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Foliar-applied Iron Enhances Bermudagrass Tolerance to Herbicides

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Abstract. Field experiments were conducted to determine the effects of foliar iron (Fe) applied with postemergence herbicides on injury, color, and quality of 'Tifway' bermudagrass [*Cynodon transvaalensis* Burt-Davy × *Cynodon dactylon* (L.) Pers.]. Iron significantly decreased injury and improved quality and color of 'Tifway' bermudagrass in conjunction with herbicide treatment. Turf injury was less for 4 to 18 days after the initial MSMA application when Fe was added. Injury was also less from sequential Fe treatment with MSMA + metribuzin (up to 4 days) and MSMA + imazaquin (from 4 to 10 days) compared to the respective herbicides applied alone. There was no difference in turf injury from Fe when imazaquin at 1.3 kg·ha⁻¹ was applied as a single treatment. However, turf treated with Fe and two applications of imazaquin (9- to 10-day interval) recovered from herbicide injury faster than when treated only with the herbicide. Iron did not prevent immediate 2,4-D + mecoprop + dicamba injury to the bermudagrass, but did hasten turf recovery from injury at 26 days after treatment. With a few exceptions, 'Tifway' bermudagrass quality was higher and color improved when Fe was added. However, injury expressed as loss of shoot density was not affected by Fe and only injury expressed as color loss was improved by Fe. Chemical names used: 3,6-dichloro-2-methoxybenzoic acid (dicamba), 2-[4,5-dihydro-4-methyl-4-(1-methylethyl)-5-oxo-1H-imidazol-2-yl]-3-quinolinecarboxylic acid (imazaquin), (±)-2-(4-chloro-2-methylphenoxy)propanoic acid (mecoprop), 4-amino-6-(1,1-dimethylethyl)-3-(methylthio)-1,2,4-triazin-5(4H)-one (metribuzin), monosodium salt of MAA (MSMA), and (2,4-dichlorophenoxy)acetic acid (2,4-D).

Postemergence herbicides are necessary to control emerged weeds in bermudagrass turf. For example, MSMA (Johnson, 1975) has been used for control of large crabgrass (*Digitaria sanguinalis* L. Scop.), MSMA + metribuzin (Johnson, 1980) for goosegrass (*Eleusine indica* L. Gaertn.) imazaquin or MSMA + imazaquin (Coats et al., 1987) for purple nutsedge (*Cyperus rotundus* L.), and 2,4-D + mecoprop + dicamba for various broadleaf weeds (Johnson, 1987). Although these herbicides are labeled for bermudagrass, various degrees of turf injury usually occur within a few days following herbicide application. Injury may be expressed as loss of shoot density and/or discoloration. Slight to moderate discoloration of bermudagrass occurred when treated with MSMA (Johnson, 1981) or imazaquin (Coats et al., 1987), while severe injury was reported when the grass was treated with MSMA + metribuzin (Johnson, 1980) or 2,4-D + mecoprop + dicamba (Johnson, 1978, 1983). However, bermudagrass fully recovered within 2 to 4 weeks after herbicide treatments regardless of the amount of initial injury.

When selecting herbicides for weed control, it is desirable to use chemicals in conjunction with a management system that causes the least amount of injury to the desired turf. This is especially true on turf sites where high quality is expected. In an earlier study, bermudagrass injury from postemergence herbicides was masked or reduced by nitrogen treatments (Johnson, 1984). Several researchers have reported that foliar-applied Fe improves the color and quality of creeping bentgrass (*Agrostis palustris* Huds.) (Schmidt and Snyder, 1984; Snyder and Schmidt, 1974); Kentucky bluegrass (*Poa pratensis* L.) (Yust et al. 1984), and centipedegrass [*Eremochloa ophiuroides* (Munro.) Hack.] (Carrow et al., 1988). Snyder and Schmidt (1974) suggested that frequent Fe treatments may offset the effects of adverse environmental conditions. However, we found no research data on the possible effects of Fe on herbicide injury to bermudagrass. In addition, the response of turfgrasses to Fe varies with application rates (Horst, 1984), turfgrass species (Beard, 1973), temperature, and rate of turf growth (Carrow et al. 1988; Schmidt and Snyder, 1984).

Since postemergence herbicides temporarily discolor bermudagrass and Fe improves greenness, experiments were conducted on bermudagrass to determine if Fe applied with postemergence herbicides would prevent or reduce turf injury.

Materials and Methods

Two experiments were conducted on 'Tifway' bermudagrass maintained at a mowing height of 2 to 3 cm at Griffin, Ga. during 1988. The grass was mowed with a reel mower three

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times per week and clippings were returned before treatments were applied, but removed thereafter.

The turfgrass was fertilized with 50N-22P-42K ($\text{kg}\cdot\text{ha}^{-1}$) in mid-April and 50 kg N/ha was applied in late May. No additional N was applied to plots treated with herbicides and Fe in late June and early July, while 50 kg N/ha was applied in late June to plots treated with herbicides and Fe in August. Rainfall was supplemented with irrigation as needed to maintain optimum turfgrass growth.

Turfgrass injury was rated visually (0 = no injury, 100 = complete kill) in both experiments, but visual color was rated only in Expt. 1. The color was rated from 1 = no green (all brown or yellow) to 9 = dark green. In addition, turfgrass quality ratings based on a combination of shoot density, color, and uniformity (0 = no live turf; 10 = ideal density, color, uniformity) were made. Ratings were made at various times from 2 to 39 days after the initial treatment.

A factorial arrangement of herbicides was used in a randomized complete block design with four replications in Expt. 1 and three in Expt. 2. Plot size was 1.5×3.0 m. Analysis of variance was conducted by the General Linear Model procedure in the Statistical Analysis Systems (SAS Institute, 1982). Various post hoc contrasts were hypothesized to determine difference between Fe treatments within a herbicide.

Experiment 1. The soil type was an Appling loamy sand (Typic Hapludult) with 2.2% organic matter, 79% sand, 14% silt, and 7% clay. Soil test results using the procedures of the Univ. of Georgia soil test laboratory were: pH 5.7, 48 mg P/kg (very high) and 59 mg K/kg (medium).

Herbicide treatments were MSMA ($2.2 \text{ kg}\cdot\text{ha}^{-1}$), MSMA + metribuzin ($2.2 + 0.14 \text{ kg}\cdot\text{ha}^{-1}$), 2,4-D + mecoprop + dicamba ($1.1 + 0.6 + 0.1 \text{ kg}\cdot\text{ha}^{-1}$) imazaquin ($0.6 \text{ kg}\cdot\text{ha}^{-1}$), and an untreated control. Iron chelate treatments were 0 and $1.12 \text{ kg}\cdot\text{ha}^{-1}$. The $1.12\text{-kg}\cdot\text{ha}^{-1}$ Fe level resulted in significant color response on 'Tifgreen' bermudagrass (White and Schmidt, 1988) and was found to be a practical foliar rate on Kentucky bluegrass (Yust et al., 1984). The Fe source was Lawn-Plex (RGB Laboratories, Kansas City, Mo.), which contains 8% sulfur and 8% chelated Fe derived from ammonium thiosulfate and iron phosphate-citrate in a liquid formulation. Herbicide and Fe treatments were applied (to the same plots) on 27 June and 7 July 1988, with the study repeated on an adjacent site with applications on 15 and 24 Aug. 1988. Data collected from the 27 June and 7 July sites will be referred to as location 1 and data from the 15 and 24 Aug. site as location 2. Herbicide and Fe treatments were applied within 15 min of each other in separate applications to avoid any tank mixing problems. The broadcast spray water volume was $375 \text{ liter}\cdot\text{ha}^{-1}$ for the herbicides and $1600 \text{ liter}\cdot\text{ha}^{-1}$ for Fe. Water pH was 8.50, and all treatments were applied within 30 min of water addition. After the addition of Lawn-Plex to the water, pH was 6.2 and no problem with Fe precipitation was noted. A nonionic surfactant (alkylaryl polyoxyethylene glycol free fatty acid isopropanol) was applied with 2,4-D + mecoprop + dicamba and imazaquin at 0.5% (v/v). No additional surfactant was applied with MSMA or MSMA + metribuzin.

Experiment 2. The soil type was an Appling sandy clay loam with 1.7% organic matter, 55% sand, 22% silt, and 23% clay. Soil tests were: pH 6.5, 30 mg P/kg (high), and 58 mg K/kg (medium).

Herbicide treatments were MSMA at 2.2 and $6.7 \text{ kg}\cdot\text{ha}^{-1}$, imazaquin at 0.4 and $1.3 \text{ kg}\cdot\text{ha}^{-1}$, MSMA + imazaquin at 2.2 + 0.4 and 6.7 + $1.3 \text{ kg}\cdot\text{ha}^{-1}$, and an untreated control. The

lower amount of each herbicide is considered to be the normal recommended level, while the higher one is three times at normally recommended. Iron source was the same as given in Expt. 1, and levels were 0, 0.28, and $1.12 \text{ kg}\cdot\text{ha}^{-1}$. The data for Fe at $0.28 \text{ kg}\cdot\text{ha}^{-1}$ are not presented because bermudagrass showed little, if any, response to this level. The herbicides and Fe treatments were tank-mixed, as a grower would do, and applied as a single broadcast spray application in 375 liter of water/ha on 16 Aug. 1988. No precipitation of Fe was noted upon tank mixing, and Fe-herbicide responses observed in Expt. 2 were similar to those in Expt. 1, where materials were applied separately. The nonionic surfactant described in Expt. 1 was applied with all treatments at 0.25% (v/v). Other application conditions were as described in Expt. 1. In all experiments, treatments were applied between 0830 to 1000 HR, the air was between 25 and 27C, and no rain fell during the day.

Results and Discussion

Turfgrass injury. In Expt. 1, 'Tifway' bermudagrass exhibited less injury when Fe was applied to turf treated with MSMA than when treated only with MSMA (Table 1). The Fe response lasted for 4 days after treatment with MSMA at location 1 and for 18 days after the initial chemical treatment at location 2.

Iron reduced MSMA + metribuzin injury at 4 days after treatment at either location compared to injury obtained from the herbicides applied alone (Table 1). Even though Fe did not significantly influence the response of turf treated with a second application of MSMA + metribuzin at 9- to 10-day interval at both locations, turf treated with only herbicide was injured 21% more at 18 days at location 1 and 13% more at 15 days at location 2 than turf treated with Fe and these herbicides. The response of bermudagrass to Fe and MSMA or Fe and MSMA + metribuzin was similar at location 2. At location 2, Fe decreased injury for a longer time period for MSMA than MSMA + metribuzin.

Iron applied with 2,4-D + mecoprop + dicamba did not decrease turf injury for up to 18 days after the initial herbicide treatment. Turf treated with Fe and 2,4-D + mecoprop + dicamba recovered faster 18 to 26 days after the initial herbicide treatment than turf treated only with the herbicide (Table 1). Similar results also occurred from sequential treatments with Fe and imazaquin at location 1. Also, at location 2, turf injury in plots treated with a second application of Fe and imazaquin was less at 15 through 26 days than turf treated only with imazaquin.

In Expt. 2, the initial injury of 'Tifway' bermudagrass was less when MSMA or MSMA + imazaquin was applied with than without Fe (Table 2). The decrease in turf injury from Fe in plots treated with MSMA at 2.2 or $6.7 \text{ kg}\cdot\text{ha}^{-1}$ and MSMA + imazaquin at $2.2 + 0.4 \text{ kg}\cdot\text{ha}^{-1}$ lasted for 4 days, while the decrease from MSMA + imazaquin at $6.7 + 1.3 \text{ kg}\cdot\text{ha}^{-1}$ persisted for 10 days. Imazaquin applied alone or with Fe caused slight injury to 'Tifway' bermudagrass. The addition of Fe decreased injury only at 21 days after treatment for imazaquin at $0.4 \text{ kg}\cdot\text{ha}^{-1}$. Iron did not decrease injury to imazaquin at $1.3 \text{ kg}\cdot\text{ha}^{-1}$. Similar responses observed in Expts. 1 and 2 indicate that method of application, i.e., tank-mixing Fe and herbicides or applying them separately, had little or no influence on results.

Iron applied alone did not injure 'Tifway' bermudagrass (Tables 1 and 2). Beard (1973) reported that Fe was less phytotoxic to bermudagrass than to bentgrass. Horst (1984) reported favorable growth of bermudagrass when treated with Fe during the establishment period.

These experiments show that Fe decreases MSMA, MSMA

Table 1. Influence of Fe on injury of bermudagrass treated with herbicides in Expt. 1, Griffin, Ga., 1988.

Treatments			Turf injury (days after first treatment) ^y											
Herbicide carrier	Herbicide rate (kg·ha ⁻¹)	Fe contrast ^z	Location 1						Location 2					
			4	9	15	18	26	39	4	9	15	18	26	39
Untreated	—	Yes	0	0	0	0	0	0	0	0	0	0	0	0
		vs. No	0	0	0	0	0	0	0	0	0	0	0	0
MSMA	2.2	Yes	1	4	2	7	0	2	2	2	0	0	0	0
		vs. No	16**	7	2	13	2	2	6*	11**	13**	13**	0	0
MSMA + metribuzin	2.2+0.14	Yes	23	1	13	22	10	6	31	6	34	20	5	0
		vs. No	48**	6	14	28	11	8	41*	5	39	19	6	2
2,4-D + mecoprop + dicamba	1.1+0.6+0.1	Yes	6	8	16	19	13	13	1	2	14	16	16	13
		vs. No	5	8	16	27	23**	17	4	5	20	22	23*	13
Imazaquin	0.6	Yes	1	6	10	30	20	2	11	8	15	13	19	6
		vs. No	1	5	20	33	28**	3	11	13	31**	30**	33**	9

^zContrast values based on: *** Significant at the 0.05 and 0.01 levels, respectively, for Fe within herbicide treatment. Herbicide and Fe treatments were applied 27 June (0 day) and 7 July (10 days) in location 1 and 15 (0 day) and 24 Aug. (9 days) in location 2. Iron was applied at 0 (No) and 1.12 kg·ha⁻¹ (Yes).

^yTurfgrass injury ratings were based on 0 = no injury and 100 = complete kill. Data are the means of four observations.

Table 2. Influence of Fe on bermudagrass injury and quality treated with herbicides in Expt. 2, Griffin, Ga., 1988.

Treatments			Turfgrass (days after treatment)							
Herbicide carrier	Herbicide rate (kg·ha ⁻¹)	Fe contrast ^z	Injury ^y				Quality ^x			
			2	4	10	21	2	4	10	21
Untreated	—	Yes	0	0	0	0	9.3	9.1	9.2	9.3
		vs. No	0	0	0	0	9.2	9.2	9.1	9.3
MSMA	2.2	Yes	0	3	0	0	9.2	9.1	9.1	9.4
		vs. No	8**	9**	0	0	8.7*	8.5**	9.1	9.4
MSMA	6.7	Yes	13	13	0	0	8.3	8.3	9.1	9.4
		vs. No	48**	30**	2	0	5.2**	6.5**	9.1	9.2
Imazaquin	0.4	Yes	3	13	12	2	9.1	8.2	8.3	9.1
		vs. No	2	10	13	10**	9.1	8.5	8.1	8.5**
imazaquin	1.3	Yes	2	8	22	18	9.1	8.4	7.7	7.8
		vs. No	3	12	23	20	9.0	8.1	7.3	7.8
MSMA + imazaquin	2.2+0.4	Yes	2	13	5	0	9.1	8.2	8.8	9.2
		vs. No	15**	22*	6	0	8.0**	7.2**	8.7	9.2
MSMA + imazaquin	6.7+1.3	Yes	14	20	20	5	7.9	7.7	7.4	9.1
		vs. No	47**	45**	38**	10	5.1**	5.2**	5.8**	8.5

^zContrast values based on: *** Significant at the 0.05 and 0.01 levels, respectively, are for Fe within herbicide treatment. Herbicide and Fe treatments were applied 16 Aug. 1988. Iron was applied at 0 (No) and 1.12 kg·ha⁻¹ (Yes).

^yTurfgrass injury ratings were based on 0 = no injury and 100 = complete kill.

^xTurf quality ratings were based on 0 = turf brown or dead and 10 = uniform green color with dense stand. Data are means of three observations.

+ metribuzin, and MSMA + imazaquin injury to bermudagrass. The decrease in injury was more pronounced as rates of either MSMA or MSMA + imazaquin increased. Iron did not affect the immediate response of bermudagrass to 2,4-D + mecoprop + dicamba, but less injury occurred over time when Fe was added. Iron did not affect the injury of bermudagrass immediately after the initial imazaquin treatment, but hastened the recovery of turf treated twice within a 9- to 10-day period.

Coats et al. (1987) reported less bermudagrass injury with MSMA + imazaquin at 2.2 + 0.84 kg·ha⁻¹, for 2 to 6 weeks after treatment when compared to injury from imazaquin at 0.84 kg·ha⁻¹ alone. In our study, bermudagrass injury was higher for 4 to 10 days after treatment with MSMA + imazaquin than with imazaquin alone (Table 2). However, by 21 days, the grass recovered faster in MSMA + imazaquin-treated plots than when treated with imazaquin alone.

Turfgrass quality and color. The turfgrass injury reported in

Table 3. Influence of Fe on foliar color of bermudagrass treated with herbicides in Expt. 1 at Griffin, Ga., 1988.

Treatments			Turf injury (days after first treatment) ^y											
Herbicide carrier	Herbicide rate (kg·ha ⁻¹)	Fe contrast ^z	Location 1				Location 2							
			4	9	15	18	26	39	4	9	15	18	26	39
Untreated	—	Yes	8.3	8.0	8.2	8.2	8.0	7.6	8.1	8.2	8.4	7.9	7.8	7.9
		vs. No	8.3	8.0	8.0	8.0	7.9	7.5	8.1	8.0	8.2	7.8	7.8	7.9
MSMA	2.2	Yes	8.2	7.8	7.9	7.9	8.0	7.5	7.9	8.0	8.0	7.8	7.9	7.8
		vs. No	7.4**	7.6	7.9	7.8	8.0	7.1*	7.2*	7.4*	7.3**	7.2**	7.9	7.8
MSMA + metribuzin	2.2+0.14	Yes	6.3	8.5	7.2	7.1	8.1	7.4	6.1	8.5	6.6	7.4	7.9	7.7
		vs. No	5.5	8.2	7.2	6.9	8.1	7.0*	5.4*	8.3	6.1	7.4	7.8	7.7
2,4-D + mecoprop + dicamba	1.1+0.6+0.1	Yes	7.9	7.7	7.5	7.3	8.1	8.1	7.9	7.9	7.6	7.8	8.0	8.0
		vs. No	7.9	7.3	7.1	6.8	7.9	7.9	7.6	7.9	7.3	7.4	7.8	8.0
Imazaquin	0.6	Yes	8.3	7.7	7.5	6.3	6.7	8.3	7.4	7.8	7.2	7.4	7.9	7.9
		vs. No	7.9	7.2*	7.2	6.3	6.3	8.3	7.2	7.1**	6.4**	6.9**	7.5	7.9

^zContrast values based on: *** Significant at the 0.05 and 0.01 levels, respectively, for Fe within herbicide treatment. Herbicide and Fe treatments were applied 27 June (0 day) and 7 July (10 days) in, location 1 and 15 (0 day) and 24 August (9 days) in location 2. Iron was applied at 0 (No) and 1.12 kg·ha⁻¹ (Yes).

^yTurf color ratings were based on 1 = brown and 9 = uniform dark green color with no discoloration. Data are the means of four observations.

Tables 1 and 2 from herbicide treatments was expressed as reduction in degree of greenness and/or a loss of density. No effects of Fe applied with herbicides on shoot density were observed (data not shown).

There was no color response of Tifway bermudagrass from Fe applied alone in Expt. 1 (Table 3), but the turf had received ample N as shown by the high color ratings for the untreated control. The rate of Fe used was one commonly applied and that has enhanced the color of bermudagrasses (White and Schmidt, 1988) and other grass species Carrow et al., 1988; Schmidt and Snyder, 1984; Yust et al., 1984). Horst (1984) reported root and rhizome growth responses to Fe at 1.12 kg·ha⁻¹ on bermudagrass during establishment, but did not report color data.

Bermudagrass color was enhanced when Fe was applied as a sequential treatment with various herbicides (Table 3). A positive color response to Fe occurred for 4 days when the turf was treated with MSMA alone or with metribuzin at both locations. The improved turf color with Fe when bermudagrass was treated with MSMA lasted for 18 days at location 2. Iron enhanced the color of turf only slightly at 9 days after treatment with imazaquin at location 1, but turf color ratings were higher from Fe from 9 through 18 days at location 2. There was no difference in turf color from Fe treatment when 2,4-D + mecoprop + dicamba was used.

While Fe applied with herbicide often reduced the magnitude of color loss compared to turf treated with only herbicide, it did not necessarily result in as green a turf as the control (Table 3). For example, at location 2, Fe applied with imazaquin improved color compared to imazaquin alone, but color ratings at 9 to 18 days after treatment ranged from 7.2 to 7.8 for imazaquin plus Fe compared to the Fe check range of 7.9 to 8.2. Thus, Fe may not prevent all color loss, but does decrease the magnitude. This was especially apparent for imazaquin and 2,4-D + mecoprop + dicamba.

In Expt. 2, visual quality and turf injury data were closely related (Table 2). Whenever Fe reduced injury, turfgrass quality improved. However, when comparing injury or quality ratings of a particular Fe plus herbicide combination to those of the Fe control, Fe application normally did not totally reduce injury or

improve quality, except for MSMA. Therefore, Fe applied with a herbicide may reduce color loss, but the herbicide may still cause some color loss and/or loss of shoot density.

The advantages to using Fe with postemergence herbicides on 'Tifway' bermudagrass were: reduced injury, enhanced color, and, therefore, increased quality. It should be emphasized that this response did not occur at all rating dates, nor did each herbicide respond the same. Generally, the response of bermudagrass treated with Fe and MSMA alone or with metribuzin or imazaquin occurred immediately after the initial treatment and the length of response to Fe depended on the time of herbicide treatment. When MSMA was applied in two applications in late June and early July, or as a single application in mid-August, the turf response to Fe lasted for 4 days. When MSMA was applied to bermudagrass in two applications in mid- to late-August, Fe decreased injury for up to 18 days after treatment.

When imazaquin was applied alone in one application, there was no bermudagrass response to Fe, but the turf responded to Fe after a second imazaquin treatment. Bermudagrass response to Fe and MSMA + imazaquin occurred immediately after treatment and the response was greater as rates of herbicides were increased.

These results show that Fe will help prevent turf injury expressed as a color loss on 'Tifway' bermudagrass for a short time following certain postemergence herbicide treatments. However, complete elimination of color loss or injury may not occur for all herbicides. The Fe treatments would be desirable in intensively managed turf areas where high quality levels are required and maintained. The usefulness of Fe with post-emergence herbicide would be questionable when applied to low-maintenance turfgrass areas.

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Harvest Maturity and Concentration and Exposure Time to Acetylene Influence Initiation of Ripening in Mangos

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Abstract. The effects of acetylene at 0, 0.1, 0.2, 0.4, 0.8, or 1.6 ml-liter⁻¹ and exposures of 4, 8, 12, or 24 hours on ripening initiation in mangos (*Mangifera indica* L.) harvested at three stages of maturity were investigated: Ripeness was assessed before and after treatment in 'Tommy Atkins', 'Ruby', and 'Amelie' mangos by analysis of texture, peel, and pulp color development, soluble solids concentration, and pH. The initiation of ripening depended on the acetylene concentration, exposure time to acetylene, the physiological maturity of the fruit at harvest, and on the cultivar. Changes that can occur during ripening had different sensitivities to acetylene gas. Acetylene treatment of 0.1 or 0.2 ml-liter⁻¹ for 24 hours at 25C initiated softening, but had no effect on the other ripening processes measured. All the ripening changes measured were initiated with a 24-hour exposure to 0.4 ml-liter⁻¹ in 'Tommy Atkins', while 0.8 ml-liter⁻¹ was required with 'Ruby' mangos. There was an interaction between gas concentration and exposure time taken to initiate ripening. The 0.8 ml-liter⁻¹ acetylene treatment required 24 hours to initiate full ripening, while 8 hours were required with 1.6 ml-liter⁻¹ acetylene and 1.0 ml-liter⁻¹ ethylene. Mature and half-mature fruit showed a similar response to gas treatments; immature fruit failed to show full ripening initiation, although softening and peel color development were enhanced.

Mango is a climacteric fruit that undergoes a distinct ripening phase; which can be initiated by the exogenous application of ethylene gas (2, 5, 11). Acetylene, an ethylene analogue, can be used to initiate fruit ripening (16). Acetylene has a lower biological activity than ethylene, and higher concentrations for the same exposure period are generally required (4). In bananas, 0.01 ml-liter⁻¹ ethylene at 18C for 24 hr initiated ripening; while 1.0 ml-liter⁻¹ acetylene was required for a similar effect

(19). In several Florida mango cultivars, 0.005 and 0.01 ml-liter⁻¹ ethylene for 24 hr at 30C initiated ripening (1). Treatment of 'Tommy Atkins' mangos with a range of acetylene concentrations indicated that 1.0 ml-liter⁻¹ for 24 hr at 25C was required for ripening initiation (11).

Commercial ripening procedures employed in producer countries, such as Brazil and Senegal, generally use acetylene gas liberated from calcium carbide by the addition of water or by contact with moisture in the air (9). No specific quantities of calcium carbide are used; thus, treatments may involve exposure to various concentrations. The effects of acetylene liberated from calcium carbide has been investigated for Dashehari mangos (6). Color development at room temperatures was found to be better with 8 than with 4 g calcium carbide, but these were inferior in taste. Fruit ripened with 4 g were found to have good color and flavor and they were higher in soluble solids concentration (SSC),

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