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*Short Communication*

# Effect of hormone treatments on deformed fruit development in pear

**Xiaoming Chen[1], Jianping Bao[1,2], Yiting Chen[1], Ting Chen[1], Changhe Zhang[3], and Xinzhong Huang[1]***

[1]Fruit Research Institute, Fujian Academy of Agricultural Sciences, Fuzhou, Fujian Province 350013, China.
[2]Team for Horticultural Plant Genetic Improvement, Plant Science and Technology College of Tarim University, Alar Xinjiang 843300, China;
[3]Jianning County Agriculture Bureau, Jianning, Fujian Province 354500, China.

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**Fruit shape is one of the most important limiting factors in the quality of pear fruits. The effects of applied plant growth regulators on fruit shape have been determined in pear. The application of naphthalene acetic acid (NAA, 20 mg/L), indole-3-butyric acid (IBA, 30 mg/L), 6-benzalyamino acid (6-BA, 30 mg/L), cleaner production promotion unit (CPPU, 10 mg/L), gibberrelin ($GA_{4+7}$, 3%) and gibberrelic acid ($GA_3$, 2.7%) at the young fruit period enhanced fruit growth, improved final fruit size, and decreased the occurrence of deformed fruit. CPPU and 6-BA significantly enhanced the growth of horizontal diameter, while $GA_3$ and $GA_{4+7}$ stimulated fruit vertical diameter that tend to grow more apparently.**

**Key words:** Plant growth regulators, deformed fruit, pear.

## INTRODUCTION

Pear, belonging to the family Solanaceae, is the most popular garden vegetable and the second most important fruit in China in terms of planting area. Fruit quality includes fruit size, overall composition and taste, and proportion of edible tissue and these link between environmental control and quality traits (Ogundiwin et al., 2009; Faniadis et al., 2010). Appearance quality has been widely used in the evaluation of fruit quality. The fruit shape, size and regularity are important quantitative trait closely related to the appearance quality (Guardiola et al., 1998, 1993; Bubán, 2000; Stover and Greene, 2005; Faniadis et al., 2010). The excellent fruit shape, size and regularity of the pear cultivars are highly prized by consumers. Under optimal growth conditions, pear fruit is regular. However, in spring under cooler temperatures (particularly night-time temperatures) and in shorter day lengths, a high percentage of the fruit become deformed. The severity of the problem varies from year to year.

Numerous deformed fruit are distinguished from normal fruit; this may cause great economic losses for peasant. However, deformed pear fruit has hardly been studied. The aim of the present study was to evaluate the effects of plant growth regulators applications and endogenous hormones on deformed pear fruit to clarify the relationship between shape and hormones in the fruit.

*Corresponding author. E-mail: 416751297@qq.com.

**Abbreviations: NAA,** Naphthalene acetic acid; **IBA,** indole-3-butyric acid; **6-BA,** 6-benzalyamino acid; **CPPU,** cleaner production promotion unit; **$GA_{4+7}$,** gibberrelin; **$GA_3$,** gibberrelic acid.

## MATERIALS AND METHODS

The experiments were conducted in 2008 using pear trees growing fruit demonstration farm in Jianning County. NAA (20 mg/L), IBA (30 mg/L), 6-BA (30 mg/L), CPPU (10 mg/L), $GA_{4+7}$ (3%), and $GA_3$ (2.7%) were initially dissolved in alcohol (95%), and then further dissolved in distilled water, after which lanolin ointment was finally added. Growth regulators of this experiment were purchased from Sigma, USA. Eight 'Mixue Pear' trees were used; uniform crown and vigour were selected. Plant growth regulators were applied to top, mid section and bottom of pear fruits at young fruit period, respectively. Ripe pear fruit of vertical and horizontal diameter was

**Table 1.** Effect of plant growth regulators on pear fruit vertical and horizontal diameter.

| Reagent | Treatment | Vertical diameter (cm) | | | Horizontal diameter (cm) | | |
|---|---|---|---|---|---|---|---|
| | | Treated fruit top | Treated fruit mid section | Treated fruit bottom | Treated fruit top | Treated fruit mid section | Treated fruit bottom |
| NAA | Treated | 6.419$^{A}$ | 6.531$^{a}$ | 6.673$^{A}$ | 3.297$^{A}$ | 3.518$^{A}$ | 3.324$^{a}$ |
| | Untreated | 6.012$^{B}$ | 6.249$^{a}$ | 6.023$^{B}$ | 3.082$^{B}$ | 3.357$^{B}$ | 3.249$^{b}$ |
| IBA | Treated | 6.372$^{a}$ | 5.936$^{a}$ | 6.632$^{A}$ | 3.293$^{a}$ | 3.302$^{A}$ | 3.549$^{A}$ |
| | Untreated | 6.603$^{a}$ | 5.949$^{a}$ | 6.161$^{B}$ | 3.270$^{b}$ | 3.196$^{B}$ | 3.329$^{B}$ |
| 6-BA | Treated | 5.909$^{A}$ | 6.088$^{A}$ | 6.272$^{A}$ | 3.208$^{A}$ | 3.254$^{A}$ | 3.349$^{A}$ |
| | Untreated | 5.543$^{B}$ | 5.637$^{B}$ | 5.863$^{B}$ | 2.985$^{B}$ | 3.053$^{B}$ | 3.102$^{B}$ |
| CPPU | Treated | 6.563$^{A}$ | 5.979$^{A}$ | 6.356$^{A}$ | 3.546$^{A}$ | 3.508$^{A}$ | 3.340$^{A}$ |
| | Untreated | 5.682$^{B}$ | 5.673$^{B}$ | 5.441$^{B}$ | 3.081$^{B}$ | 3.136$^{B}$ | 2.970$^{A}$ |
| $GA_{4+7}$ | Treated | 7.076$^{A}$ | 7.937$^{A}$ | 8.260$^{A}$ | 3.791$^{A}$ | 4.065 $^{A}$ | 4.166$^{A}$ |
| | Untreated | 6.516$^{B}$ | 6.987$^{B}$ | 7.233$^{B}$ | 3.506$^{B}$ | 3.718$^{B}$ | 3.781$^{B}$ |
| $GA_3$ | Treated | 6.978$^{A}$ | 6.841$^{A}$ | 6.813$^{A}$ | 3.678$^{A}$ | 3.577$^{A}$ | 3.614$^{A}$ |
| | Untreated | 6.151$^{B}$ | 5.934$^{B}$ | 5.964$^{B}$ | 3.509$^{B}$ | 3.141$^{B}$ | 3.387$^{B}$ |

Different capital letters within a column indicate significant difference at 1% levels, respectively.
NAA, Naphthalene acetic acid; IBA, indole-3-butyric acid; 6-BA, 6-benzalyamino acid; CPPU, cleaner production promotion unit; $GA_{4+7}$, gibberrelin; $GA_3$, gibberrelic acid.

measured. In the experiment, three replications of 10 fruits were used for each treatment and tested in a randomized block design. The control was untreated plant growth regulators. The deformed pear fruit ('Yuguan Pear', 'Hangqing Pear', 'Huangjin Pear', and 'Mixue Pear') were collected at harvest for analysis of endogenous hormone of pear. Endogenous hormone contents were determined by high performance liquid chromatography (HPLC) and measured according to Kelen et al. (2004) with some modifications. Statistical analysis of the experimental results was performed using DPS9.5 software.

## RESULTS AND DISCUSSION

It is well known that plant growth regulators are used on many fruit tree to manipulate immature fruit drop, increase fruit set or fruit size, and loosen or remove fruits (Bubán, 2000; Stover and Greene, 2005; Boonkorkaew et al., 2008; De et al., 2009; Jong et al., 2011). Plant growth regulators have strong effects on pear fruit development (Tables 1 to 3). There was a significant difference among fruit vertical and horizontal diameters of treated and untreated fruit. Treatment effects of fruit shape index was best in NAA (20 mg/L), followed by IBA (30 mg/L), $GA_3$ (2.7%), 6-BA (30 mg/L), GA (3%), and CPPU (10 mg/L). It was found that fruit shape index in different treatment position of pear fruit were ordered as follow: fruit top > fruit bottom > fruit mid section. The size order of integrated skew index of treated fruit was $GA_{4+7}$ > CPPU > $GA_3$ > 6-BA > NAA > IBA. The size order of integrated skew index of treated fruit position was fruit bottom > fruit mid section > fruit top. CPPU and 6-BA significantly enhanced the growth of horizontal diameter, while $GA_3$ and $GA_{4+7}$ apparently stimulated fruit vertical diameter that tend to grow more apparent. These results indicate that plant growth regulators were involved in the determination of fruit shape index, longitudinal diameter deflection index, horizontal radius of the deflection index and integrated skew index.

These findings thus agree with those of Guardiola et al. (1998, 1993) who showed that the effect of auxins on final fruit size was the balance

**Table 2.** Effects of plant growth regulator treatments on the occurrence of deformed fruits.

| Plant growth regulator | Fruit shape index | Longitudinal diameter deflection index | Horizontal radius of the deflection index | Integrated skew index |
|---|---|---|---|---|
| NAA | $0.956^{aA}$ | $0.072^{bC}$ | $0.047^{cdCD}$ | $0.115^{cBC}$ |
| IBA | $0.942^{abA}$ | $0.025^{aAB}$ | $0.033^{dD}$ | $0.068^{cC}$ |
| 6-BA | $0.932^{abA}$ | $0.076^{bBC}$ | $0.070^{bcCD}$ | $0.145^{bcBC}$ |
| CPPU | $0.914^{bA}$ | $0.122^{aABC}$ | $0.129^{aAB}$ | $0.247^{abAB}$ |
| $GA_{4+7}$ | $0.937^{abA}$ | $0.143^{aA}$ | $0.140^{aA}$ | $0.282^{aA}$ |
| $GA_3$ | $0.926^{abA}$ | $0.135^{aAB}$ | $0.089^{bBC}$ | $0.219^{abABC}$ |

Different capital letters within a column indicate significant difference at 1% levels, respectively. NAA, Naphthalene acetic acid; IBA, indole-3-butyric acid; 6-BA, 6-benzalyamino acid; CPPU, cleaner production promotion unit; $GA_{4+7}$, gibberrelin; $GA_3$, gibberrelic acid.

**Table 3.** Effects of different plant growth regulator treatments on bearing skew fruits.

| Treatment position | Fruit shape index | Longitudinal diameter deflection index | Horizontal radius of the deflection index | Integrated skew index |
|---|---|---|---|---|
| Fruit top | 0.95 | $0.075^{bA}$ | $0.076^{a}$ | $0.148^{a}$ |
| Fruit mid section | 0.92 | $0.077^{bA}$ | $0.081^{a}$ | $0.159^{a}$ |
| Fruit bottom | 0.93 | $0.122^{aA}$ | $0.088^{a}$ | $0.207^{a}$ |

of both effects; the initial reduction of fruitlet growth and late growth stimulation, and of El-Otmani et al. (1993) who showed that the use of the butyl glycol ester of 2,4-dichlorophenoxy propionic acid (2,4-DP) on the mandarin cultivar 'Fortune' immediately after the 'June drop' enhanced fruit growth and improved final fruit size. Furthermore, De et al. (2009) and Jong et al. (1993) found that hormones also regulated fruit set and development.

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