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EFFECT OF GROWTH REGULATORS ON SHOOT MATURITY, FLOWER INDUCTION AND YIELD OF LITCHI CV SHAHI

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ABSTRACT : A field experiment was conducted to induce the flowering in litchi through growth regulators in 8-9 years old litchi orchard (junior bearing stage) consecutively for 2 years comprising of 12 treatments of four PGRs *i.e.* GA_3 (25, 50, 75 ppm), Ethrel (100, 150 ppm), NAA (15, 25, 40 ppm), MH (15, 20, 25 ppm) and control (water spray) with three replications. Three spraying of NAA, Ethrel, MH along with control and two spraying of GA_3 was applied at pre flowering stage from 1st week of October at 30 days interval, while 3rd spraying of GA_3 was given after fruit set. Data revealed that PGRs treated plants showed comparatively lesser twig length, number of leaflet/twig, twig length and twig diameter ratio, leaflet and twig diameter ratio and more twig diameter, emergence of pure panicle and fruit yield than control (without treated plant). Plant treated with Ethrel @ 100 and 150 ppm expressed significantly higher number of pure panicle emergence (86.67 and 91.67%, respectively) and fruit yield (53.33 and 52.50 kg/plant, respectively) than other treatments. Relationship of pure panicle with fruit yield showed positive and moderately strong correlation (r = 0.71, R^2= 0.51).

Keywords : *Growth regulators, shoot maturity, flower induction, litchi.*

Bihar is known for the production of 'Shahi' litchi (*Litchi chinensis* Sonn.) in the world due to its unique fragrance and high demand of this fascinating fruit. It is considered as major cash crop trees of eastern India. The plant is highly specific to climatic condition and soil requirement and probably due to which its cultivation is restricted to the few countries in the world (Kumar *et al.,* 2). Fruit yield of litchi in different production area is irregular and frequently below the potential bearing capacity of the trees. Usually, litchi plants take longer gestation period (> 15 years) to reach at consistent and regular bearing stage. In the juvenile stage (7-14 years tree age), plants showed erratic and irregular behavior of bearing due to continuous growth flushes and the farmers suffers for such a long period in order to get regular fruiting (Kumar *et al.,* 4; and Kumar *et al.,* 5). Irregular bearing phenomenon in juvenile litchi trees happens due to continuous vegetative growth and development of the tree which is attributed to an insufficient degree of dormancy to initiate flower bud formation and subsequently initiation of flowering panicle. Dormancy in litchi is apparently influenced by dry weather or recurring period of relatively cold weather. As the litchi tree require low temperature to induce flowering and subsequently fruiting (Menzel and Simpson, 8). Shoot growth in litchi is not continuous. Generally, there is a rapid period of shoot elongation and leaf expansion followed by a period of leaf maturation, before the next period of shoot growth. In litchi, the duration and interval of growth are strongly related to environmental condition. Combination of low temperature and high vegetative flush maturity is necessary for floral initiation to occur. Exposure to high temperature invariably results in production of vegetative shoot, irrespective of flush maturity (Pandey *et al.,* 10). Strong floral initiation is marked by emergence of terminal panicles and accompanying axillary panicles (Patel *et al.,* 11). A decrease in vegetative flush maturity or increase in temperature results in a decrease in axillary shoot formation and production of several intermediate shoot structures. These include leafy panicles, stunted panicles, partially emerged buds and non-emergent swollen buds, often production on the same tree. Both temperature and flush maturity can influence subsequent shoot structure of litchi. Relationship between leaf flushing (viz. early, mid and late season) and yield of litchi indicates that out of three flushes viz. early (after harvest), mid (August to October) and late (after November) season; the early and mid season flushing influence the yield whereas, the late season flushing does not have any contribution towards yield. The mid season flushing (August - October) is of more significance in cvs. Bedana, Bombai and Deshi.

Response of various growth regulators on regulation of flowering and fruiting have been studied

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by various workers in litchi (Mishra *et al.,* 9; and Zhang *et al.,* 15) and peach (Patel *et al.,* 12). Use of various growth regulators have proved their efficacy in modifying growth, development, flowering, fruit setting and yield in several tropical and subtropical fruit crops (Kumar *et al.,* 3 and Yadav, 14). The information on use of growth regulators and their influence on shoot behaviour, flowering panicle induction, fruit yield and their inter relation is lacking particularly in juvenile litchi orchard.

MATERIALS AND METHODS

The experiment was conducted in 8-9 years old litchi orchard (junior bearing stage) during 2013-2014 consecutively for 2 years at the research farm of ICAR-NRC on Litchi, Mushahari, Muzaffarpur (Bihar) located at 210 m altitude from msl. The experiment was laid out in randomized block design (RBD) comprising of 12 treatments of four PGR's *i.e.* GA_3 (25, 50, 75 ppm), Ethrel (100, 150 ppm), NAA (15, 25, 40 ppm) and MH (15, 20, 25 ppm) and control (water spray) with three replications. Three spraying of each of NAA, Ethrel, MH along with control and two sprayings of GA_3 was applied at pre flowering stage from 1st week of October at 30 days interval, while 3rd spraying of GA_3 was given after fruit set. The litchi cv. Shahi was planted in the year 2005 at a spacing of 8.25 m x 8.25 m accommodating 144 plants per ha. Standard cultural practices were followed to grow the litchi crops as described by Kumar *et al.* (6). The experimental field was sandy loam in texture, alkaline in reaction with low to medium in fertility status.

The observations on shoot growth parameters like twig diameter, twig length and number of leaflets per twig were recorded during 1st week of February every year before panicle emergence. Twig diameter was recorded from the basal portion of the selected shoots emerged during July month with the help of digital vernier caliper and shoot length was measured from the basal portion to apex of the shoot with the help of meter scale. Number of leaflets per twig was counted from the selected and tagged shoots. Types of panicle in terms of pure panicle (inflorescence without any leaf), mixed panicle (inflorescence having panicle along with 1-2 pair of compound leaf on the basal portion) and leafy panicle (inflorescence with few flowering panicle on the tip along with major portion of leaf) were recorded from the selected twigs at flowering stage. The data were subjected to statistical analysis as per the method of Gomez and Gomez (1). Least significant of difference at 5% level was used for finding the significance of differences if any, among the treatment means.

RESULTS AND DISCUSSION

Effect on twig growth and number of leaflet

Data revealed that PGRs treated plants showed comparatively lesser twig length, number of leaflet/twig and more twig diameter than control (without treated plant). Among PGRs, MH @ 20 and 25 ppm sprayed branched expressed smaller twig length and leaflet number. Highest twig length (38.32 cm) and number of leaflet/twig (17.18) were observed in control (water spray), while lowest twig length (28.78 cm) and leaflet number (11.78) in MH 25 ppm (Table1). The smaller twig length and less number of leaf-let per twig in MH treated plant might be due to its inhibiting action on apical dominance which checked the emergence of new shoots on the terminals resulted into lesser vegetative growth of the twig. More twig length and leaflet number under untreated plant is due to continuous flushing of shoot. Twig diameter varied from 0.40 cm in MH 15 ppm to 0.51 cm in GA_3 75 ppm. The ratio between twig length and twig diameter (93.45) found to be substantially highest in control than other treatment which ranged from 64.81 to 76.78 in Ethrel 100 ppm and MH 15 ppm. Similarly, ratio of leaflet number and twig diameter also found maximum in control (41.90) than PGRs treated plant. Ethrel 100 ppm exhibited the least leaflet and twig diameter ratio (25.70) which is closely followed by Ethrel 150 ppm (27.63), MH 25 ppm (28.05) and MH 20 ppm (28.69).

Relationship of twig growth, leaflet number with emergence of pure panicle and fruit yield

Correlation study between ratio of twig length and twig diameter with emergence of pure panicle ($r = -0.81$, $R^2 = 0.66$) and fruit yield ($r = -0.51$, $R^2 = 0.26$) showed linear negative relationship which indicated that emergence of pure panicle and fruit yield in litchi dependent on the twig growth and maturity. The coefficient of determination (R^2) indicated that 66% of the total variation in pure panicle emergence can be explained by ratio of twig length and twig diameter (Fig.1 and 2). Similarly, the slope of regression line was found moderately negative for ratio of leaflet number and twig diameter with emergence of pure panicle and fruit yield with their corresponding value of correlation coefficient and coefficient of determination ($r = -0.65$, $R^2 = 0.42$) and fruit yield ($r = -0.71$, $R^2 = 0.50$) (Fig.3 and 4).

Effect on panicle emergence

Panicles or terminal inflorescences in litchi are initiated in dormant apical buds on stem that developed vegetative from lateral buds. Foliar application of PGRs significantly influenced the panicle emergence and fruit yield in junior litchi trees. All the PGRs treated twig showed more contribution towards emergence of pure panicles than control. Ethrel 150ppm expressed highest emergence of pure panicle (91.67%) with least mixed (8.33%) and no leafy panicle which was closely followed by ethrel 100ppm with 86.67% pure panicle, 11.67% mixed and leafy 1.67% flushes. However, the untreated plant showed lowest percentage of pure panicle (55%) and highest leafy panicles (28.33%) (Table 1 & Fig. 5). These results are in agreement with the findings of Kumar *et al.* (5) and Mandal *et al.* (7) who reported that application of ethrel proved to be the most effective for flowering and fruit induction in litchi. Growth promoting substance such as Ethephon when used as a foliar spray has been reported to be beneficial for floral initiation and inflorescence development in longan (Qiu *et al.,* 13). Fewer number of flowering panicles in untreated plant is might be due to continuous flushes leads to partial shoot maturity which ultimately resulted into poor flowering emergence and less yield.

Relationship of pure panicle with fruit yield

Results indicated that fruit yield in litchi showed positive and moderately strong correlation with emergence of pure panicle (Fig.6). When data was plotted on a scatter diagram, the slope of regression line was positive ($r = 0.71, R^2 = 0.51$). The coefficient of determination (R^2) indicated that 51% of the total variation in fruit yield can be explained by emergence of pure panicle.

Table 1: Effect of PGRs on vegetative, reproductive and yield performance of litchi cv. Shahi.

Treatments	Twig dia. (cm)	Twig length (cm)	No. of leaflet/ twig	Twig length: twig dia. ratio	Leaflet No.: twig dia. ratio	Types of panicle emergence			Yield (kg/ plant)
						Pure	Mixed	Leafy	
GA_3 25 ppm	0.48	33.80	13.73	71.16	28.89	68.33	15.00	16.67	35.00
GA_3 50 ppm	0.46	34.37	14.21	74.71	30.88	68.33	20.00	11.67	38.67
GA_3 75 ppm	0.51	36.40	14.88	72.07	29.47	66.67	20.00	13.33	47.85
Ethrel 100 ppm	0.49	31.44	12.47	64.81	25.70	86.67	11.67	1.67	53.33
Ethrel 150 ppm	0.47	30.80	12.85	66.24	27.63	91.67	8.33	0.00	52.50
NAA 15 ppm	0.44	31.58	14.82	72.60	34.07	68.33	18.33	13.33	29.00
NAA 25 ppm	0.45	30.07	17.75	66.82	39.43	71.67	20.00	8.33	39.67
NAA 40 ppm	0.46	30.23	16.05	66.44	35.27	76.67	13.33	10.00	43.33
MH 15 ppm	0.40	30.33	14.04	76.78	35.53	65.00	28.33	6.67	30.00
MH 20 ppm	0.42	29.93	11.91	72.11	28.69	71.67	16.67	11.67	30.00
MH 25 ppm	0.42	28.78	11.78	68.52	28.05	76.67	20.00	3.33	46.67
Control	0.41	38.32	17.18	93.45	41.90	55.00	16.67	28.33	25.00
CD (P= 0.05)	0.06	4.67	3.36	-	-	5.83	7.58	5.56	14.37

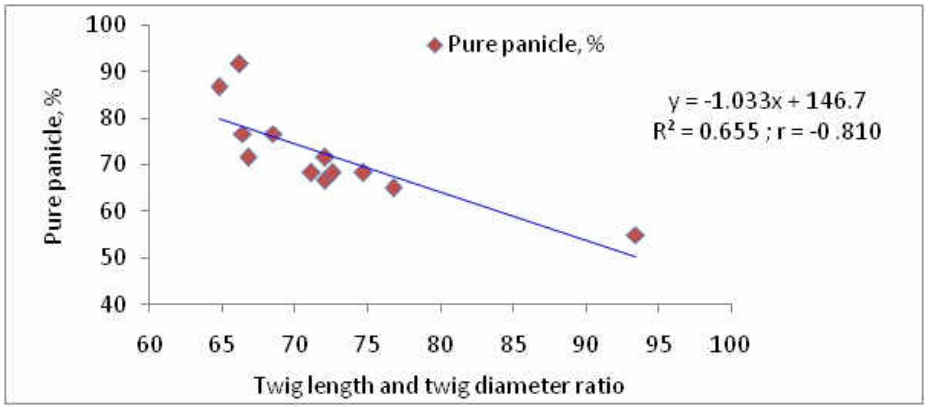

Fig.1: Relationship between ratio of twig length and twig dia. vs pure panicle

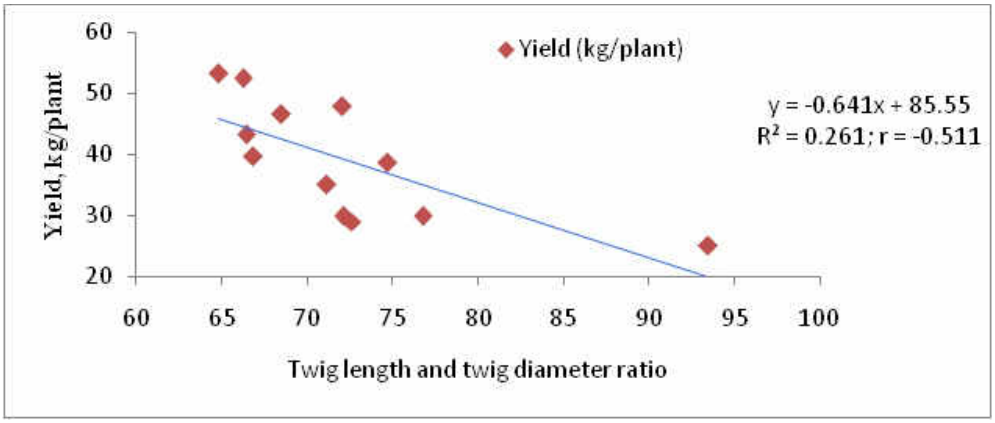

Fig. 2: Relationship between ratio of twig length and twig dia. vs fruit yield

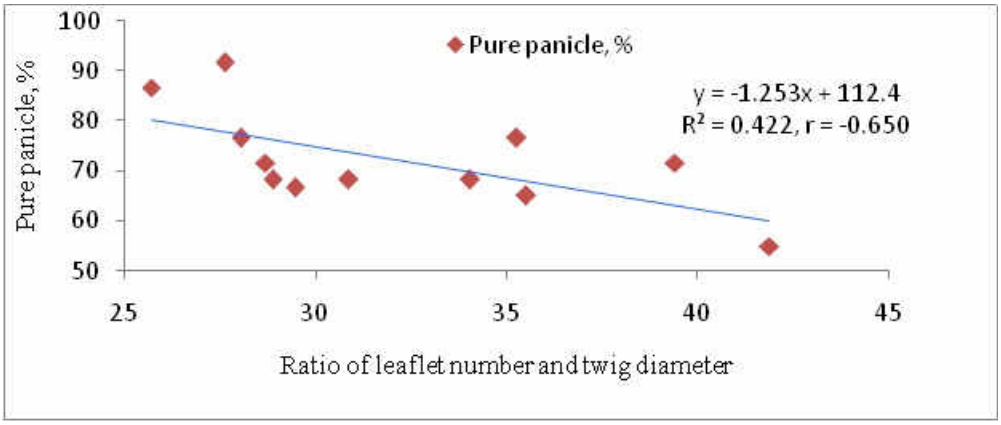

Fig. 3: Relationship between leaflet number: twig dia. vs pure panicle

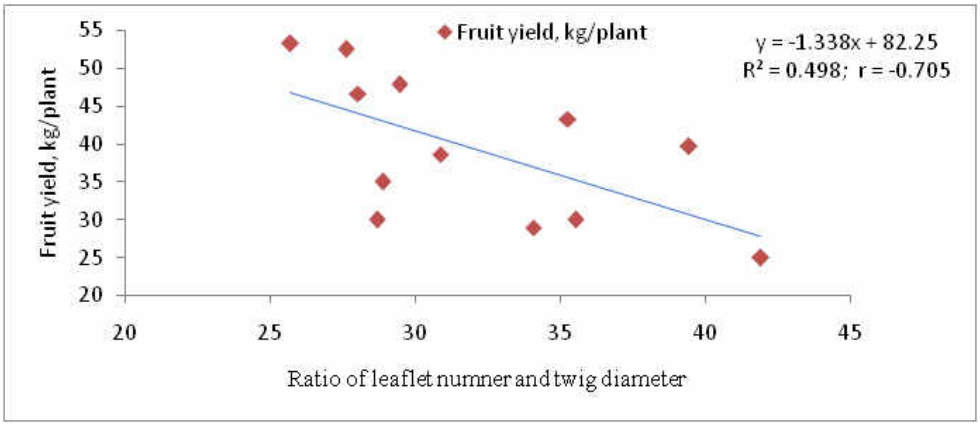

Fig. 4: Relationship between leaflet number: twig dia. vs fruit yield

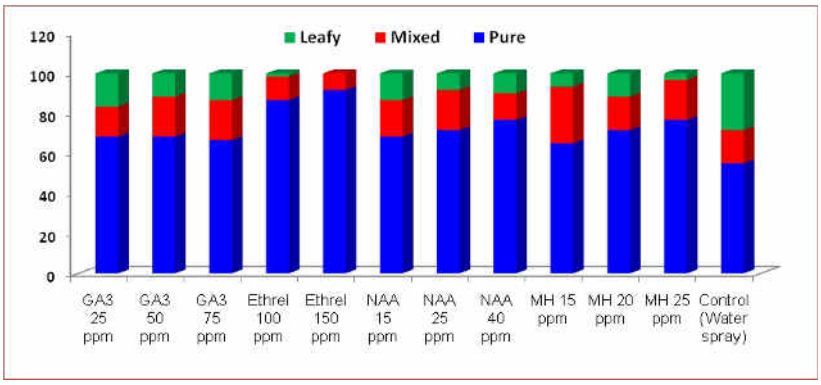

Fig. 5: Effect of PGRs on type of panicle emergence in litchi cv. Shahi

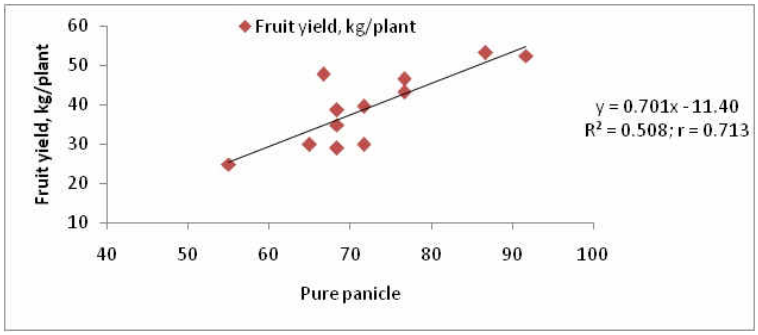

Fig.6: Relationship between pure panicle and fruit yield

Effect on fruit yield

The highest fruit yield (53.33 kg/plant) was obtained in the plant treated with ehtrel 100ppm which is followed by ehtrel 150ppm (52.50 kg/plant), GA_3 75ppm (47.85 kg/plant) and MH 25ppm (46.67 kg/plant). The lowest fruit yield (25.0 kg/plant) was recorded in untreated plant (Table 1). The highest fruit yield in ethrel treated plant is due to emergence of more number of pure panicle that contributed to more fruit bearing per twig.

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