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采前喷施赤霉素(GA_3)对杧果果实产量、品质和采后贮藏特性的影响

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摘 要:【目的】探明'贵妃'杧果生长期喷施GA_3对果实产量、品质和采后贮运特性的影响,以期为GA_3在杧果生产中的规范与合理使用提供科学的理论依据。【方法】选用'贵妃'杧果为试材,用不同质量浓度(50、100、250 mg·L^{-1})的GA_3于盛花期后15、25、35 d各喷1次,测定'贵妃'杧果的产量、坐果量、单果质量、果皮色素(叶绿素、类胡萝卜素、花色苷)、果实色泽参数(L、a、b值)、可溶性固形物含量、果实硬度、可滴定酸含量、维生素C含量和采后病害发生等指标。【结果】采前喷施GA_3能够增加'贵妃'杧果的产量和坐果量,促进果实膨大,增加果形指数,但果实的硬度和可溶性固形物含量下降,可滴定酸含量上升,果实品质下降,采后病害发病率上升。较高质量浓度下(250 mg·L^{-1})GA_3增产不显著,但果实品质明显降低,并诱导果实出现采后滞绿现象。【结论】海南'贵妃'杧果采前喷施GA_3,较低质量浓度(50~100 mg·L^{-1})可以增产,促进坐果和果实膨大,果实食用品质小幅下降。较高质量浓度(250 mg·L^{-1})增产不明显,果实品质下降幅度大,可诱导果实出现采后滞绿现象。因此,海南'贵妃'杧果采前喷施GA_3质量浓度以50 mg·L^{-1}为宜,可以增加产量、拉长果实、提高果实色泽,对果实品质影响较小,不会诱导果实采后滞绿。

关键词:杧果;赤霉素;产量;果实品质;果实颜色

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Effects of pre-harvest GA_3 spraying on yield, quality and storability of mango fruit

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Abstract:【Objective】To test the suitable concentration and timing of gibberellin (GA_3) application on mango trees (*Mangifera indica* L. 'Guifei', an early-maturing cultivar) at fruit growth and development period, we compared the effects of GA_3 spraying at different concentrations on yield, quality and postharvest storage characteristics of the mango fruits. GA_3 is used by fruit growers to increase production due to its effects on promoting fruit enlargement and enhancing coloration. However, with abuse usage of GA_3, many farms produced quite a lot of stay-green fruits at ripening in 2011. Our previous studies on the effects of multiple plant growth regulators using in fruits production by farmers on postharvest ripening of mango

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fruits indicated that high concentration of GA_3 spraying could induce stay-green at ripening and reduction of fruit quality in 'Guifei' mango.【Methods】Health 'Guifei' mango trees with consistent size and vigor were selected from a commercial orchard located in Dongfang city, Hainan province of China. The age of the trees was about 12 years old. GA_3 at concentrations of 50 mg·L^{-1}, 100 mg·L^{-1} and 250 mg·L^{-1} were sprayed each one time at 15 d, 25 d and 35 d after flowering with clean water serve as the control. Three trees were selected for one treatment (3 repetitions). Random group was arranged. The fruits were harvested at 113 d after anthesis when reached commercial value (physiological maturity), then loaded in corrugated carton box, each layer of fruits were placed soft paper to avoid damage. After that the fruits were taken back to laboratory immediately, storaged in a room under 25±1 ℃ and 85%±5% relative humidity (RH). Fruit color parameters of fruit peel such as *L* value, *a* value and *b* value, the contents of total chlorophylls, anthocyanins, and carotenoids were measured at harvest and during storage to estimate the effect of GA_3 on mango postharvest color changing. Fruit firmness, soluble solid content (TSS) content, titration acid (TA) content, and vitamin C content were measured to estimate the effect of GA_3 on inner quality of mango. The yield, fruit weight (fruit with seed and fruit without seed), fruit shape index, the fruit number per tree and the disease incidence induced by fungi were tested.【Results】The yield, the number of fruits every tree, fruit enlargement and fruit shape index were increased by GA_3 spraying. The yield per tree increased by 23.48%, 19.85% and 11.42%, respectively by using 50 mg·L^{-1}, 100 mg·L^{-1} and 250 mg·L^{-1} GA_3. The number of fruits every tree improved by 9.24% and 20.13%, respectively by 50 mg·L^{-1} and 100 mg·L^{-1} GA_3 treatment. Reverse effect was induced by 250 mg·L^{-1} GA_3 which was decrease the number of fruit by 4.62%. The weight of fruit increased effect was obviously higher on the fruit without seed than on the fruit with seed. The weight of seedless fruit were increased by 23.48%, 19.85% and 11.42%, respectively after spraying 50 mg·L^{-1}, 100 mg·L^{-1} and 250 mg·L^{-1} GA_3 compared with the control, and the weight of seed fruit were increased by 2.35%, 5.26% and 6.20%, respectively. The effect on fruit shape index by GA_3 was noticeable on the fruit without seed compared with the fruit with seed. GA_3 250 mg·L^{-1} spraying induced the shape index of fruit with seed increased by 3.15% and fruit without seed increased by 6.20%. GA_3 spraying during fruit growth affected the content of pigments on mango peel and the fruit color development during maturation and ripening. At harvest, the *L* value, *a* value and *b* value were no obvious difference between the treatments (GA_3: 50 mg·L^{-1}, 100 mg·L^{-1} and 250 mg·L^{-1}) and the control, but at ripening their values of the treatments were all lower than the control. At harvest (physiological maturity), the content of chlorophylls and carotenoids on peel were reduced by GA_3, and the content of anthocyanins was increased. The effect on fruits treated by GA_3 250 mg·L^{-1} was more obvious and the content of chlorophylls and carotenoids were decreased by 4.87% and 5.46 %, respectively. The content of anthocyanins treated by GA_3 250 mg·L^{-1} was improved by 19.24% and the fruit color was more bright red. At ripening, the contents of chlorophylls and carotenoids on peel were improved by GA_3, and the increase of treatment GA_3 250 mg·L^{-1} were by 136.37% and 9.88% respectively. The content of carotenoids by GA_3 250 mg·L^{-1} was decreased by 3.78%. The color changing from green to yellow was inhibited by GA_3 during storage. The effect on fruit quality was not evident by GA_3 50 mg·L^{-1}, while the fruit quality treated by GA_3 250 mg·L^{-1} was reduced. The fruit firmness and TSS content of treatment 250 mg·L^{-1} GA_3 decreased by 11.76% and 5.07% respectively compared with the control, and the acid content increased by 18.85%. The postharvest disease incidence rate was enhanced by GA_3, and the incidence of anthrax and stalk rot of fruits treated by GA_3 250 mg·L^{-1} were increased by 327.55% and 95.45%, respectively.【Conclusion】GA_3 (50 mg·L^{-1} and 100 mg·L^{-1}) spraying during fruit development increased the yield of 'Guifei' mango, pro-

moted fruit enlargement, improved fruit shape index, but declined fruit quality reflecting by decreasing TSS content and fruit firmness while increasing TA content and disease incidence. High concentration of GA_3 (250 mg·L^{-1}) induced stay-green fruit with no obvious effect on yield. These results suggest that the suitable concentration of GA_3 spraying at fruit growth and development time is 50mg·L^{-1}, which could increase the fruit weight and yield without decrease fruit quality.

Key words: Mango; GA_3; Yield; Quality; Color

杧果(*Mangifera indica* L.)为漆树科常绿乔木,因其果实香、美味可口、营养价值高,有着“热带果王”的称号。‘贵妃’杧果,又名‘红金龙’,是海南的主栽品种之一,成熟时色泽红艳,果肉细滑,汁多、皮薄、营养价值高,受到消费者的喜爱。在生产上‘贵妃’杧果会出现2种类型果实:一种是胚发育良好、有种子的果实,质量约350 g,简称“有胚果”,在海南俗称“母果”;一种是胚败育的果实,没有种子,果实质量约75 g,简称“无胚果”,在海南俗称“公果”。无胚果一般占比高于90%,果小价低,严重影响‘贵妃’杧果产量和种植的经济效益。近几年种植者开始在‘贵妃’杧果生产上施用促进增产和膨大果实的生长调节剂,在提高经济效益的同时,也出现了生长调节剂的滥用,产生严重的负面效果,比如导致畸形果增加,品质下降,采后果实转色不正常等现象[1]。农药920是目前‘贵妃’杧果生产上经常使用的膨大剂药剂之一,其主要成分是赤霉素。赤霉素又名赤霉酸,其化学结构属于二萜类酸,由四环骨架衍生而得,已知的赤霉素种类至少有38种。‘贵妃’杧果使用920不但能促进果实膨大,而且可以提高果皮花色苷含量,使果实外观更加鲜艳。由于其效果好,近年使用的浓度出现越来越高的趋势。2011年在海南三亚地区开始出现‘贵妃’杧果采后果皮滞绿现象,即使用乙烯催熟仍不能改善这种滞绿现象,笔者前期研究了2,4-D(2,4-dichlorophenoxya-cetic acid)、噻苯隆(thidiazuron)、氯吡苯脲(Forchlorfenuron)、赤霉素(GA_3)等多种植物生长调节剂对‘贵妃’杧果采后转色和贮藏特性的影响,发现在‘贵妃’杧果生长阶段使用高浓度GA_3可以诱导果皮采后出现滞绿现象[1]。黄铭慧等[2]在海南省三亚市南雅镇采前用2.0 g·L^{-1} GA_3喷施‘贵妃’杧果,发现2.0 g·L^{-1}的GA_3造成果实不能完全转色。而2014年朱敏等[3]做的‘贵妃’杧果采前GA_3(50~500 mg·L^{-1})喷施试验,并没有发现采前使用GA_3诱导采后滞绿现象。因此海南‘贵妃’杧果采前喷施GA_3的最佳时期、次数、浓度,对产量、品质、诱导果采后滞绿的影响等均不明确,需要进一步研究。笔者选用‘贵妃’杧果为试材,研究其果实生长期间喷施GA_3对产量、品质和贮运特性的影响,以期形成适宜的GA_3施用技术,尽快规范GA_3在海南杧果生产上的合理使用,避免出现采后果实滞绿、果实品质严重下降等生产问题。

1 材料和方法

1.1 材料

供试杧果树:品种‘贵妃’,树龄约12 a(年),地点海南省东方市中国热带农业科学院杧果标准化示范园。选择树体大小、树势较一致的杧果树进行试验。

GA_3:上海宝曼生物科技有限公司,纯度≥99%。

1.2 方法

1.2.1 *处理方法* GA_3设3个质量浓度:50、100、250 mg·L^{-1},以清水作对照(CK)。每处理选3株树,3次重复,随机区组排列。于盛花期后15 d、25 d和35 d各喷1次,共喷3次,果实在盛花期后113 d采收。用瓦楞纸箱包装,每层杧果之间放置软物隔离保护,放置在(25±1)℃、相对湿度(RH)(85±5)%的冷库中贮藏。

1.2.2 *测定指标和方法* 测定指标:单株坐果量、单株产量,无胚果单果质量、有胚果单果质量、果形指数,无胚果数量、有胚果数量、果实采后色泽参数(采用L、a、b模式,L值从小到大表示果实的亮度和对比度增加,a值从小到大表示果实从深绿到红色的转变,b值从小到大指果实颜色从亮蓝色到焦黄色的转变)、果皮色素(叶绿素、花色苷、类胡萝卜素)含量、可溶性固形物含量、果实硬度、可滴定酸含量、维生素C含量、采后病害发病率和滞绿果实数量。

测定方法:单株产量和单果质量用称重法;果形指数=果实的纵/横径,果实纵径(果实最大长度)、横径(果实最大宽度)用游标卡尺测量;果实采后色泽参数HROMA METER CR-410色彩计测定;叶绿素