Journal of Applied Horticulture, 18(1): 71-75, 2016

Effect of chemicals and physical means on harvesting span, yield and quality of litchi (*Litchi chinensis* Sonn.) cv. Rose Scented

M. Pal, R.L. Lal, P. Nautiyal* and P. Joshi

*Department of Horticulture, College of Agriculture, G.B. Pant University of Agriculture and Technology, Pantnagar-263145, U.S. Nagar (Uttarakhand), India. *E-mail: pankajnautiyal2009@gmail.com*

Abstract

An investigation was carried out for extending harvesting span of litchi (*Litchi chinensis*) cv. Rose Scented on twenty year old litchi trees at Pantnagar, U.S. Nagar (Uttarakhand, India). The experiment consisted of 10 treatments [30% shade net (T_1), 50% shade net, (T_2), 20 ppm GA_3 (T_3), 40 ppm GA_3 (T_4), 20 ppm BA (T_5), 40 ppm BA (T_6), 4% KNO_3 (T_7), perforated polyethylene bagging (T_8), silver thiosulphate (STS), 10 mM (T_9) and control (T_{10})] in Randomized Block Design with four replications. The application of KNO_3 @ 4% resulted in significantly higher fruit set per panicle (64.93). Maximum fruit drop of 79.05 per cent was observed under control while under shade net (30%) low per cent fruit drop was recorded. Shade net (50%) checked the fruit cracking (4.49%) whereas; maximum fruit cracking took place in untreated trees. The maximum delay in harvest (16 days) was recorded in shade net 50% closely followed by shade net 30% (14 days). Significantly more fruit yield per tree (116.50 kg) was recorded in shade net (50%). Treatment of GA_3 (40 ppm) being at par with BA @ 20 and 40 ppm exhibited significantly more TSS, total sugars and non-reducing sugars. Application of KNO_3 @ 4% exhibited significantly higher reducing sugars and lower titratable acidity, however, difference in ascorbic acid content were found to be non-significant among different treatments. Shading extended the harvesting span and maximized fruit quality and yield of litchi.

Key words: Shade, GA_3, BA, litchi, quality, maturity time

Introduction

The litchi (*Litchi chinensis* Sonn.) is one of the most important subtropical fruit known for its beauty, fragrance and aril quality. Uttarakhand is an important state in India for litchi growing. The Rose Scented cultivar of litchi is the popular cultivar in Uttarakhand. The litchi industry in Uttarakhand is dependent upon this cultivar but the availability of this cultivar in the market is for limited span due to very short harvesting period. The harvesting span may be extended for few days by using different means such as genotypes or by chemicals or by physical means. However, much scope is not there as available genotypes differ little with regard to their maturity period. To extend the harvesting span two strategies may be employed *i.e.* either delaying the harvesting date or advancement of harvesting date. Exogenous application of plant growth regulators for improving fruit quality and shelf life of litchi has been reviewed by Guangwen *et al*. (2010). Higher fruit quality attributes were recorded with GA_3 (40 ppm) followed by GA_3 20 ppm over other treatments. Reduced fruit cracking was also observed in trees which were sprayed with GA_3 and BA (Mishra *et al*., 2012)

Early flowering and fruiting was observed in mango by using potassium nitrate (Kumar *et al.,* 2003). Wang *et al*. (2005) found that the cytokinins reduced the sugar accumulation and pigmentation in litchi. The harvest period in one orchard is quite short, which is 7-10 days. This harvesting period may be extended through delaying the fruit maturation and ripening. The use of shade net delayed the harvesting period and extended fruit availability (Pal and Mishra, 2012). Mandal *et al*. (2014) observed that ethrel (2 mL/L) was most effective for flower induction and fruit quality in litchi cultivar 'Bombai'. Yin *et al.* (2001) reported that the application of silver thiosulphate delayed the maturation and colouration of fruits which extended the harvesting period of litchi in the orchard. Considering the above points in the view, an experiment was designed to determine the influence of different treatments on time of fruit maturity and quality in litchi.

Materials and methods

The experiment was conducted at Horticulture Research Centre, Patharchatta, GBPUA&T, Pantnagar, U.S. Nagar, Uttarakhand, India, on twenty year old plants spaced at 10 X 10 m.

Trees shaded by erecting overhead shade nets producing 30% (T_1) and 50 % (T_2) shade. To improve the fruits color, the shade nets were removed before one week of harvesting. GA_3 @ 20 ppm (T_3) and 40 ppm (T_4) and BA (6-Benzyl adenine) @ 20 ppm (T_5) and 40 ppm (T_6) were sprayed only once before 15 days of harvesting (15th May). KNO_3 (4%) was sprayed at one centimeter panicle size during February (T_7). Bagging of fruit bunches (T_8) with perforated and transparent polyethylene was done two weeks before the normal expected date of harvesting (on 15th May). Two spray of silver thiosulphate @ 10 mM at 15 days interval were given on 30th April and 15th May, respectively (T_9). There were 10 treatments applied including control (T_{10}) in Randomized Block Design with four replications. All trees were given uniform cultural practices except treatment and all the treatments were applied on separate trees.

Results and discussion

The data revealed that in treatment T_7, fruit set/panicle was maximum (64.93) followed by T_3 (61.68) while in control trees fruit set/panicle was minimum (45.50). Treatment T_2, T_3, T_7 and T_9 showed improvement over control (Table 1). Treatment with KNO_3 (4%) resulted in maximum initial fruit set**.** Dalal *et al.* (2005) and Khattab *et al.* (2006) reported higher fruit set by the application of KNO_3 (4%) in mango. The fruit retention was maximum in the treatment T_4 (GA_3 @ 40 ppm) followed by treatment T_1 (shade net 30%). Kassem *et al*. (2010) reported that the GA_4 resulted higher fruit retention and yield followed by Amcotone and NAA in persimmon. Rani and Brahmachari (2001) reported that GA_3 proved to be the best for enhancing the fruit retention when sprayed at 50 ppm concentration in litchi cv. Purbi and Deshi.

Minimum fruit drop was recorded in shade net (30%) followed by GA_3 (40 ppm) while maximum fruit drop was recorded in untreated trees. Fruit drop in litchi is a serious problem. Reduction in the fruit drop of litchi has been reported as a result of exogenous application of growth regulators (Munish *et al.*, 2003). Minimum percentage of fruit cracking was noted in treatment T_2 (4.49%) followed by T_1 (5.28%) while the maximum fruit cracking was registered in untreated trees. Pal and Mishra (2012) reported that the litchi trees under shade net resulted in decreased fruit cracking and delayed harvesting span. Data indicated that shade nets are best for less fruit cracking of litchi fruits. Foliar spray of gibberellins and benzyl adenine are also good for reduced percentage of fruits cracking. All the treatments except KNO_3 (4%) resulted in delayed harvesting over control. However, maximum delay in harvest (16 days) was recorded in shade net 50% closely followed by shade net 30% (14 Days) and KNO_3 @ 4% resulted in advancement of fruit harvest for 2 days in comparison to control. Similar findings were observed by Tomer *et al.* (2001) and Yin *et al.* (2001) in litchi. It is well known that litchi fruits require a minimum heat unit to reach its maturity. Use of shade nets acts as barrier for sun rays thereby results in less heat available to the fruits and therefore, delays the fruit maturity. Delay in maturation due to spray of STS indicate that ethylene is involved in regulation of the ripening events (Tomer *et al*., 2001).

The higher fruit weight was recorded in BA (20 ppm), GA_3 (40 ppm) and BA (20 ppm), however, lowest fruit weight (19.06 g) was recorded in control. Treatments produced the fruits of significantly higher weight than the control (Table 2). These

Table 1. Effect of physical and chemical treatments on fruit set per panicle, fruit retention, fruit drop, fruit cracking and harvesting span in litchi cv. Rose Scented

Treatment	Initial fruit set per panicle	Fruit retention (%)	Fruit drop (%)	Fruit cracking (%)	Harvest advance (-) or delay (+) over control
Shade net, 30% (T_1)	53.68	23.90	71.91	5.28	14
Shade net, 50% (T_2)	61.07	19.94	78.95	4.49	16
GA_3, 20 ppm (T_3)	61.68	19.90	78.76	7.43	02
GA_3, 40 ppm (T_4)	48.87	24.92	74.05	6.13	04
BA, 20 ppm (T_5)	55.68	23.76	75.81	7.99	05
BA, 40 ppm (T_6)	51.95	22.93	75.28	7.93	08
KNO_3, 4% (T_7)	64.93	19.85	78.84	10.77	-02
Perforated polyethylene bagging (T_8)	54.13	21.37	77.83	8.33	01
STS, 10 mM (T_9)	59.50	20.41	78.34	9.21	08
Control (T_{10})	45.50	19.94	79.05	12.71	-
S.Em.±	4.07	1.52	1.70	1.33	-
LSD (*P*=0.05)	11.83	4.41	4.93	3.85	-

Table 2. Effect of physical and chemical means on physical quality characteristics of fruits

Treatments	Fruit weight (g)	Fruit volume	Specific gravity	Fruit length (cm)	Fruit width (cm)	Shape index	Peel weight (g)	Pulp weight (g)	Seed weight (g)	Waste index	Juice (%)
Shade net, 30% (T_1)	21.99	20.97	1.04	34.71	32.99	1.05	2.06	16.20	3.72	26.32	50.76
Shade net, 50% (T_2)	22.08	21.09	1.04	33.77	31.91	1.05	2.09	16.30	3.69	26.19	49.48
GA_3, 20 ppm (T_3)	22.21	21.19	1.04	36.25	34.44	1.05	2.16	16.32	3.72	26.49	50.41
GA_3, 40 ppm (T_4)	22.26	21.27	1.04	36.76	35.01	1.05	2.15	16.38	3.73	26.41	50.99
BA, 20 ppm (T_5)	22.31	21.31	1.04	36.00	33.95	1.06	2.22	16.41	3.67	26.44	49.42
BA, 40 ppm (T_6)	22.24	21.25	1.04	35.66	34.11	1.04	2.16	16.38	3.70	26.36	50.28
KNO_3, 4% (T_7)	22.20	21.01	1.05	37.09	35.49	1.04	2.18	16.20	3.81	27.04	48.51
Perforated polyethylene bagging (T_8)	21.32	20.24	1.05	35.74	33.47	1.06	2.13	15.68	3.50	26.46	46.26
STS, 10 mM (T_9)	22.26	20.07	1.05	35.72	34.50	1.03	2.16	15.65	3.47	26.49	49.05
Control (T_{10})	19.06	18.41	1.03	33.76	33.01	1.02	2.04	13.56	3.46	28.90	44.19
S.Em.±	0.35	0.36	0.01	0.99	0.94	0.01	0.06	0.29	0.06	0.39	0.37
LSD (*P*=0.05)	1.03	1.06	0.01	2.89	2.72	0.01	0.18	0.86	0.19	1.15	1.08

Fig. 1. Effect of shade net (30%) on fruits

Fig. 2. Effect of shade net (50%) on fruits

results are in accordance with the findings of Pal and Mishra (2012). Fruit volume in the treatments varied between 18.41 to 21.31 mL (Table 2) being minimum in control (18.41 mL) which was significantly different from rest of the treatments. Higher fruit volume was recorded in BA (20 ppm). The reason for the increased size may be rapid cell division and enlargement caused by the presence of growth substances. This is in conformity with the results obtained by Das and Das (2002) in litchi cv. Rose Scented. Observations revealed that specific gravity of fruits varied from 1.03 to 1.05 (Table 2). Minimum specific gravity (1.03) was found in control. KNO_3 (4%), perforated polyethylene bagging and STS (10 mM) recorded significantly higher specific gravity of the fruits over control and rest of the treatments were at par with control. Similar effects were also reported by Dutta (2004) in guava.

The maximum fruit length was recorded in the treatment T_7 followed by treatment T_4 (36.76 mm) and treatment T_3 while control trees recorded minimum (33.76 mm) fruit length. Treatments T_4 and T_7 were found significant over control. The reason for increase in size may be due to increased nutrition and consequently rapid cell division and enlargement caused by the presence of growth substances. This finding is in the accordance with the results obtained by Dutta and Dhua (2005) in mango cv. Himsagar. Maximum fruit width was recorded in T_7 (35.49 mm) followed by treatment T_4 (35.01 mm) whereas, treatment T_2 showed the minimum (31.91 mm) fruit width. Rest of the treatments were non-significant. Dutta (2004) also recorded better fruit length and diameter with the application of KNO_3 @ of 1 to 2 per cent in guava cv. L-49.

Minimum shape index (1.02) was found in the control followed by 1.03 in STS (10 mM). However, there was no significant difference among both the treatments. Maximum (1.06) shape index was observed in treatments T_5 and T_8 which is not desirable (Table 2). Higher shape index is due to high difference between length and diameter of fruit. These results are in accordance with the findings of Das and Das (2002) in litchi. Various treatments had non-significant effect on peel weight. Peel weight varied from 2.04 to 2.22 g, it was maximum in the treatment T_5 (2.22 g). Minimum peel weight (2.04 g) was recorded in control (Table 2).

Pulp weight varied from 13.56 to 16.41 g (Table 2). All the treatments had significantly higher pulp weight over control. Higher pulp weight was recorded in T_5 followed by T_4 and T_6. Minimum pulp weight (13.56 g) was recorded in control. Data on seed weight (Table 2) indicated that the maximum seed weight (3.81 g) was found in treatment T_7 (KNO_3 @ 4%) followed by 3.73 g in GA_3 @ 40 ppm. Treatments T_1, T_2, T_3, T_4, T_5, T_6 and T_7 had higher value over control. Rani and Brahmachari (2001) observed that the spray of BA @ 10 and 20 ppm increased fruit weight, aril percentage and decrease stone percentage in litchi cv.

Table 3. Effect of physical and chemical means on chemical qualities and yield of litchi fruits

Treatments	TSS (°B)	Total sugar (%)	Reducing sugar (%)	Non reducing sugar (%)	Titratable acidity (%)	Ascorbic acid (mg/100 g pulp)	TSS/acid ratio	Yield per tree (kg)	Increase in yield over control (kg)
Shade net, 30% (T_1)	20.63	13.12	9.88	3.21	0.69	28.16	29.90	114.00	32.25
Shade net, 50% (T_2)	20.78	13.13	9.91	3.21	0.70	32.70	29.56	116.50	34.75
GA_3, 20 ppm (T_3)	21.00	13.58	9.93	3.45	0.63	28.56	33.36	112.50	30.75
GA_3, 40 ppm (T_4)	22.15	14.25	10.22	4.03	0.56	28.83	39.63	107.50	25.75
BA, 20 ppm (T_5)	21.75	13.02	9.93	3.12	0.61	28.53	35.51	107.00	25.25
BA, 40 ppm (T_6)	21.40	13.20	10.18	3.01	0.66	28.92	32.23	109.00	27.25
KNO_3, 4% (T_7)	20.52	13.43	10.42	3.01	0.52	27.99	39.15	103.00	21.25
Perforated polyethylene bagging (T_8)	20.66	13.08	9.91	3.16	0.69	28.18	30.76	102.50	20.75
STS, 10 mM (T_9)	20.75	13.50	10.12	3.38	0.67	27.98	30.01	115.00	33.25
Control (T_{10})	18.13	12.52	9.70	2.82	0.73	25.84	24.67	81.75	–
S.Em.±	0.43	0.11	0.06	0.17	0.01	1.62	1.07	2.80	-
LSD (P=0.05)	1.26	0.34	0.20	0.50	0.045	4.70	3.11	8.15	-

China. This increase may be due to increase in size of fruits and smaller size of stone thus producing larger aril percentage. Perusal of data presented in Table 2 revealed that minimum waste index of 26.19 per cent was found in shade net (50%) followed by shade net 30% (26.32). Significantly higher waste index of 28.90 was recorded in control. Increase in peel weight due to growth promoting affect of the chemicals contributed towards the reduced waste index (Rani and Brahmachari, 2001).

The juice percentage of the fruits from all the treatments including control ranged from 44.19 to 50.99 per cent (Table 2). Maximum juice per cent (50.99%) was noted in GA_3 @ 40 ppm which was found at par with T_1, T_3 and T_6. Minimum juice content (44.19%) was found in control. All the treatments proved superiority over control. The results are in close conformity with the findings of Brahmachari and Rani (2000). In general, all the treatments significantly produced higher Total Soluble Solids over control. Significantly higher TSS content (22.15°B) was obtained in T_4 which was at par with T_5 (21.75) and T_6 (21.40). Lower TSS content (18.13°B) was recorded in control. There was non-significant difference among treatments T_1, T_2, T_3, T_7, T_8 and T_9 (Table 2). These results are similar to the findings of Pal and Mishra (2012) who reported that GA_3 resulted in increased TSS of litchi.

Data on total sugars presented in Table 3 revealed that minimum total sugar (12.52%) was found in control while maximum was recorded in the treatment T_4 (14.25%) followed by T_3 (13.58%). Total sugar content in all the treatments were found significantly higher than control. Treatments other than control were at par. Significantly higher reducing sugar percentage (10.42%) was found in KNO_3 (4%) followed by 10.22 per cent in GA_3 (40 ppm) while it was lower (9.70%) in control (Table 3). Perusal of data presented in Table 2 showed that maximum non-reducing sugar (4.03%) was observed in the treatment T_4 (GA_3 @ 40 ppm) followed by (3.45%) in the treatment T_3 (GA_3 @ 20 ppm), whereas, minimum non-reducing sugars (2.82%) was found in control. All the treatments excluding treatments T_3, T_4 and T_9 were at par with control. Pal and Mishra (2012) found that application of 40 ppm of GA_3 on litchi resulted in increased sugar content. Data presented in Table 3 revealed that treatment T_2 (shade net 50%) differed significantly from rest of the treatments including control in terms of acidity of the fruits. Total acid content varied from 0.52 to 0.73 per cent. Maximum acidity (0.73 %) was recorded in control while minimum acidity (0.52%) was recorded in treatment KNO_3 @ 4%. Khattab *et al.* (2006) also reported that application of KNO_3 (1-4%) decreased the acidity of mango fruits.

Ascorbic acid content in fruites was also influenced by various treatments. In general, ascorbic acid content varied from 25.84 to 32.70 mg/100 g of pulp. In shade net (50%), ascorbic acid content of 32.70 mg/100 g pulp was recorded which was significantly higher over rest of the treatments while control yielded significantly lower (25.84 mg/100 g of pulp) ascorbic acid content (Table 3). The TSS/acid ratio presented in Table 3 reveal that total soluble solids and acid ratio varied from 24.67 to 39.63. Maximum TSS/acid ratio (39.63) was observed in GA_3 (40 ppm) and minimum was recorded in control. All the treatments were significantly superior over control. Findings are in close conformity with Khattab *et al.* (2006). Wahdan *et al*. (2011) also reported that the fruit quality was significantly improved in fruits harvested from trees sprayed with GA_3 40 ppm at two months after full bloom in mango.

Data on the effect of different treatments on fruit yield and fruit yield attributing characters are depicted in Table 3. Data revealed that a significant variation exists in yield due to the different treatments. In general, all treatments recorded higher yield over control. Significantly higher yield was recorded in T_2 (116.5 kg) followed by T_1 (114.00 kg), T_9 (115.00 kg) and T_3 (112.5 kg) while in control significantly lower yield (81.75 kg) was recorded. Zora and Agrez (2002) reported increased fruit yield of 'Kensington Pride' mango with the treatment of silver thiosulphate which is in close conformity to the present findings.

The study revealed that shading can minimize the fruit drop, fruit cracking, delay the harvesting span and maximize fruit quality and yield of litchi.

References

Brahmachari, V.S. and R. Rani, 2000. Effect of growth substances on fruit drop, yield and physico-chemical composition of litchi fruits. *Prog. Hort.,* 32(1): 50-55.

Dalal, S.R., V.S. Gonge, B.J. Jadhao and N.D. Jogdande, 2005. Effect of chemical on flowering and fruit yield of mango cv. Pairy. *Intl. J. Agr. Sci.,* 1(1): 24-25.

Das, M.C. and R.P. Das, 2002. Response of some plant growth substances on fruit drop, fruit splitting and fruit physical parameters of litchi (*Litchi chinensis* Sonn.). *Indian J. Hort.,* 14(1): 1-4.

Dutta, P. and R.S. Dhua, 2005. Foliar spray of potassium for high yield and quality of Himsagar mango. *Hort. J*., 18(3): 153-156.

Dutta, P. 2004. Foliar potassium spray in improving the quality of Sardar guava (*Psidium guajava* L.). *Orissa J. Hort.,* 32(1): 103-104.

Guangwen, Z., Z. Tian and Y. Shi, 2010. Advances in the use of exogenous plant growth regulators on litchi. *Agri Sci. Tech*., 11(6): 65-70.

Kassem, H.A., A.M. Kobbia, H.A. Marzouk and M. Sebaiey, 2010. Effect of foliar sprays on fruit retention, quality and yield of *Costata persimmon* trees. *Emir. J. Food Agric.*, 22(4): 259-274.

Khattab, M.M., G.M. Haseeb, A.E. Shaban and M.A. Arafa, 2006. Effect of paclobutrazol and potassium nitrate on flowering and fruiting of Ewais and Sidik mango trees. *Bull. Facul. Agr. Cairo Univ.,* 57(1): 107-123.

Kumar, S.P., Y.N. Reddy and D.S. Hari, 2003. Effect of foliar spray of chemicals on flowering and fruiting of shoots emerging after pruning on mango (*Mangifera indica* L.) cv. Baneshan. *South Indian Hort.,* 51(1-6): 7-11.

Mandal, D., A. Sarkar and B. Ghosh, 2014. Induction of flowering by use of chemicals and cincturing in 'bombai' litchi. *Acta Hort.*, 1029: 265-271.

Mishra, D.S., P. Kumar and R. Kumar, 2012. Effect of GA_3 and BA on fruit weight, quality and ripening of 'Rose Scented' litchi. *HortFlora Res. Spectrum*, 1(1): 80-82.

Munish, A., P.S. Kahlon and B.V.S. Mahajan, 2003. Effect of exogenous application of growth regulators on fruit drop, cracking and quality of litchi (*Litchi chinensis* Sonn.) cv. Dehradun. *Agr. Sci. Digest.,* 23(3): 191-194

Pal, M. and D.S. Mishra, 2012. Extending harvesting period of litchi (*Litchi chinensis* Sonn.) through chemicals application. *HortFlora Res. Spectrum*, 1(3): 235-238.

Rani, R. and V.S. Brahmachari, 2001. Effect of plant bioregulators on cracking and physico-chemical composition on fruit in China litchi. *Prog. Hort.,* 33(1): 32-36.

Tomer, E., I. Zipori, M. Goren, S. Shooker, M. Pipa and Y. Floux, 2001. Delaying the ripening of Mauritius litchi fruit. *Acta Hort.,* 558: 315-317.

Wang, H.C., X.M. Hung, G.B. Hu, Z.Y. Yang and H.B. Huang, 2005. A comparative study of chlorophyll loss and its related mechanism during fruit maturation in pericarp of fast and slow, degreening litchi pericarp. *Scientia Hort*., 106: 247-257.

Wahden, M.T., S.E. Habib, M.A. Bassal and E.M. Qaoud, 2011. Effect of some chemicals on growth, fruiting, yield and fruit quality of "Succary Abiad" mango cv. *Journal American Science*, 7(2): 651-658.

Yin, J.H., F.F. Gao, G.B. Hu and S.H. Zhu, 2001. The regulation of litchi maturation and coloration by abscisic acid and ethylene. *Acta Hort.,* 558: 293-296.

Zora, S. and V. Agrez, 2002. Fruit set, retention and yield of mango in relation to ethylene. *Acta Hort.,* 575(2): 805-811.

Received: November, 2015; Revised: December, 2015;
Accepted: January, 2016