solids content of two litchi varieties were measured at ripe stage and presented in Table 3. It was observed that, the varietal difference in relation to total soluble solids (TSS) contents was significant. China-3 contained the higher TSS (21.23 ^{0}Brix) and the lower (19.48 ^{0}Brix) was found in Mongolbari (Table 3). The various foliar application treatments used in the present investigation exerted significant variation on TSS contents. Total soluble solids (TSS) content of the fruits ranged from 18.28 to 21.99 ^{0}Brix. Maximum total soluble solid (21.99 ^{0}Brix) was recorded from T_8 treatment, which was statistically identical with T_5 (21.85 ^{0}Brix) and T_2 (21.55 ^{0}Brix) treatment. The minimum TSS (18.29 ^{0}Brix) was recorded in T_0 treatment, followed by T_3 (19.37 ^{0}Brix) (Fig. 4). The results of the present experiment are in agreement with those of Sharma and Roy (1987) whom reported that total soluble solids varied from variety to variety. They reported that TSS of litchi cultivars Shahi, Rose Scented, Prubi, China and Bedana were 20.8, 19.6, 19.0, 20.5 and 19.0%, respectively.

Total sugar content of litchi pulp

Significant variations were found in total sugar content of two litchi varieties. The higher sugar content (14.20%) was recorded in China-3 and the lower percentage of sugar (13.42%) was recorded from Mongolbari (Table 3). The different foliar application treatments involved in the investigation were found to cause significant effects in relation to total sugar content. Total sugar content of the fruits ranged from 13.05 to 15.14% .The maximum sugar content was recorded in T_5 (15.14%), followed by T_2 (14.68%) and T_8 (14.23%). The minimum (13.05%) was found in T_0 treatment, followed by T_9 treatment (13.33%)(Table 4). The range of sugar content in fruits of Indian varieties varies from 6.74 to 18.0% with average 11.85% (Singh and Singh, 1954; Chadha and Rajput, 1969). Chan *et al.* (1975) found 18.7% sugar in Brewster cultivars grown in Hawaii.

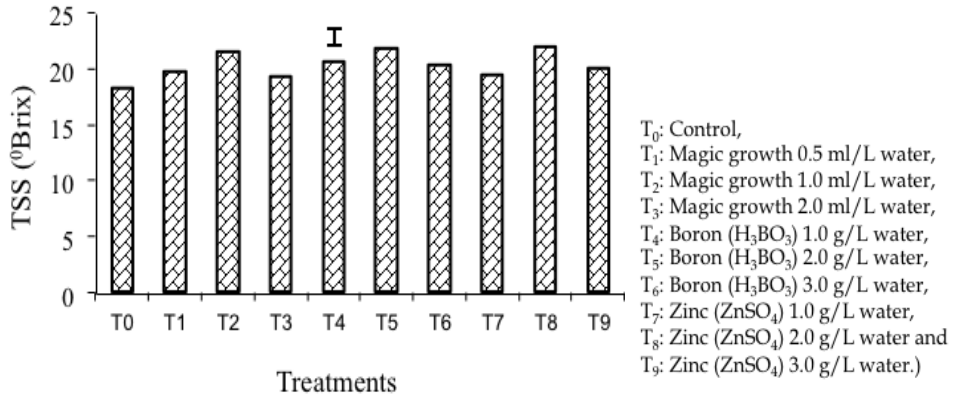

Fig. 4. Main effects of foliar application treatments on TSS (^{0}Brix) content of litchi. Vertical bar represents LSD at 1% level of significance.

Reducing sugar content

Significant variations were found between the varieties in respect of reducing sugar content of fruit pulp. Higher quantity of reducing sugar (10.58%) was measured in China-3, while the lower (9.76%) reducing sugar was found in Mongolbari (Table 3). Variations among the different foliar application treatments in relation to reducing sugar content were statistically significant. Reducing sugar content of the fruits ranged from 9.13 to 11.14%. The Maximum reducing sugar content (11.14%) was found in T_5 treatment followed by 10.95% in T_2, while the minimum (9.13%) was found in T_7 treatment which was statistically similar with T_9 (9.51%), T_0 (9.67%) and T_4 (9.71%) (Table 4). The results are in agreement with the findings of Singh *et al.* (1991) who reported that treatment with Urea increased reducing sugar. Singh *et al.* (1973) studied seven cultivars of litchi fruit and found that reducing sugar of ripe fruit varied from 8.23 to 14.48%.

Non-reducing sugar content

The varietal difference had not any significant variation in the non-reducing sugar contents.The higher non- reducing sugar (3.66%) was found in Mongolbari, while the lower (3.62%) was found in China-3 (Table 3). The effects of different foliar application treatments were found to be significant in relation to non-reducing sugar contents in litchi. Non reducing sugar content of the fruits ranged from 3.19 to 4.22%. The highest (4.22%) non-reducing sugar was found in T_7 treatment, followed by (4.00%) in T_5 treatment, whereas the lowest was (3.19%) found in T_6, followed by (3.38%) in

untreated (Table 4). Singh *et al.* (1973) studied seven cultivars of litchi fruit and found that non-reducing sugar of ripe fruit varied from 3.02 to 6.60%.

Vitamin C content

Significant differences were observed between the litchis varieties in case of vitamin C content. The ascorbic acid content of the fruits of two litchi varieties ranged from 27.48 mg/100 g to 30.32 mg/100 g. The fruit pulp of Mongolbari contained the higher percentage of ascorbic acid (30.32 mg/100 g) and the lower 27.48 mg/100 g was recorded in China-3. Various foliar application treatments adopted in the present study showed significant variation in relation to vitamin C content. Vitamin C content of the fruits ranged from 24.50 mg/100 g to 33.51mg/100 g. The maximum vitamin C was found in T_0 treatment, followed by 31.90 mg/100 g in T_7 treatment. The minimum vitamin C content (25.50 mg/100 g) was obtained from T_5 treatment, followed by (25.84%) in T_2 treatment (Fig. 5). Palaniswamy *et al*. (1974) reported that vitamin C content of ripen litchi varied from 31 to 64 mg/100g. These findings are in agreement with Kumar and Kumar (1989) who reported that fruits sprayed with zinc showed higher sugar content and lower acidity than unsprayed mango fruits.

Titratable acidity

Variations in between the varieties in relation to titratable acidity were statistically significant. The higher titratable acidity (0.58%) was found in Mongolbari. The fruit of China-3 had the lower content of titratable acidity (0.0.47%) (Table 3). The different foliar application treatments used in the present study in terms of the titratable acidity exhibited significant result. Titratable acidity content of the fruits ranged from 0.34 to 0.73%. The highest titratable acidity (0.73%) was found in T_0, followed by (0.66%) in T_4 treatment. On the other hand, the lowest titratable acidity (0.34%) was found in T_5 treatment, followed by (0.37%) in T_8 treatment. Singh and Singh (1954) reported a range of 0.2 to 0.64% acids for 12 Indian cultivars of litchi fruit. A range of 0.31 to 0.50% acids was noticed in Hawaii cultivars of litchi.

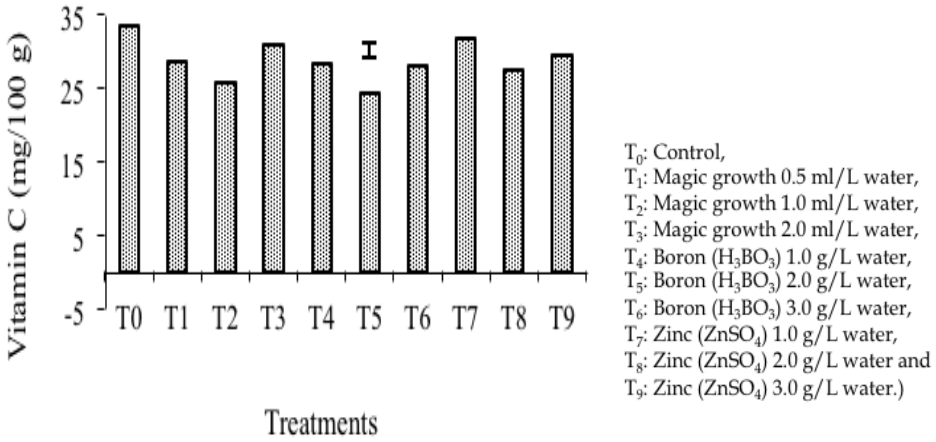

Fig. 5. Effects of foliar application treatments on vitamin C (mg/100g) contents of litchi pulp at mature stage, Vertical bar represents LSD at 1% level of significance.

Pulp pH

Statistically significant variations in pulp pH were noticed between the varieties. The pH of the juice of two litchi varieties ranged from 3.98 to 4.54. The higher (4.54) pH was found in China-3. The lower pH (3.98) was noted from the juice of Mongolbari. The variations among the different foliar application treatments in terms of pulp pH were significant. pH of the fruits ranged from 3.52 to 5.18. The highest pulp pH (5.18) was found in T_5 treatment, followed by (4.83) in T_2 treatment and the lowest (3.52) was recorded in T_0treatment, followed by (3.72) in T_7 treatment (Fig. 6). Menzel and Simpson (1986) also reported that pH of the juice of litchi was in the range between 3.45 and 4.22.Teaotia *et al.* (1963) studied the chemical composition of five cultivars of litchi and reported that pH, ranged from 4.7 to 5.0.

Sugar/acid ratio

Significant differences were observed between the litchis varieties in case of sugar/acid ratio. The sugar/acid ratio of the fruits of two litchi varieties was ranged from 44.61 to 52.66. Chaina-3 showed the higher sugar/acid ratio (52.66) and the lower (44.61) was recorded in Mangolbari (Table 3). Various foliar application treatments adopted in the present study showed significant variation in relation to sugar/acid ratio. The sugar/acid ratio of the fruits ranged from 39.02 to 62.56. The highest sugar/acid ratio (62.56) was found in T_5 treatment, followed by (57.30) in T_2 treatment and the lowest (39.02) was recorded in T_0, followed by (41.85) in T_7 treatment.

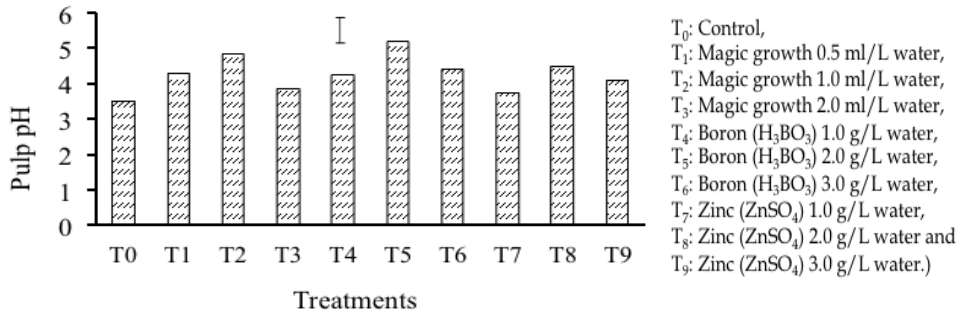

Fig. 6. Effects of foliar application treatments on pulp pH of litchi. Vertical barrepresent LSD at 1% level of significance

Table 3. Effect of varietal differences on the biochemical composition of two varieties of litchi

Variety	Total soluble solids (^{0}Brix)	Total sugar (%)	Reducing sugar (%)	Non reducing sugar (%)	Titratable acidity (%)	Sugar/acid ratio
China-3	21.23	14.20	10.58	3.62	0.47	52.66
Mongolbari	19.48	13.42	9.76	3.66	0.58	44.61
$LSD_{0.05}$	0.34	0.04	0.04	0.06	0.033	0.21
$LSD_{0.01}$	0.45	0.05	0.06	0.09	0.004	0.28
Level of significance	**	**	**	NS	**	**

Table 4. Effect of different foliar application treatments on the bio chemical composition of litchi

Treatments	Total sugar (%)	Reducing Sugar (%)	Non reducing sugar (%)	Titratable acidity (%)	Sugar/acid ratio
T_0 (Control)	13.05	9.67	3.38	0.73	39.02
T_1(Magic growth 0.5 ml/L water)	13.57	10.09	3.48	0.55	47.94
T_2(Magic growth 1.0 ml/L water))	14.68	10.95	3.73	0.40	57.30
T_3(Magic growth 2.0 ml/L water)	13.45	10.13	3.32	0.47	43.36
T_4 (H_3BO_3 1.0 g/L water)	13.58	9.71	3.87	0.66	47.68
T_5(H_3BO_3 2.0 g/L water)	15.14	11.14	4.00	0.34	62.56
T_6(H_3BO_3 3.0 g/L water)	13.75	10.56	3.19	0.49	49.52
T_7($ZnSO_4$ 1.0 g/L water)	13.35	9.13	4.22	0.52	41.85
T_8($ZnSO_4$ 2.0 g/L water)	14.23	10.82	3.41	0.37	51.89
T_9($ZnSO_4$ 3.0 g/L water)	13.33	9.51	3.82	0.51	45.25
$LSD_{0.05}$	0.09	0.10	0.14	0.006	0.46
$LSD_{0.01}$	0.12	0.13	0.19	0.009	0.62
Level of significance	**	**	**	**	**

** = Significant at 1% level of probability, NS = Not Significant

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