lateral were measured (Table 4). As the inlet pressure was increased, there was an increase in the pressure gradient along the line. In order to achieve a minimal pressure drop of about 10%, inlet pressures between 0.5 to 1.0 atm should be applied. Methyl bromide had no apparent effect on the plastic tubing of the system.

Fumigation increased tomato yields considerably over that obtained in the control. In addition to beneficial effects on weeds and broom-rape control, fumigation increased the Zn and Fe levels in tomato leaves. The greater mineral uptake in the fumigated treatments probably was due to increased availability, and improved root functioning after elimination of pathogenic influences and broom-rape competition.

If a crop is irrigated with a drip system, fumigation of soil strips on which plants are growing is possible by passing methyl bromide through the drip laterals. A system designed to distribute water uniformly would also distribute gas satisfactorily if proper pressure were used.

Improper fumigation may occur if there are leaks in the tubing or fittings, or if emitters are plugged. Fumigant may not reach high areas on poorly levelled fields. Careful removal of the plastic cover will avoid soil recontamination.

While this method of fumigation appears to be a suitable technique for soil treatment where drip irrigation is mainly used, it need not be the only method. If total field eradication of a disease or weed is required, other methods can be employed. However, the simplicity and convenience of this method and its low cost does enable the farmer to use it frequently and whenever circumstances justify its use.

Table 3. Soil fumigation influence on microelement content in tomato leaves.

Element	Content in leaves (ppm) Treated plots	Control plots	Significance
Cu	12.3	12.5	n.s.
Zn	24.7	20.3	*
Fe	115.0	90.8	**
Mn	28.2	28.2	n.s.
Fe/Mn	4.1	3.3	**

*, ** Significant at the 5% and 1% level, respectively; n.s. = not significant.

Table 4. Pressure (atm) differences in a 50 m drip lateral with 100 two-liter/hr emitters during the flow of methyl bromide.

Inlet	Center	End
0.5	0.45	0.45
0.8	0.6	0.6
1.0	0.9	0.9
2.0	1.5	1.5
2.5	1.8	1.0
3.0	2.5	2.0
4.0	2.0	1.8

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Effects of Ethephon on Yield and Quality of Winter Squash, *Cucurbita maxima* Duch.[1]

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Abstract. **(2-Chloroethyl)phosphonic acid (ethephon) applied at 2- to 4-leaf stages on winter squash cultivars 'Boston Marrow', 'Golden Delicious' and 'Hybrid 530' resulted in pistillate flowers at most early nodes, but these generally aborted. Ethephon applications usually resulted in greater numbers of marketable squash which tended to be smaller in size. The only instance of a significant yield increase occurred on 'Golden Delicious' with 2 applications of 150 ppm ethephon. Earlier appearing nodes on ethephon treated plants produced marketable fruit and harvest, based on external color, could have been made up to a week earlier. Presently, ethephon seems to be of limited commercial promise for winter squash under Arkansas conditions.**

Since 1963, winter squash has been produced in the Arkansas River Valley near Van Buren and in Northwest Arkansas for the baby food industry. Weather delayed plantings have resulted in unprofitable crops. In later plantings, squash usually bloom and set fruit under high temperature, longer daylength and higher solar radiation; conditions which favor fewer pistillate flowers. Cultivars and/or cultural methods that would assure good yields when later plantings are necessary would be valuable. Various cultivar and cultural studies have been conducted (1,2). Differences in yield performance exist among cultivars in later plantings, but for most cultivars both fruit no. and yields are lower compared to earlier planting dates (1), primarily due to the production of fewer pistillate flowers.

Ethephon has shown promise for increasing yields for various cucurbits through sex expression changes. In monoecious cucumber (*Cucumis sativus* L.) conversion from staminate to pistallate flowers at most nodes has been widely reported (3, 6, 8). In gynoecious cucumber cultivars ethephon results in more fruit being set and an apparent slowing of fruit growth, with the net effect of a greater yield of the more valuable smaller size grades (4, 8). Lippert et al. (5) reported that ethephon altered sex expression toward more pistillate flowers and also resulted in pistillate flowers occurring on the main stem in muskmelon (*Cucumis melo* L.), although no commercial benefit resulted. Tompkins and Smay (9) reported increased early set and early yield in summer squash (*Cucurbita pepo* L.) from use of ethephon. We are unaware of any published studies on the use of ethephon on winter squash, (*C. maxima*).

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Preliminary trials with ethephon in 1972 at Fayetteville on *C. maxima* cvs. Boston Marrow, Golden Delicious and Giant Banana showed that ethephon applications resulted in pistillate flowers at most of the first 8 to 12 nodes on the main stem, but most flowers were small and quickly aborted even though sufficient numbers of open staminate flowers were present for pollination. In untreated plants staminate flowers first appear at nodes 5 to 8 and thereafter at each node except when a pistillate flower occurs. Pistillate flowers of squash usually occur at nodes 9 or later on the main stem and at nodes 4, 5 or sometimes later on secondary branches. When ethephon was applied more pistillate flowers set and produced fruit earlier and at more nodes so that the no. of marketable fruit were greater at harvest. However, because of reduced fruit size yields tended to be lower in all cultivars. Nevertheless the results obtained in some treatments were sufficiently promising to merit further research.

'Golden Delicious' and 'Boston Marrow' were grown in 1973 and 'Golden Delicious' and Hybrid 530' were grown in 1974 at Fayetteville. 'Golden Delicious' and 'Boston Marrow' were grown at Van Buren in 1974. Plots were fertilized with a complete fertilizer before planting and were irrigated with overhead sprinklers to maintain a minimum of 20% available soil moisture in the top 30 cm of soil. We do not feel that moisture or fertilizer affected treatment response. Ethephon treatments were applied to plants at different stages of plant development at rates shown in Tables 1 – 3. Sprays were applied until runoff occurred. Applications were made early in the morning before daily temperatures increased. Observations were made of bloom development and fruit set, and all well developed, well colored fruit were harvested. Fruit samples were canned and quality evaluations of soluble solids, and color were made. The Hunter Color Difference Meter was used for color determinations. The sample was prepared as a mixture of 2 parts water to 1 part squash. This blend has correlated well with visual color determinations. Solids were converted to original fresh weight basis while color is reported as the Hunter a/b ratio (1, 2).

Ethephon applications in 1973 and 1974 at both locations, resulted in pistillate flowers at the first 6 or 7 nodes except for those made at fruit color break. Most of these flowers aborted even though other earlier plantings provided open staminate flowers for sufficient pollination. Occasionally pistillate flowers did set fruit at earlier nodes on ethephon treated

Table 1. The effect of ethephon and cultivar on yield and processed quality of winter squash. Fayetteville, Arkansas, 1973.[z,y]

Ethephon treatment[x]	Yield (millier/ha)	No. of marketable squash per plot[w]	Avg size (kg)	Canned product[v] Soluble solids (%)	Canned product[v] Hunter a/b color
			Boston Marrow		
150 ppm, 2 leaf stage	54.4 a	16.5 a	5.9 a	10.5 c	.30 a
150 ppm, 2 & 4 leaf stages	68.2 a	18.8 a	6.5 a	9.0 b	.34 ab
300 ppm, 2 leaf stage	55.4 a	19.0 a	5.2 a	9.3 b	.34 ab
300 ppm at color break of 1st fruit	62.6 a	15.2 a	6.5 a	10.3 c	.38 b
None	67.9 a	20.0 a	7.9 b	8.6 a	.42 b
			Golden Delicious		
150 ppm, 2 leaf stage	42.4 a	26.0 a	2.9 a	12.2 b	.43 b
150 ppm, 2 & 4 leaf stages	69.3 c	34.5 a	3.6 b	10.5 ab	.37 ab
300 ppm, 2 leaf stage	51.7 b	35.5 a	2.6 a	9.3 a	.42 b
300 ppm, color break of 1st fruit	52.4 b	31.0 a	3.0 a	10.9 ab	.38 ab
None	58.0 b	23.8 a	3.6 b	11.4 b	.33 a

[z]Mean separation in columns by Duncans multiple range test, 5% level.
[y]Planted May 17, 1973, harvested Aug. 20, 1973.
[x]Ethephon was applied to runoff to entire plant.
[w]Each plot was 7.31 x 2.44 m and contained 8 plants with 4 replications.
[v]Soluble solids are converted to % original squash wt. Hunter color is as read on blend of 2 parts water, 1 part squash by wt. Higher a/b indicates deeper orange and more desirable color.

Table 2. The effect of ethephon and cultivar on yields and quality of winter squash. Fayetteville, Arkansas 1974.[z,y]

Ethephon treatment[x]	Yield (millier/ha)	No. of marketable squash per plot[w]	Avg size (kg)	Processed quality[v] Soluble solids (%)	Processed quality[v] Hunter a/b color
			Hybrid 530		
100 ppm, 2 & 4 leaf stage	44.2 a	19.0 ab	4.2 a	8.0 bc	.32 b
150 ppm, 2 & 4 leaf stage	48.2 ab	22.8 b	3.8 a	7.2 bc	.32 b
200 ppm, 2 & 4 leaf stage	42.5 a	22.8 b	3.4 a	6.7 ab	.30 b
None	53.0 b	18.0 a	5.3 a	5.7 a	.26 a
			Golden Delicious		
100 ppm, 2 & 4 leaf stages	23.6 ab	21.0 a	2.0 b	13.6 c	.21 b
150 ppm, 2 & 4 leaf stages	27.4 b	23.8 a	2.1 b	12.2 b	.22 b
200 ppm, 2 & 4 leaf stages	20.1 a	24.5 a	1.5 a	11.7 b	.16 a
None	28.1 b	21.0 a	2.4 b	9.5 a	.22 b

[z]Mean separation in columns by Duncans multiple range test, 5% level.
[y]Planted May 30, 1974, harvested Sept. 2-4, 1974, except checks were harvested one week later.
[x,w,v]See comparable footnotes, Table 1.

Table 3. The effect of ethephon and cultivar on yield and quality of winter squash. Van Buren, Arkansas 1974.[z,y]

Ethephon treatment[x]	Yield (millier/ha)	No. of marketable squash per plot[w]	Avg size (kg)	Processed quality[v] Soluble solids (%)	Processed quality[v] Hunter a/b color
			Boston Marrow		
300 ppm, 2 leaf stage	37.0 a	10.5 b	6.3 a	6.0 b	.23 a
150 ppm, 2 & 4 leaf stage	39.4 a	9.2 ab	7.7 b	5.8 b	.18 a
300 ppm, 2 & 4 leaf stage	40.8 a	10.5 b	7.4 ab	5.7 b	.20 a
300 ppm, 4 leaf stage	40.8 a	10.5 b	6.9 a	6.1 b	.18 a
None	35.8 a	8.2 a	7.8 b	5.0 a	.22 a
			Golden Delicious		
300 ppm, 2 leaf stage	24.0 a	18.0 ab	2.4 ab	9.5 b	.14 a
150 ppm, 2 & 4 leaf stage	27.8 a	19.5 ab	2.5 ab	8.7 a	.20 b
300 ppm, 2 & 4 leaf stage	26.0 a	20.8 b	2.2 a	9.3 ab	.11 a
300 ppm, 4 leaf stage	26.0 a	20.0 b	2.3 ab	9.1 ab	.20 b
None	24.4 a	16.0 a	2.7 b	9.1 ab	.19 b

[z]Mean separation in columns by Duncans multiple range test.
[y]Planted May 16, 1974, harvested July 31, 1974.
[x,w,v]See comparable footnotes Table 1.

plants than on control plants, especially in 'Golden Delicious' and 'Hybrid 530'. On these cultivars 2 or 3 pistillate flowers would often be set on consecutive nodes while on the control plants, 3 or more nodes always separated pistillate flowers. The treated plants returned to a more normal flowering sequence as the plants developed, but they usually had more pistillate flowers than the controls. Fruit set after plants returned to more normal flowering did not mature before harvest.

The no. of marketable squash closely reflected the no. of fruit set during the effective period of the ethephon (Tables 1-3). In 3 of the 6 cultivar x location tests there were no significant differences in no. of fruit at harvest. Ethephon applied at the 2- 4-leaf stages at the rate of 150 and 200 ppm increased the no. of marketable fruit with 'Hybrid 530' at Fayetteville in 1974 (Table 2). At Van Buren in 1974, 300 ppm of ethephon increased fruit no. on 'Boston Marrow' when single or double applications were made (Table 3). Fruit no. of 'Golden Delicious' was increased by 300 ppm of ethephon when applied at the 2- and 4-leaf and the 4-leaf stage.

Fruit size was reduced by all ethephon applications on 'Boston Marrow' and by all but one treatment on 'Golden Delicious' at Fayetteville in 1973 (Table 1). All ethephon treatments reduced fruit size of 'Hybrid 530' and 'Golden Delicious' in 1974 at Fayetteville (Table 2). Only the 200 ppm rate significantly reduced average fruit size in 'Golden Delicious'. At Van Buren 300 ppm applied at 2- or 4-leaf stage of 'Boston Marrow' reduced fruit size, but application at the 2 and 4 leaf stages did not (Table 3). On 'Golden Delicious' only the 300 ppm treatment at the 2 and 4 leaf stage significantly reduced average fruit size. Application of 300 ppm ethephon at color break reduced average fruit size of both cultivars in the 1973 Fayetteville experiment (Table 1).

Ethephon applications generally reduced yields significantly in the 1973 and 1974 Fayetteville experiments or had no beneficial effect (Table 1-2). At the Van Buren experiment no significant yield differences occurred. The only significant yield increase over the control was with 'Golden Delicious' at Fayetteville in 1973 when 150 ppm ethephon was applied at the 2- and 4-leaf stages (Table 1).

No quantitative estimates of foliage growth were made but photographic observations clearly indicated a depressing effect on total vine growth by ethephon applications, the depression being greater with higher rates and dual applications. Growth depression was greater on 'Golden Delicious' than on 'Boston Marrow'. To compensate for this effect it is possible that a higher plant density could be used when ethephon application is being considered. Increased yields might thus result that could make ethephon applications worthwhile.

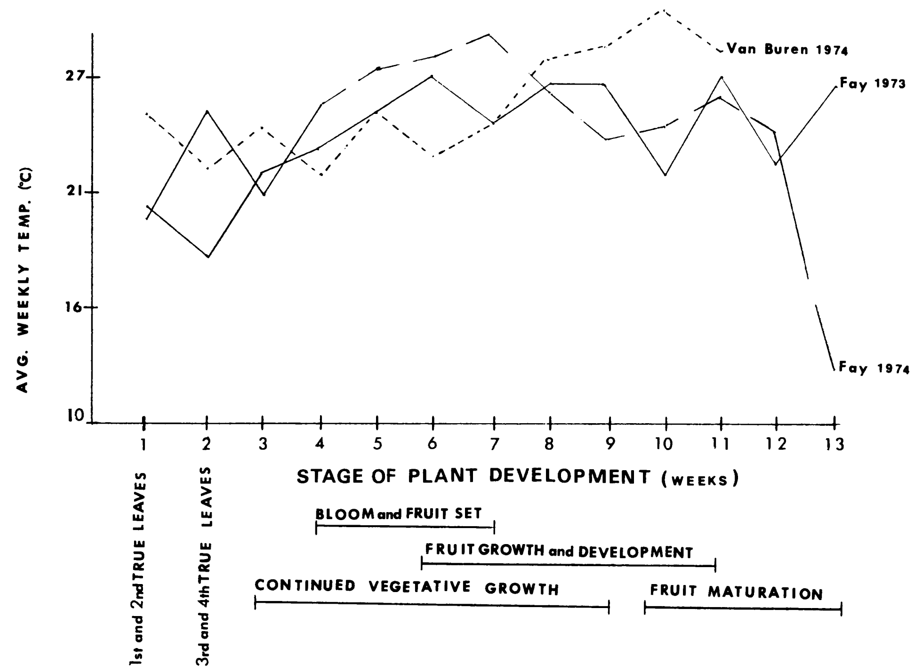

Fig. 1. Average weekly temperatures from 10 days after planting until harvest and corresponding stages of plant development of winter squash, *C. maxima*.

Soluble solids tended to be higher with ethephon, although results were inconsistent (Tables 1-3). On 'Boston Marrow' at both locations, all ethephon applications resulted in higher soluble solids (Tables 1, 3). At Fayetteville 1974, solids were higher in 'Golden Delicious' squash from ethephon treated plots (Table 2), while at Van Buren no significant differences resulted (Table 3).

Ethephon effects on color of the canned squash were erratic. At Fayetteville, 1973, ethephon tended to lower color of 'Boston Marrow' and to increase color in 'Golden Delicious' (Table 1). In 1974 at Fayetteville, color was improved in 'Hybrid 530' when ethephon was applied, but with no improvement in 'Golden Delicious' (Table 2). At Van Buren, there was no effect on 'Boston Marrow' color, while some ethephon treatments significantly reduced color values in 'Golden Delicious' (Table 3).

There were differences in no. and yields of squash due to location, and also due to year at Fayetteville. Yields of 'Golden Delicious' were much higher in Fayetteville in 1973 than at either locations in 1974, and were associated with greater numbers and larger size of marketable squash. Observations indicated that differences in the no. of pistillate flowers were mainly responsible for differences in the no. of marketable squash in the 3 trials. A similar difference was apparent in comparing 'Boston Marrow' between Fayetteville 1973 and Van Buren 1974. Higher temp during the early development of the plants was apparent in Van Buren in 1974 (Fig. 1). At Fayetteville in 1974, temp was quite high during the 2nd and 5th weeks of development and temp during the 2nd week averaged 7°C higher than in 1973. Nitsch (7) reported that high temp and long days tended to keep cucurbit plants (*C. pepo, Cucumis sativus*, and *C. Anguria*) in the staminate phase, which is in close agreement with our experience in *C. maxima* under Arkansas conditions.

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