Effects of Cultivars and Plant Growth Regulators on Fruit Set and Fruit Retention of Litchi under Chitwan Conditions

K. Sigdel[1] and G.K. Shrestha[2]

ABSTRACT

In Nepal, litchi flowers in Terai, inner Terai and foot-hills of Mahabharat range. But fruit set and retention is always a complex problem in this region with a number of factors involved in it. To overcome this problem an experiment was conducted at IAAS, Rampur, Chitwan during January to June 2003 in a split-plot design with 3 cultivars as main plot factor and 4 plant growth regulators as subplot factor. Variations on the effect of cultivars and PGRs on fruit set number and fruit retention number were noted. Muzaffarpur' and 'Rose Scented' litchies had maximum fruit set number and final fruit retention, but 'Calcuttia Late' had minimum fruit set and final retention. Fruit retention showed exponentially decreasing trend throughout the growth and development period starting from 36.9 to 47.4% on 10 days after fruit set (DAFS) to 6.7 to 9.6 % on 55 DAFS (at harvest). NAA retained 4.0% more fruits than that of control upto 40 DAFS.

Key word: *Litchi chinensis*, cultivar, ethephon, 2,4-D, naphthalene acetic acid.

INTRODUCTION

The litchi is a subtropical long-lived evergreen fruit tree cultivated in Terai, inner Terai and foot hills of Mahabharata range in Nepal. In Nepal, the estimated coverage and production of litchi are 3,850.2 ha and 16734 MT, respectively (MOAC, 2005). Litchi is a highly remunerative and demanded fruit crop. As its supply is met by importation from India more of litchi production is essential in Nepal that can be achieved by improving existing production technologies. Among these technologies the use of PGR has been employed in different countries to increase fruit set and fruit retention. Litchi flowers in warm subtropics, but poor fruit set and premature fruit drop are always a complex problem in this region with a number of factors involved in it. The fruit set in initial stages is very high in all litchi cultivars, but a very little proportion of it was carried to maturity. The depletion of auxins may cause fruitlet abscission which can be supplemented by the exogenous application of PGRs as reported by various researchers.

Suryanarayana and Das (1978) obtained significantly highest initial fruit set with NAA (20 ppm) which was closely followed by 2,4-D (10 ppm) in 'Muzaffarpur' litchi when sprayed at pre-emergence of panicles. Chandel (1995) reported the highest fruit set with NAA (20 ppm) when sprayed once before flowering and repeated again at pea size stage of fruit. In Nainital, Singh and Phogat (1984) observed lowest drop with NAA (10 ppm) in 'Calcuttia' litchi when sprayed once at pit hardening stage. Kumar and Kumar (1994) reported lesser fruit drop percent with NAA (10 ppm and 20 ppm) in 'Rose Scented' litchi; when sprayed thrice at fortnightly intervals beginning from the pea size stage. In Assam, Das and Das (2001) reported that 2, 4-D (20 ppm) proved most effective in controlling fruit drop. This

[1] Horticulture Development Officer, DOA
[2] Prof., Department of Horticulture, IAAS, Rampur, Chitwan, Nepal.

paper reports on the response of 'Rose Scented', 'Calcuttia Late' and 'Muzaffarpur' litchies to plant growth regulators in fruit set and fruit retention.

MATERIAL AND METHODS

The study was conducted at the new litchi block of Horticultural Farm at IAAS Rampur Chitwan for 6 months from January to June, 2003. Split-Plot Design (3 × 4 factorial) was used in this experiment; 3 cultivars viz. 'Rose Scented', 'Muzaffarpur' and 'Calcuttia Late' as main plot factor and 4 PGRs [water spray (control), 2,4-D, ethephon and NAA] as sub-plot factors. Eight to 10 years old trees spaced at 10 × 10 meter in square system and grown under identical cultural practices were selected for the study. 2,4-Dichlorophenoxyacetic acid (2,4-D) as 2,4-D sodium salt (80%), Ethephon (2-Chloroethylphosphonic acid) as thrive (39%) and NAA (α-Naphthaleneacetic acid) as plantofix (4.5%) under these trade names were used for spraying .

Individual healthy trees were selected on the basis of cultivar trueness, uniformity in size and the tree height. Selected 24 trees were painted on the trunk with white enamels. Four uniform panicles from each direction were tagged by coloured ribbon to facilitate counting of flowers and fruitlets with the help of Hand Tally Model H-102 Line Original Style Japan. Aqueous solutions of PGR, each with 20 ppm were sprayed at pre-emergence stage of panicles (25 January on all cultivars) and at pea size stage (1 to 2 g) of fruit (15 April for 'Rose Scented') and 24 April on remaining 2 cultivars. Fruit set was counted at maximum fruit set time, i.e. on 3 April for 'Rose Scented' and 9 April for remaining cultivars. Finally, fruit retention was counted at an interval of 10 days from the days of fruit set to harvest.

The recorded data was statistically analyzed by using standard procedures of Gomez and Gomez (1984). MSTAT-C was applied for the analysis of variance and mean separation at 5% level of significance. The exponential decay curve of the form ($y = ae^{-bx}$) provided in SPSS 10.0 was fitted in fruit retention data where y = fruit retention, a = intercept of line in y axis, b = linear regression coefficient, x = days after fruit set.

RESULTS AND DISCUSSION

Fruit set

Litchi trees carry fruits 1 to 10 percent of the female flowers until harvest, a relatively higher set compared with avocado and mango, which may set less than 0.1 percent of the female flowers (Menzel, 2002). Among the three cultivars tested in this study, varietal difference in fruit set number/percent were noted but not significant (Table 1). Although, fruit set number per panicles ranged from 27.3 in 'Calcuttia Late' to 47.4 in 'Muzaffarpur'; the latter cultivar showed the highest fruit set percent (10.4%). The high fruit set in 'Muzaffarpur' could be associated with the presence of more pistillate flowers as also reported by Singh and Dhillion (1983). The 'Calcuttia Late' had minimum number of flowers (409.5). This cultivar has irregular bearing tendency which might have resulted in low flower number and fruit set in this year.

The reduced fruit set in all the cultivars in present study could be due to high rainfall that occurred during flowering period (Figure 1). Such negative effect of rainfall on fruit set in litchi was reported by Sinha *et al.* (1999). In fact, rain extending over several days during

anthesis could cause failure in fruit set due to ruining of splitted stigma and pollens (Menzel and Simpson, 1994).

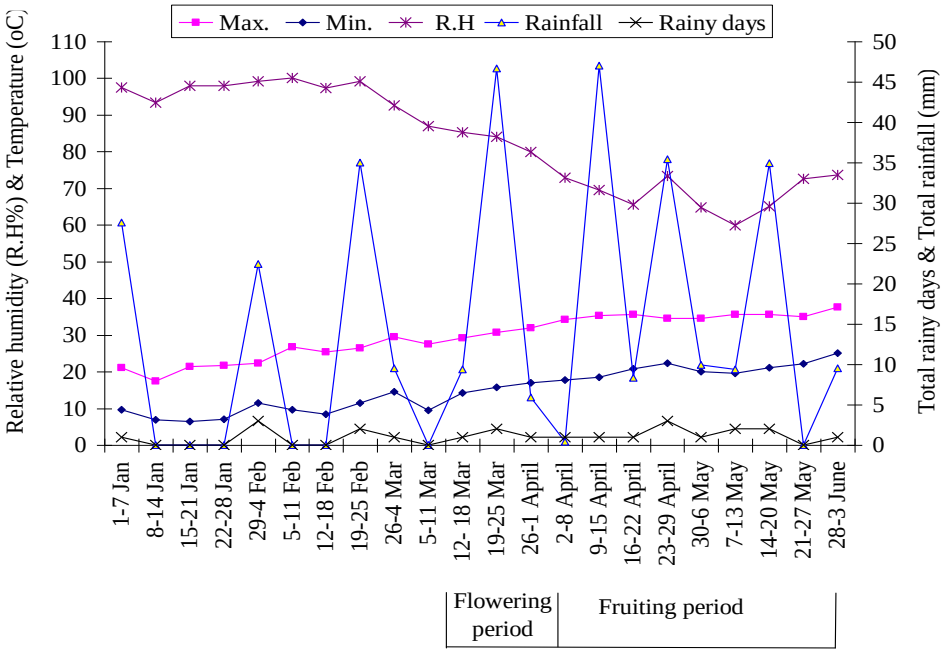

Figure 1. Weather data from Jan.1st to Jun.3rd at 7 days interval at IAAS, Rampur, 2003.

Table 1. Effects of cultivars and PGRs on average flower number, fruit set number and fruit set percent per panicle in litchi at IAAS, Rampur, Chitwan, 2003.

Cultivars (A)	Flower number	Fruit set number	Fruit set percent
'Rose Scented'	770.1	43.5	6.3
'Muzaffarpur'	614.1	47.4	10.4
'Calcuttia Late'	409.5	27.3	8.7
S.E (±)	60.69	3.60	1.68
Plant growth regulators (B)			
Control	590.0	41.4	8.3
2,4-D	677.8	44.0	7.1
Ethephon	578.5	37.6	11.4
NAA	545.3	34.6	7.1
S.E (±)	96.24	5.46	2.54
S. E A × B (±)	166.69	9.46	4.41

S.E = standard error

The another cause of low fruit set could be due to the litchi bug population build up infesting the flowering and fruiting panicles, because of delayed (April 25) 2nd spray of desis. The application of different PGRs on litchi trees at Rampur showed a variation in fruit set number per panicle (from 34.6 with NAA to 44.0 with 2, 4-D) and fruit set percent (from 7.1 with auxins to 11.4% with ethephon). In spite of variation among the treatments exhibited effect of PGR on fruit set was not significant. Ethephon resulted in maximum fruit set percent (11.4 %) may be due to more hermaphrodite flowers as suggested by Mitra

and Sanyal (2001). 2,4-D and NAA recorded low fruit set percent (7.1%) which was similar to the findings of Sinha *et al.* (1999). The interaction effect of cultivars and the PGRs was neither significant nor consistent.

Fruit retention

The depletion of auxins may be the one of the reason of fruitlet abscission which can be supplemented by the exogenous application. Fruit retention was counted at 10 days intervals from the count of fruit set to the time of harvest.

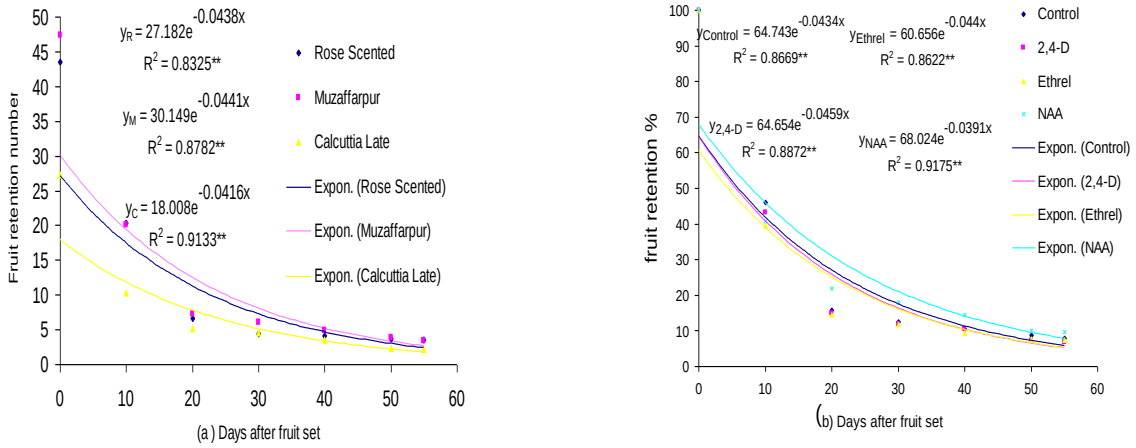

Figure 2. The non-linear relationship between the fruit retention (Y) and days after fruit set (X) at IAAS, Rampur, Chitwan, 2003.

Fruit retention percent /fruit retention number (Y) over number of days after fruit set (DAFS = X) showed exponentially decreasing trend since regression coefficient value [$r^2 > 0.83$, $P < 0.01$ for Y verses X (value ranges 0-55)] was statistically highly significant in all the cultivars irrespective of PGRs (Figure 2). The fruit retention percent/ number was much higher during initial counts which reduced to just half after 10 days and reduced rapidly until 20 DAFS in all cultivars irrespective of PGRs treatment. Onward these upto harvests, more number of fruits were retained on slow decreasing trend comparatively (Table 2). Similar trend of fruit drop over time, where intense fruit drop occured within 20 DAFS was also reported in different litchi cultivars (Kanwar and Kahlon, 1985). Variation in fruit retention number among three cultivars was observed with maximum in 'Rose Scented' (3.5) and minimum in 'Calcuttia Late' (2.2) at the time of harvest but the effects were not high enough to show variations statistically significant (Table 2). Singh and Dhillon (1981) also recorded maximum fruit number in 'Rose Scented'. Kumar *et al.* (1996) said 'Calcuttia Late' has less flowering and fruit set as well as irregular and low bearing nature, which might have resulted in the least fruit retention observed in the study.

Plant growth regulators did not affect fruit retention number but maximum fruit retained with NAA (3.4) at harvest. Fruit retention percent varied from 6.7 to 9.6% per panicles at harvest. The effect in fruit retention percent was significant from 20 DAFS to 40 DAFS but not later. In this present study 6.3% to 4% more fruit were retained with NAA as compared to control from 20 DAFS to 40 DAFS. Of the PGRs treatments, NAA retained maximum fruits (9.6%) at harvest. Although the effect of PGRs was not significant, but NAA application retained more fruits consistently from 20 DAFS (Table 2). More fruit retention with NAA spray were also reported by others (Kumar and Kumar, 1994; Chandel, 1995). Auxin (NAA) delays the activity of hydrolytic enzymes polygalacturonase and cellulase,

that is responsible for degradation of the cell wall and middle lamella in the abscission zone of the fruit stalk (Goren, 1993). There was no significant interaction effect between cultivars and plant growth regulators.

Table 2. Effects of cultivars and PGRs on the average fruit retention of litchi at different time intervals at IAAS, Rampur, Chitwan, 2003.

	Fruit retention % (fruit number per panicle)					
Cultivars (A)	10 DAFS	20 DAFS	30 DAFS	40 DAFS	50 DAFS	55 DAFS
Rose Scented	47.4 (20.3)	15.6 (6.6)	10.6 (4.4)	9.9 (4.2)	8.7 (3.7)	8.2 (3.5)
Muzaffarpur	42.9 (20.1)	16.1 (7.2)	13.4 (6.0)	11.0 (4.9)	8.6 (3.9)	7.7 (3.4)
Calcuttia Late	36.9 (10.3)	18.7 (5.2)	16.7 (4.6)	12.8 (3.6)	8.1 (2.3)	7.8 (2.2)
S.E A (±)	3.08 (2.74)	1.67 (0.32)	1.78 (0.34)	1.94 (0.48)	1.41 (0.37)	1.25 (0.33)
Plant growth regulators (B)						
Control	46.1 (19.1)	15.7b (6.5)	12.6b (5.1)	10.4b (4.4)	8.8 (3.7)	7.9 (3.2)
2,4-D	43.2 (18.9)	15.0b (5.9)	11.8b (4.7)	10.5b (4.2)	7.3 (3.0)	6.7 (2.8)
Ethephon	39.4 (15.3)	14.5b (5.8)	11.9b (4.4)	9.5b (3.6)	7.6 (2.9)	7.4 (2.8)
NAA	40.8 (14.1)	22.0a (7.1)	18.0a (5.8)	14.4a (4.7)	10.1 (3.6)	9.6 (3.4)
LSD at 5%	- (-)	4.56* (-)	3.66* (-)	3.37* (-)	ns (-)	- (-)
S.E B (±)	2.79 (1.93)	1.62 (0.77)	1.15 (0.61)	0.92 (0.46)	0.82 (0.33)	0.75 (0.31)
S.E A × B(±)	4.83 (3.35)	2.81 (1.33)	1.99 (1.05)	1.60 (0.79)	1.42 (0.57)	1.30 (0.53)

Significant means are separated by LSD and column indicated with the same letters are not different at 5%, * = significant, ns = non-significant, S.E = standard error.

CONCLUSION

Fruit set and fruit retention in litchi under Chitwan condition were studied to see if there were differences among the cultivars along with PGRs application. Variations was observed due to cultivars and PGR uses but the effects were not high enough to show variations statistically significant. Fruit retention pattern shows exponentially declining trends during the fruit growth and development period. Since this research was conducted on the panicle level it should be conducted on the orchard level to draw concrete results and again exact time and number of application of PGRs requires further systematic evaluation before recommending PGR for commercial use by farmers. Among the PGRs tested, NAA has shown some encouraging results which should be further tested systematically in these cultivars for better fruit set and retention.

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