Indian J. Hort. 68(1), March 2011: 139-141

Short communication

Uniconazole promotes carbohydrate accumulation in bulbs of Lilium Oriental hybrid 'Sorbonne'

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Lilium Oriental hybrid 'Sorbonne' is one of the most popular commercial lilium varieties in cut flower market in China. Carbohydrate reserves in bulbs have an extraordinary buffering and supportive role during blossoming periods for good quality flowers. Great efforts have been made to study the carbohydrate metabolism in root crops such as white yam using plant growth regulators (Abdul Jaleel *et al.*, 1). These studies proved that the triazole compounds are effective in promoting the carbohydrate accumulation in sink organs. Uniconazole [(E)-1-(4-chlorophenyl)-4, 4-dimethyl-2-(1,2,4-triazol-l-yl)-1-penten-3-ol] is a potent and active member of the triazole family which is able to induce changes in morphogenesis, photosynthetic ability, phytohormonal balance and favor the carbon flux to sink organs (Fletcher *et al.*, 3). Triazole family has also been extensively used in ornamental plants to control plant height and produce compact plants (Monica Meijon *et al.*, 4). However, to our knowledge, little attention has been paid to test the effect of uniconazole on the morphological characteristics and carbohydrate metabolism of bulb in lily plants. Thus, the main objective of this work is to evaluate the effect of uniconazole on carbohydrate accumulation in bulbs of *Lilium* Oriental hybrid 'Sorbonne'.

The *Lilium* Oriental hybrid 'Sorbonne' bulbs having perimeter of 16-18 cm were bought and planted at 10 September, 2007. The soil was a mixture of peat moss and perlite (2:1), with 10 g APEX® fertilizer (14-14-14) per bed, no fertiliser was used afterward. Uniconazole solutions were sprayed on the leaves at 0, 80 and 160 ppm, respectively, at 45 days after plantation (DAP). The plants were uprooted randomly since 45 DAP at 30-day intervals until 135 DAP, and then used for analysis of growth and biochemical constituents. The initial bud formation was observed since 75 DAP, most plants reached full blossoming period at 105 DAP and after that the senescence of flowers began. All samples were tested with five replicates per experiment.

Samples which contained 0.5 g fresh lily bulb were tested for sucrose and starch contents (McCready *et al.*, 4). Data analysis was carried out using the SPSS 11.5 software package. The carbohydrate contents were subjected to one-way ANOVA (Duncan's test) to compare the differences between treated and un-treated plants (Fig. 2). Comparison with P value of <0.05 was considered significantly different. The plant heights were obviously reduced by uniconazole treatments of both concentrations, especially during the blossoming period (Fig. 1A). This reduction is in accordance with the decrease in stolen length caused by triazole compounds in potato and could be due to inhibition of gibberellin synthesis (Xu *et al.,* 6). Leaf number in all plants began to decrease significantly at 105 DAP as the senescence of bottom leaves began (Fig. 1B).

Uniconazole treatments of both concentrations delayed the senescence and facilitated the photosynthesis thereby enhancing the carbohydrate reserves in lily bulbs. Fresh bulb weight decreased at the initial blossoming period as the formation of buds certainly depleted carbohydrate reserves not only in leaves but also in bulbs. Consequently, the fresh bulb weights were marginally elevated by both treatments at blossoming period, with 80 ppm treatment superior to that of 160 ppm treatment (Fig. 1C). It is worth noticing that although the plant height decreased with a remarkable coefficient in plants with 160 ppm treatment, the increase of leaf number led to an increase of shoot weight, so the biomass of leaves and stems actually was not reduced.

Sucrose and starch contents in treated plants maintained at similar level as that of control at the vegetative growth period, but they were significantly higher than that of control, at the blossoming period which is the key period for carbohydrate accumulation (Fig. 3). The magnificent increase could be explained by the following reasons. First, uniconazole enhanced the photosynthetic ability of plants by increasing chlorophyll contents in leaves. The stimulation of cytokinin synthesis caused by triazole compounds could be the reason for the increase of chlorophyll contents as it enhances chloroplast differentiation, chlorophyll biosynthesis and prevents chlorophyll degradation (Fletcher *et al.*, 3). The abundant carbohydrate synthesis not only supported the reproductive growth

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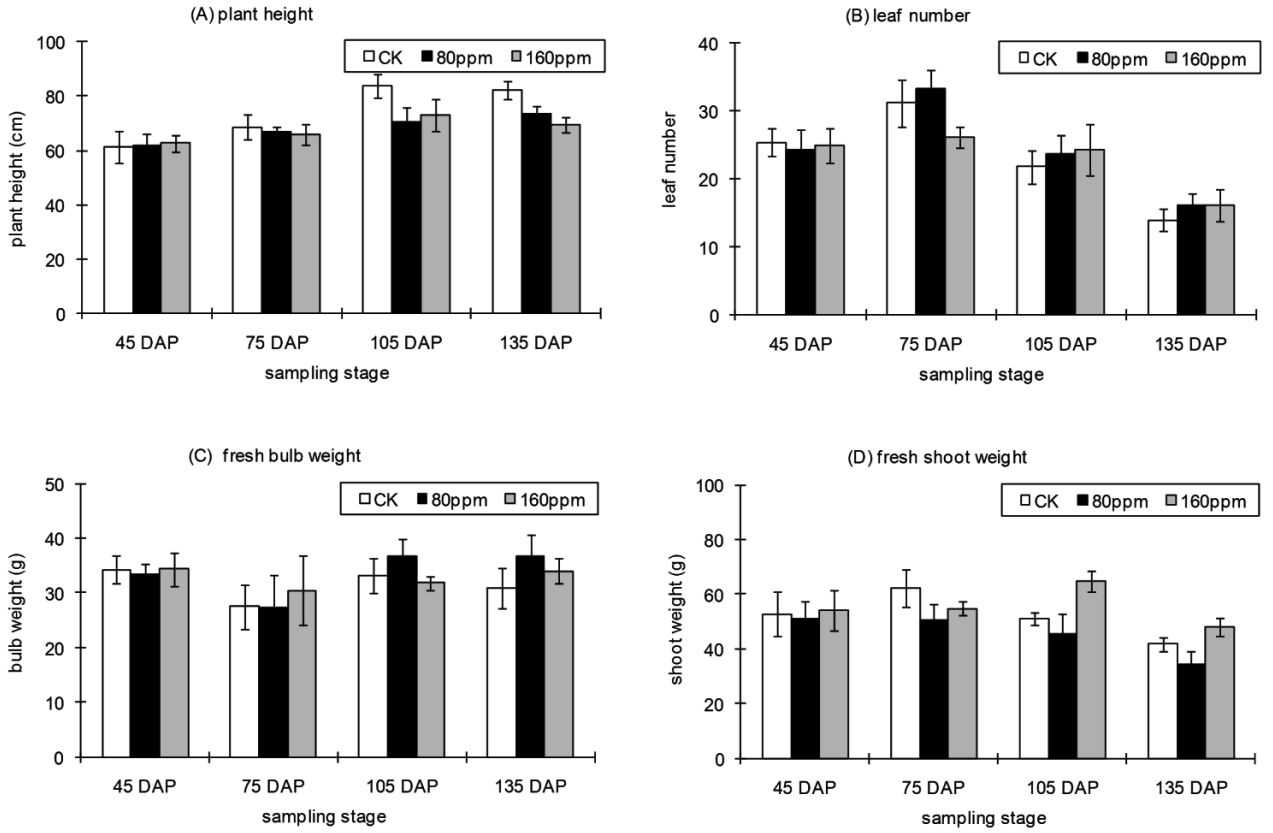

Fig. 1. Morphological parameters of un-treated and treated lily plants measured at 45, 75, 105 and 135 DAP, respectively. Values are given as mean ± SD of five samples in each group. Plant height (cm) was recorded as the length of the main stem and its branches up to the tip. The weight of stems, leaves and flower buds were summed up as total shoot weight (g).

but also enabled more carbon fluxes to flow back to bulbs. The photosynthetic ability was also enhanced by the delay of leave senescence in response to uniconazole treatments (Fig. 1B). Second, uniconazole is well known for its anti-gibberellin effect which is efficient in reducing growth of leaves and stems and facilitating carbohydrate accumulation in sink organs such as lily bulb. It is in accordance with many reports on positive effect of triazole family in sink organs such as rice (Yim *et al*., 7). However, the 160 ppm treatment did not reduce the biomass of leaves and stems, so it needs to be evaluated carefully when it concerns to suppression of vegetative growth. Third, the increased sink strength of lily bulbs presumably enhanced photosynthesis and improved translocation of photo-assimilates to the sink organ. Furthermore, Abdul Jaleel *et al.* (1) revealed that triazole compounds could directly inhibit the, amylase activity and increase important starch and sucrose synthesizing-enzymes SPS, SS and AI activities in white yam (*Dioscorea rotundata* Poir.).

In conclusion, uniconazole is proved to a feasible way to improve carbohydrate accumulation in bulbs of *Lilium* Oriental hybrid 'Sorbonne'. The effect of uniconazole treatment may differ from low concentration to high concentration. Thus, more field experiments and evaluation must be done before commercial application in lily bulb production.

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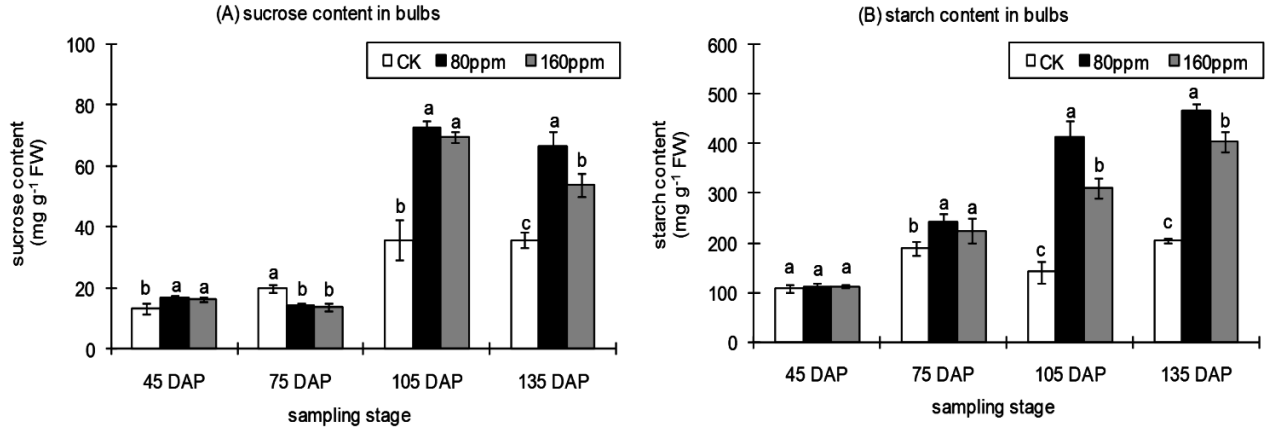

Fig. 2. Effect of uniconazole treatments on the sucrose and starch contents in lily bulbs on different growth stages. Values are given as mean ± SD of five samples in each group. Vertical bars represent standard errors. Bar values are not sharing a common superscript (a,b,c) differ significantly at P≤0.05.

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Received: December, 2010; Revised: February, 2011; Accepted : February, 2011