NORTH AMERICA

Foliar Potassium Improves Cantaloupe Marketable and Nutritional Quality

By G.E. Lester, J.L. Jifon, and W.M. Stewart

Potassium is important in optimizing both crop yield and economic quality. Root activity and K uptake are generally reduced during the reproductive phase of crop development. This study has shown that supplementing sufficient soil K with additional foliar K applications during cantaloupe fruit development and maturation improves fruit marketable quality by increasing firmness and sugar content, and fruit human-health quality by increasing ascorbic acid, beta-carotene, and K levels.

Potassium is required by plants in much greater amounts than other mineral nutrients, with the exception of N. Potassium uptake by plants from soil solution is influenced by several factors, including soil moisture conditions, pH, texture, aeration, temperature, and balance with other nutrients. Plant development stage also influences the capacity for K uptake. More K is taken up during the vegetative growth stages when roots are actively growing than in fruit growth (reproductive) stages when root growth is inactive (Beringer et al., 1986).

Developing fruit are stronger sinks for photoassimilates than roots and other vegetative tissues. This competition for photoassimilates reduces root growth and energy supply for nutrient uptake (Marschner, 1995). Thus, during reproductive development soil K supply may not be adequate to support crucial processes that ultimately determine yield and quality. More specifically, muskmelon (cantaloupe) has some of the highest fruit K concentrations among fruit, hence developing melons have a high demand for K and often rely on re-translocation from vegetative tissues (Williams and Kafkafi, 1998).

Previous research has demonstrated that this apparent K deficiency during fruit development and maturation can be mitigated through supplemental foliar K applications to netted cantaloupe (Lester et al., 2005).

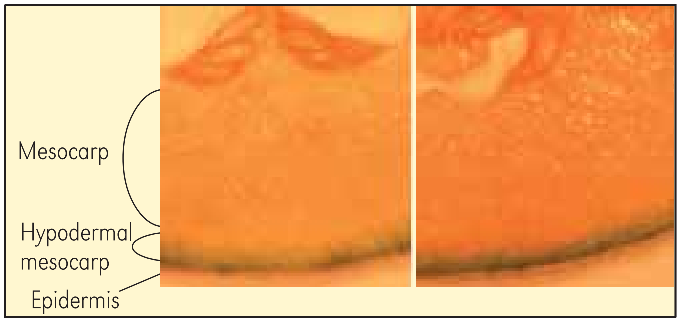

Figure 1. Control fruit in the left photo averaged 7.1% SSC and 18 ppm beta-carotene. The KM+S treated fruit in the right photo averaged 10.2% SSC and 26 ppm beta-carotene.

The objective of this glasshouse study was to further investigate the effect of foliar K application on cantaloupe quality parameters and to compare two K sources: a glycine amino acid complexed K…Potassium Metalosate™ (KM)… and KCl, both applied with and without a surfactant.

Netted, orange-flesh cantaloupe 'Cruiser' fruit were grown in a glasshouse at the USDA-ARS Kika de la Garza Research Center in Weslaco, Texas, in the fall of 2004 and spring of 2005. Procedures previously described by Lester et al. (2005) were used. Plants were grown in a commercial potting medium in 15-liter pots, watered daily through an automated drip irrigation system. A complete water soluble fertilizer was delivered through fertigation twice per week during vegetative and fruit development stages to ensure that soil nutrient status was not limiting. Immediately after fruit set (anthesis) and up to fruit maturation (abscission), entire plants including fruit were sprayed to runoff with one of the following: 1) KM solution; 2) KCl solution; 3) KM

Table 1. Influence of growing season (spring or fall) and two sources of supplemental foliar K (KM and KCl), applied with or without a surfactant (S), on fruit K concentration and firmness. Epidermis refers to the peel, hypodermal mesocarp is the outer green pulp of the melon and the mesocarp is the edible pulp.

	Tissue K concentration, % fresh wt.			Fruit tissue firmness, Newtons, N	
Treatment	Epidermis	Hypodermal mesocarp	Mesocarp	External	Internal
Fall 2004					
KM	0.330 b[1]	0.225 b	0.246 a	19.7 a	11.4 a
KCl	0.354 a	0.207 bc	0.230 b	19.7 a	10.7 a
KM+S	0.330 b	0.250 a	0.241 a	18.8 a	11.5 a
KCl+S	0.335 b	0.225 b	0.245 a	19.2 a	12.0 a
Control	0.329 b	0.189 c	0.217 c	14.5 b	8.6 b
Spring 2005					
KM	0.364 b	0.302 b	0.273 a	15.8 a	10.3 ab
KCl	0.449 a	0.274 bc	0.255 b	15.7 a	9.6 b
KM+S	0.372 b	0.312 ab	0.260 b	16.8 a	10.0 ab
KCl+S	0.364 b	0.340 a	0.260 b	17.7 a	11.1 a
Control	0.365 b	0.266 c	0.235 c	12.7 b	7.5 c

[1]Means within a column and within a season followed by the same letter are not significantly different using LSMEANS comparisons at $p \leq 0.05$, n = 10.

Abbreviations and notes for this article: K = potassium; N = nitrogen; KCl = potassium chloride; ppm = parts per million; SSC = soluble solids concentration

Table 2. Influence of growing season (spring or fall) and two sources of supplemental foliar K (KM and KCl), applied with or without a surfactant (S), on fructose, glucose, sucrose, total sugars, relative sweetness, and SSC of netted muskmelon 'Cruiser'.

Treatment	Sugar, % fresh wt. Fructose	Glucose	Sucrose	Total	Relative sweetness[z], % sucrose equiv.	SSC, %
Fall 2004						
KM	1.92 a[1]	1.08 a	3.36 ab	6.36 b	7.57 b	9.7 a
KCl	1.90 a	1.11 a	3.21 ab	6.22 b	7.46 b	9.2 b
KM + S	1.75 b	1.08 a	4.12 a	6.95 a	8.03 a	9.8 a
KCl + S	1.73 b	1.00 a	3.62 ab	6.35 b	7.43 b	9.7 a
Control	1.68 b	0.99 a	2.90 b	5.57 c	6.61 c	8.9 c
Spring 2005						
KM	1.45 a	0.94 bc	3.13 ab	5.53 a	6.40 a	9.6 b
KCl	1.29 c	0.91 c	3.19 ab	5.40 a	6.15 b	9.7 b
KM + S	1.38 b	0.96 ab	3.27 a	5.62 a	6.42 a	10.1 a
KCl + S	1.38 b	1.00 a	3.15 ab	5.54 a	6.33 ab	9.9 ab
Control	1.24 c	0.90 c	2.98 b	5.12 a	5.68 c	8.8 c

[1]Means within a column and within a season followed by the same letter are not significatly different using LSMEANS comparisons at $p \leq 0.05$, n = 10.
[z]Relative sweetness = 1.8 (mg/g fresh wt. fructose) + 0.7 (mg/g fresh wt. glucose) + 1.0 (mg/g fresh wt. sucrose).

plus a nonionic surfactant (KM+S); 4) KCl plus surfactant (KCl+S); or 5) deinonized water. Solution concentration for all K treatments was 800 ppm K (0.08% K).

Foliar K application generally resulted in higher K concentrations in fruit mesocarp (edible pulp) tissue compared to non-treated control fruit (**Table 1**). However, in both spring and fall, the effects of K source and surfactant use on fruit tissue K concentrations were generally not consistent. External and internal firmness of fruit from plants receiving foliar K were significantly higher than those from control plants in both seasons, regardless of surfactant use or K source (**Table 1**). The K-related increase in fruit firmness was associated with increased tissue pressure potential (data not shown). Pressure potential was positively correlated with SSC, total sugars, fruit sucrose, and glucose concentrations.

Total fruit sugars (osmolytes) were generally higher in K treated fruit compared to controls and also slightly greater in fall than in spring grown fruit (**Table 2**). Fruit SSC was significantly greater in K-treated fruit, regardless of season. Fruit sucrose, glucose, and fructose levels were generally increased by foliar K fertilization. Relative levels of sucrose and fructose in fruit has important implications for consumer preference since fructose is perceived to be up to 80% sweeter than sucrose. Relative sweetness of melons was increased by supplemental foliar K application compared to controls (**Table 2**). The increase in fructose: sucrose ratio indicates that foliar K fertilization has the potential to improve a key consumer preference attribute of cantaloupe.

Table 3. Influence of growing season and two sources of supplemental foliar K (KM and KCl), applied with or without a surfactant (S) on total ascorbic acid and beta-carotene concentrations of netted muskmelon 'Cruiser' fruit.

Treatment	Total ascorbic acid	Beta-carotene
	-------- ppm fresh wt. --------	
Fall 2004		
KM	36,400 a[1]	30.9 a
KCl	33,500 b	26.6 c
KM+S	35,200 ab	29.6 ab
KCl+S	36,000 ab	28.6 b
Control	30,000 c	25.7 c
Spring 2005		
KM	26,800 b	22.9 b
KCl	28,000 ab	23.1 b
KM+S	28,300 a	25.1 a
KCl+S	27,000 ab	26.6 a
Control	24,200 c	21.8 c

[1]Means within a column and within a season followed by the same letter are not significatly different using LSMEANS comparisons at $p \leq 0.05$, n = 10.

Ascorbic acid (vitamin C) and beta-carotene (vitamin A) were generally higher in fruit treated with K than in control fruit (**Table 3 and Figure 1**). However, there were no consistent K source effects on these quality parameters. The beneficial effects of supplemental K probably resulted from a combination of improved leaf photosynthetic CO_2 assimilation, assimilate translocation from leaves to fruit, improved leaf and fruit water relations, increased enzyme activation and substrate availability for ascorbic acid and beta-carotene biosynthesis, all associated with adequate K nutrition (Gross, 1991, Hopkins, 1963). Differences between the two K sources were minimal and use of a surfactant tended to have a positive effect on K response. These quality improvements were obtained by implementing a simple management tool that growers can adopt anywhere in the world. BC

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Dr. Lester is a researcher with USDA-ARS-SPA-SARC, at Weslaco, Texas; e-mail: glester@weslaco.ars.usda.gov. Dr. Jifon is with Texas A&M University, Texas Agricultural Experiment Station, Weslaco. Dr. Stewart is IPNI Southern and Central Great Plains Region Director, located at San Antonio.

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