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Effect of Poultry Manure, Methylbromide and Biotron* on Growth and Yield of Plastic House Tomato

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ABSTRACT :

Application of poultry manure (70 ton/ha) tended to increase marketable tomato yields throughout the harvest season. Seasonal total yields as well as mid total and seasonal marketable fruit numbers were significantly increased by manure applications. Small and total unmarketable fruit yields and numbers were not significantly affected.

Methylbromide soil fumigation (89 g/m^2) tended to increase marketable yields and fruit numbers throughout the harvest season. Yields and numbers of small and total unmarketable fruits were similar for methylbromide treated plots and the control expect for the significantly higher total unmarketable fruit numbers early in the season; however the early and seasonal total fruit numbers were significantly increased.

All biotron levels (0-3000 ml/ha) had no significant effects on "marketable and total" yields and fruit numbers. Early small fruit yields and numbers were significantly reduced at the 2000 ml/ha compared with the control.

In general, manure, methylbromide and biotron exerted no beneficial effects on the average weight per fruit.

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* Biotron = microbial enzymatic soil metabolizer.

Manure significantly increased plant dry weight and its components, plant height, number of internodes and average internode length. Stem and plant dry weights, plant height after 80 days and at the end of season and average internode length were significantly increased by methylbromide soil fumigation. In contrast biotron had no significant effects on vegetative growth.

Key words : Biotron, Methylbromide, Plastic house, Poultry manure.

INTRODUCTION

Tomato is the leading vegetable crop in Jordan. Several cultural practices have been adopted to increase yield of tomato including chemical fertilizers (Suwwan et al., 1987), and soil fumigation with methylbromide (Jaworski et al., 1981). Application of fertilizers, in excessive amounts, proved harmful to soil and crop (Suwwan et al., 1987) while soil fumigation with methylbromide is very expensive and effective for one season only (Muhammed and Suwwan, 1988).

Chicken manure increased yields of strawberry (Alberegts and Howard, 1981) and tomato (Suwwan and Hattar, 1987). Greater fruit numbers and larger tomato fruits were also reported (Suwwan and Hattar, 1987). Appliction of 25 ton/ha poultry manure to plastic house tomato significantly increased dry matter of the vegetative growth and its components (Suwwan and Hattar, 1987)

Methylbromide soil fumigation increased yields of cucumber (Khtoom, 1981). Yield of tomato has been also found to increase linearly with increasing width of both fumigation and mulched beds (Jaworski et al., 1981). Tomato transplants from methylbromide treated plots were more vigorous and uniform compared with those of the control (McCarter et al., 1976). Bed fumigation with methylbromide-chloropicrin gas mixture increased fresh weight of pepper, tomato and cabbage transplants (Jaworski et al., 1980).

Biotron increased tomato yields by 17.3% (Annonymous, 1983). Broad bean yields were also increased by about 20.6 % and 28.9 % when liquid and solid forms of biotron were used, respectively (Annonymous, 1984). "Biotron plus" increased squash yields by 15.9 % and 11.9 % when associated with manure and inorganic fertilizer, respectively (Saber and Abdallah, 1987).

Biotron application increased fruit set in squash (Annonymous, 1984) and broad bean (Annonymous, 1984; Gonay et al; 1983) especially in fertilized broad bean plots (Gonay et al; 1983). Number of female flowers and fruits was also increased in squash (Annonymous, 1984). Leaf area and weight of squash plants (Saber and Abdallah, 1987) and plant height of broad beans (Annonymous, 1984) were also increased.

Available information indicated that the combined effects of "biotron", organic matter and soil fumigation with methylbromide on yield and fruit quality of tomato are not yet investigated. Hence, this research was initiated to investigate the effects of 4 levels of "biotron", 2 levels of poultry manure and 2 levels of methylbromide on growth and yield of the "Hymar" tomato cultivar under plastic house conditions in the Jordan Valley.

MATERIALS AND METHODS

An experiment was carried out on a calcareous sandy loam soil during the 1988 growing season at the Jordan

University Farm in Jordan Valley to investigate the effects of poultry manure, "biotron" and soil fumigation on growth, yield and quality of plastic house tomato. A 50 x 9 m plastic house was used; the design was split-split-plot with 3 replicates. Main plots were assigned to poultry manure (23 % moisture) treatments (0 and 70 ton/ha). Sub-plots were assigned to methylbromide (98 % a.i) fumigation treatments (0 and 89 g/m^2). The sub-sub-plots were assigned to "biotron" treatments (), 1000, 2000 and 3000 ml/ha). Each treatment consisted of one 7 m-row, with plants set at 0.2 m within the row. Rows were 0.8 m apart.

The plastic house was flooded with water, allowd to dry to field capacity, plowed and rotivated. The air dry poultry manure was then evenly applied to the soil surface on January 2, 1988 and water was applied through a sprinkler irrigation system. As the soil dried to field capacity the manure was mixed with the soil. On January 12, 1988 the soil was fumigated with methylbromide for 3 days. Thereafter raised beds were thoroughly prepared.

Stock solutions of 0, 1000, 2000 and 3000 ml biotron/ha were prepared. Ten ml from the 'biotron" stock solution were mixed with 5 litres of water and applied to the soil surface using hand sprayer. Plots were irrigated immediately.

Thirty five day old tomato transplants, Lycopersicon esculentum Mill. CV. Hymar, were planted on January 21, 1988. Plants were trained to one stem by removal of axillary shoots as they appeared. Irrigation commenced at time of planting and continued as needed (Fig. 1) throughout June 14, 1988 using a drip irrigation system with laterals 0.8 m apart and drippers placed along the laterals at 0.4 m. Plants were

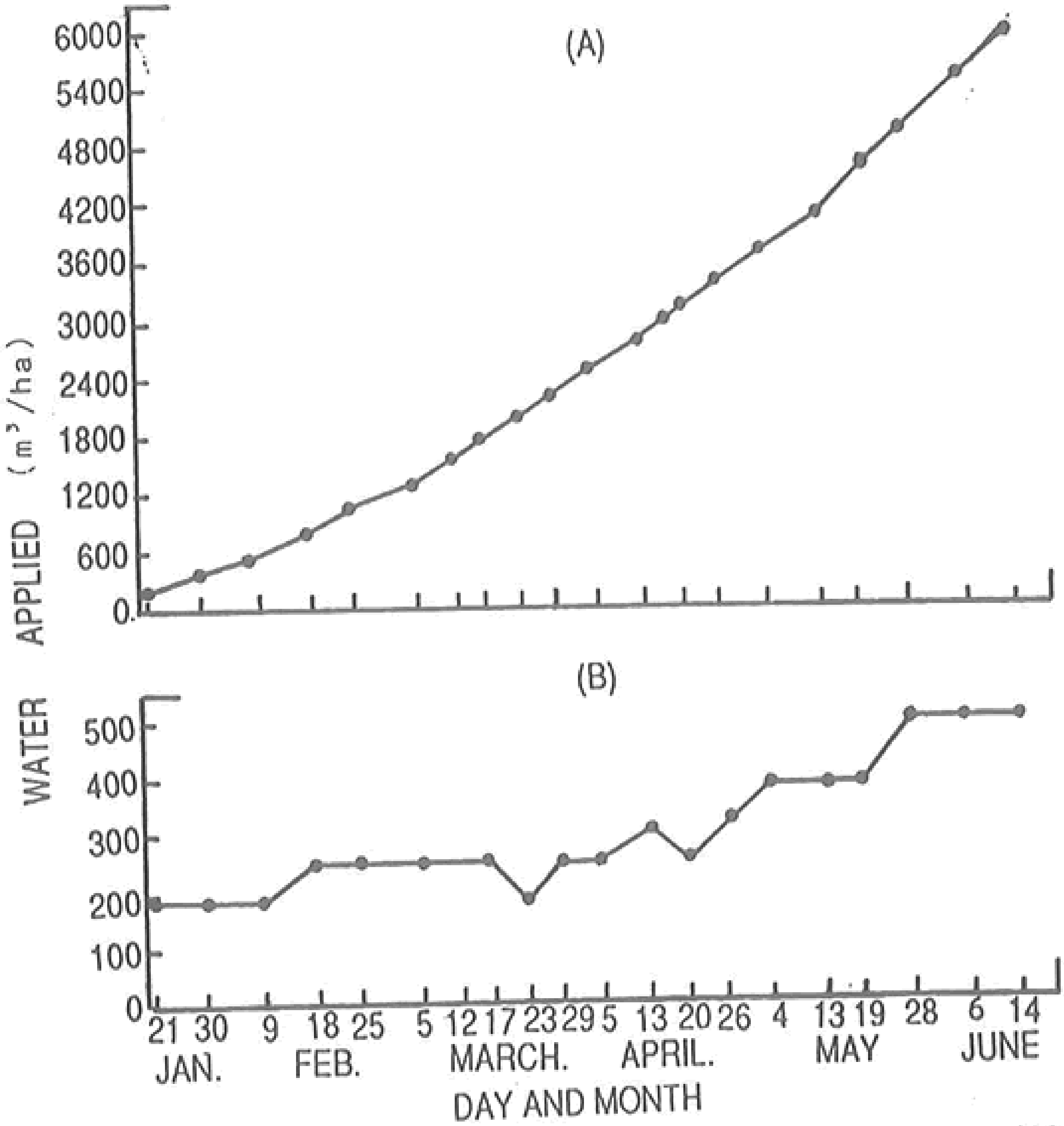

Fig. 1 : Irrigation schedule for plastic house tomato (1988 season). (A : cumulative; B : single).

spaced at 0.2 m and 5 cm away from each lateral, one on the dripper and the other in between.

Nitrogen (32 kg/ha), P (18 kg P_2O_5/ha) and K (52 kg K_2O/ha) in the form of the water soluble "climaplant" fertilizer (16 : 9 : 26 : 2MgO + oligo) were applied through the drip irrigation system at 3 increments on February 18, March 5 and March 29, 1988.

Protection against late blight was accomplished by alternate sprays of Zenib and Diathene, weekly to biweekly, at 45 g/L throughout the period of January 30 to May 1, 1988.

Red ripe tomato fruits were harvested from the middle 28 plants from each treatment at 3 to 6 day intervals throughout the harvest season (April 26 to June 18, 1988). The harvest season was divided into 3 periods : early (from April 26 to May 13), Mid (from May 14 to May 31)and late (from June 1 to June 18). Yield and number of "marketable and unmarketable" fruits as well as the average weight of individual fruits were calculated. Unmarketable fruits included small (< 50 g), sunscald, blosom-end-rot (BER), and rotted fruits. Plant height after 40 and 80 days from planting and at the end of growing season were recorded; number of internodes and average internode length, however, were taken only at the end of the season. Number of nodes to each flowering cluster and number of flowering clusters were determined. At termination of the harvest season, plants were cut down to the soil surface, separated into leaves and stems and weighed. Representative leaf, stem and root samples were dried to a constant weight at 75°C; dry matter contents were then calculated.

Representative surface soil samples from the top 25 cms were taken before "biotron" application and at the end of the growing season. For each treatment the soil was taken from 3 locations, mixed thoroughly and a representative sample was drawn. Samples were air dried, pulverized to pass through a 2 mm screen. Samples were then analyzed for pH, electrical conductivity (E.C), organic matter (O.M), N, P and K using procedures in Methods of Soil Analysis (Page, 1982).

All data was analyzed as for the split-split-plot design as described by Little and Hills (1977).

RESULTS AND DISCUSSION

As no significant interactions were detected, separate effects are presented only.

Yield

Considerable, but insignificant, increase in marketable tomato yields were detected following manure applications (Fig. 2), and to a lesser degree in the methylbromide treated plots. On the other hand biotron appliction slightly decreased marketable tomato yields most of the season. Similar, but significant effects has been reported for manure on some strawberry (Albregts and Howard, 1981) and tomato (Suwwan and Hattar, 1987). Unlike the present results on biotron (Fig. 2) yields of tomato (Annonymous, 1983) broad beans and squash (Annonymous, 1984) were increased to variable extents.

Unmarketable yields (Fig. 4) which consisted mainly from small fruits (Fig. 3, 4), concentrated during mid and late periods of the harvest season. In general manure and methylbromide showed variable tendencies to increase unmarketable yields.Tendencies to reduce unmarketable yields, however, persisted with the biotron tretments (Fig. 3, 4).

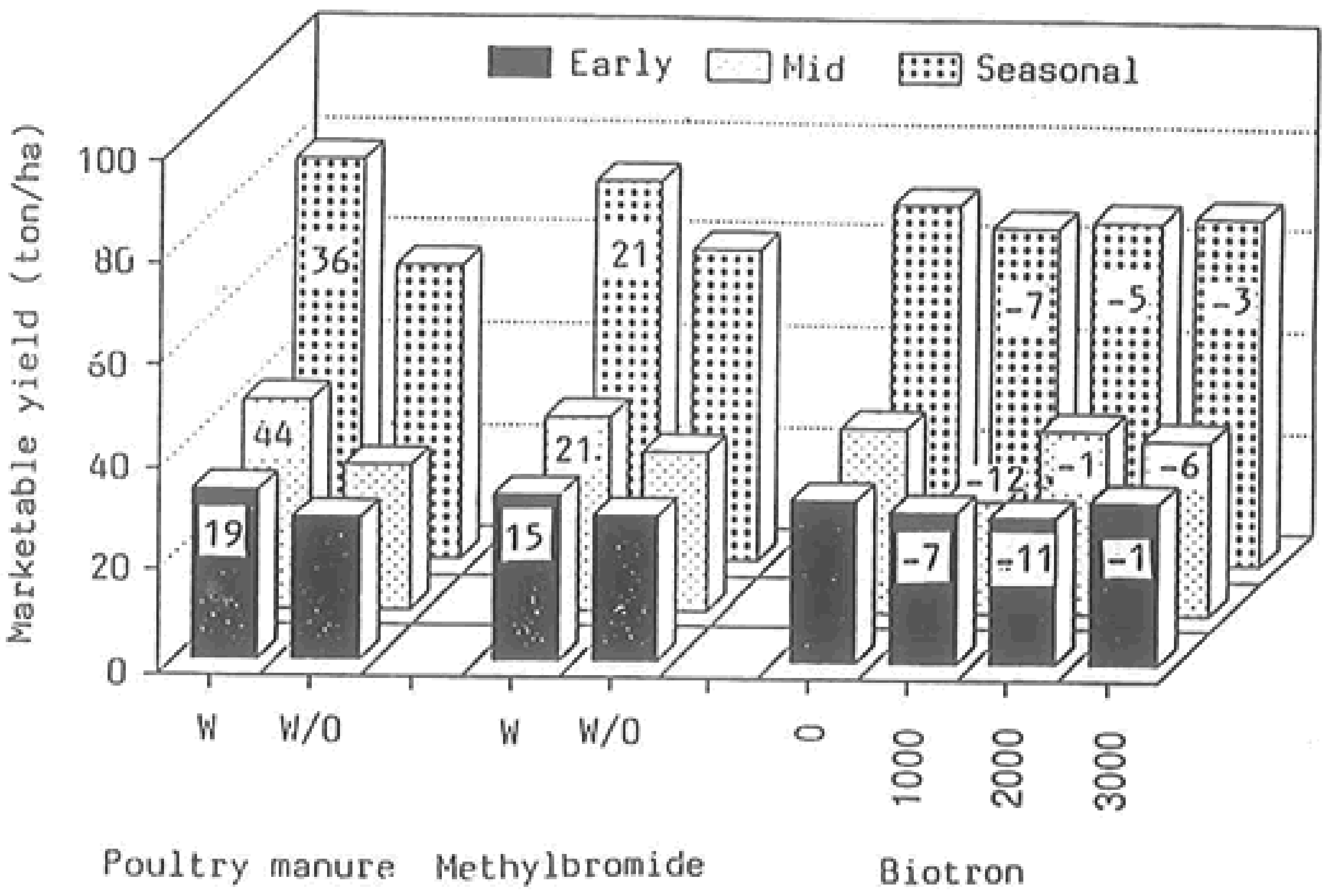

Fig.2: Separate effects of poultry manure, methylbromide and biotron on marketable yield of plastic house tomato (numbers on columns represent % increase or decrease from the control ;w: with, w/o: without)

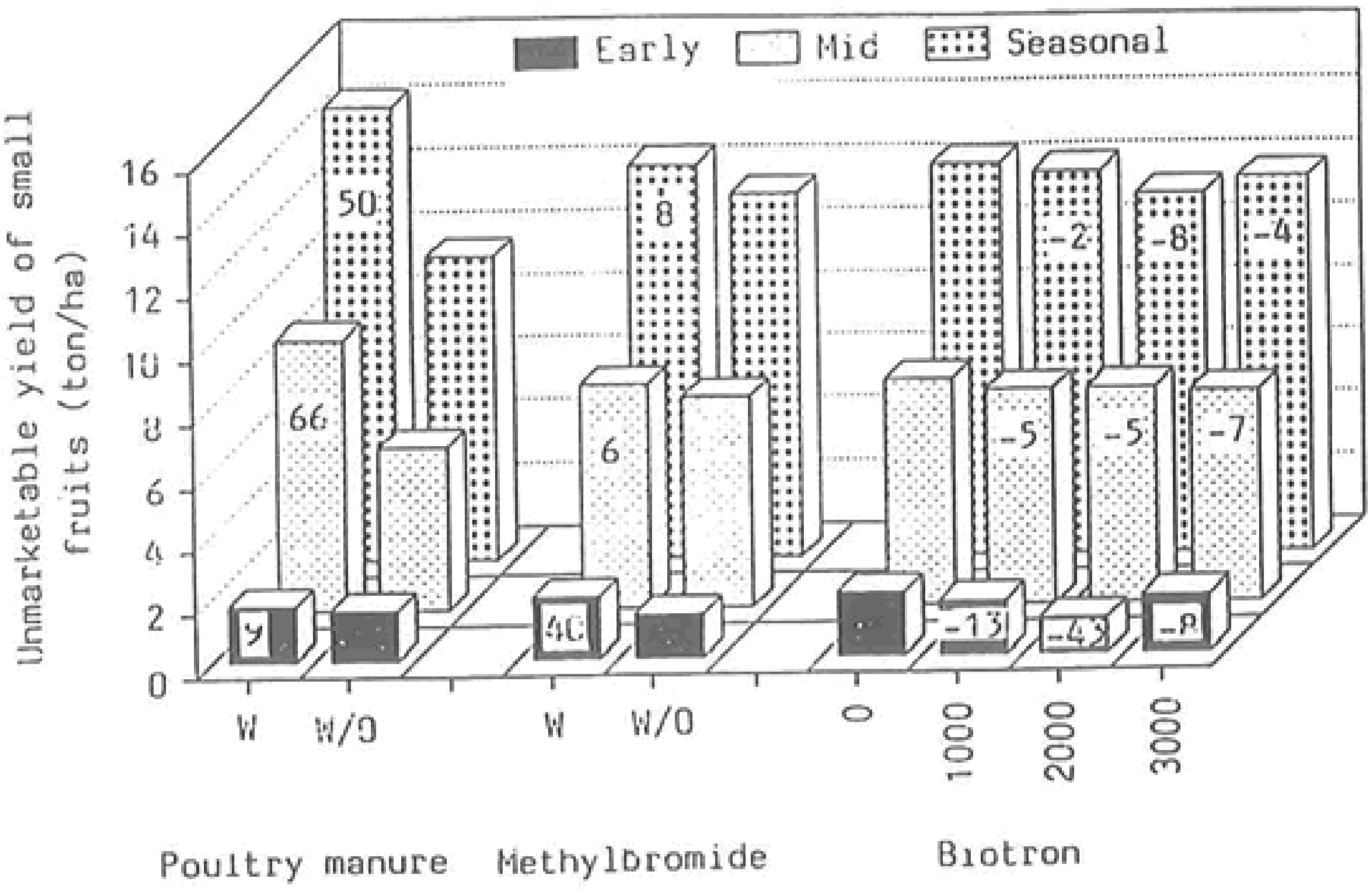

Fig.3: Separate effects of poultry manure, methylbromide and biotron on unmarketable yield of small fruits of plastic house tomato (numbers on columns represent % increase or decrease from the control ;w: with, w/o: without)

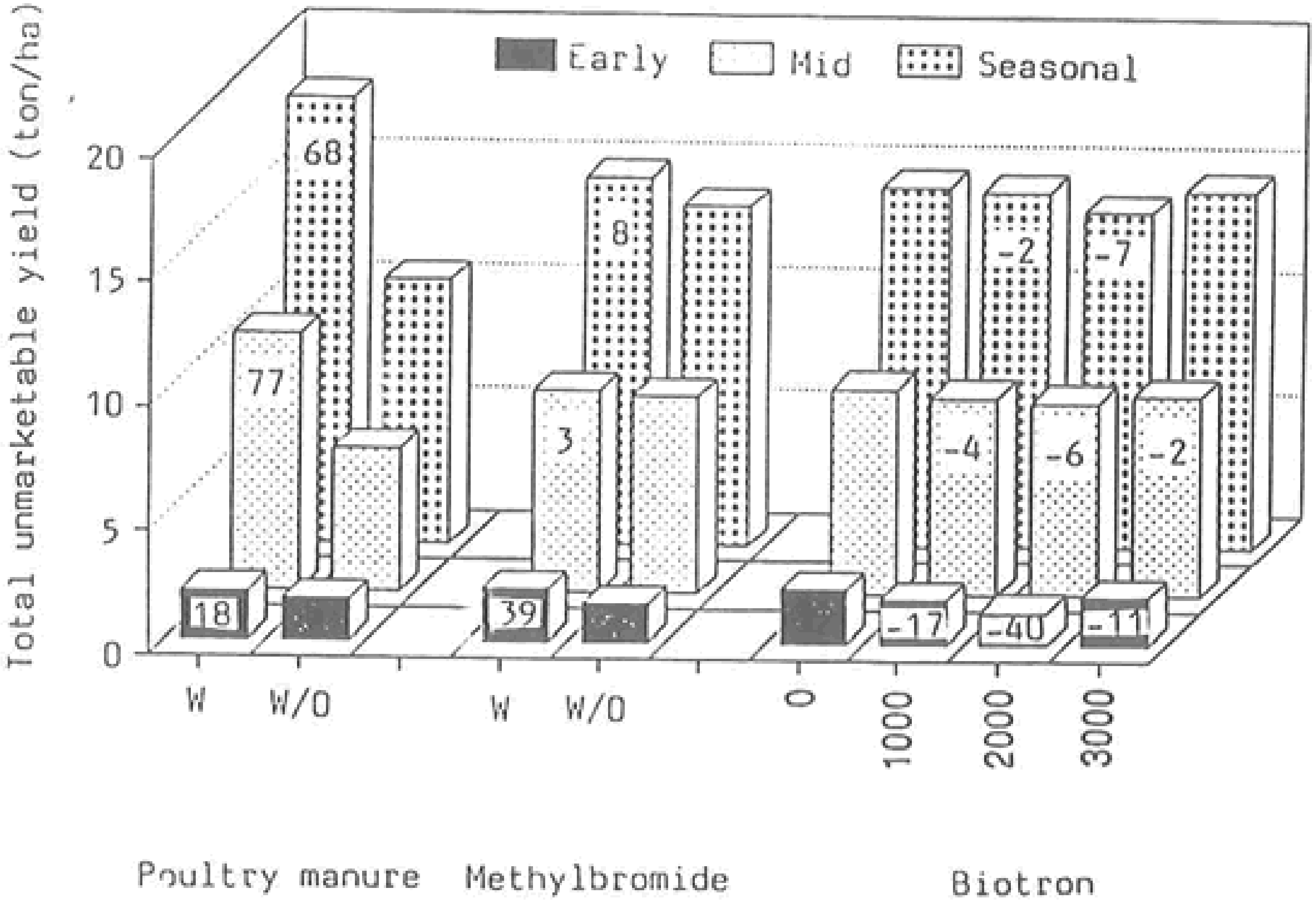

Fig.4: Separate effects of poultry manure, methylbromide and biotron on total unmarketable yield of plastic house tomato (numbers on columns represent % increase or decrease from the control ;w: with, w/o: without)

Previous investigations on organic matter effects on tomato (Suwwan and Hattar, 1987) and strawberry (Albregts and Howard, 1981) revealed similar results.

While biotron slightly reduced, organic manure and methylbromide tended to increase total yields considerably (Fig. 5). Earlier findings revealed similar enhancing effects in some crops following manure application (Albregts and Howard, 1981; Lund and Doss, 1980) or soil fumigation with methylbromide (Khtoom, 1981).

The general similarity in trends observed for total yields (Fig. 5) and their components particularly those of the small fruits (Fig. 3), undoubtedly contributed to total yields, but to variable extents, in the different plots treated with manure, methylbromide or biotron. Contribution of "BER + sunscald + rotted" fruit yields in the unmarketable and total yields were, however, negligible for almost all treatments.

Fruit number

Generally both manure and methylbromide tended to increase mrketable (Fig. 6) and unmarketable (Fig. 8) fruit numbers and their components (Fig. 7) except for the seasonal marketable fruit numbers which were significantly increased (Fig. 6) by manure. Seasonal numbers of marketable tomato fruits has been reported (Suwwan and Hattar, 1987) to increase by manure application. In contrast, biotron tended to decrease all fruit number categories (Fig. 6, 7, and 8). Similar to unmarketable yields, most of the unmarketable fruits concentrated during mid and late periods of the harvest season. Manure significantly increased mid total fruit numbers (Fig. 9), while methylbromide significantly increased the "early and seasonal" total fruit numbers.

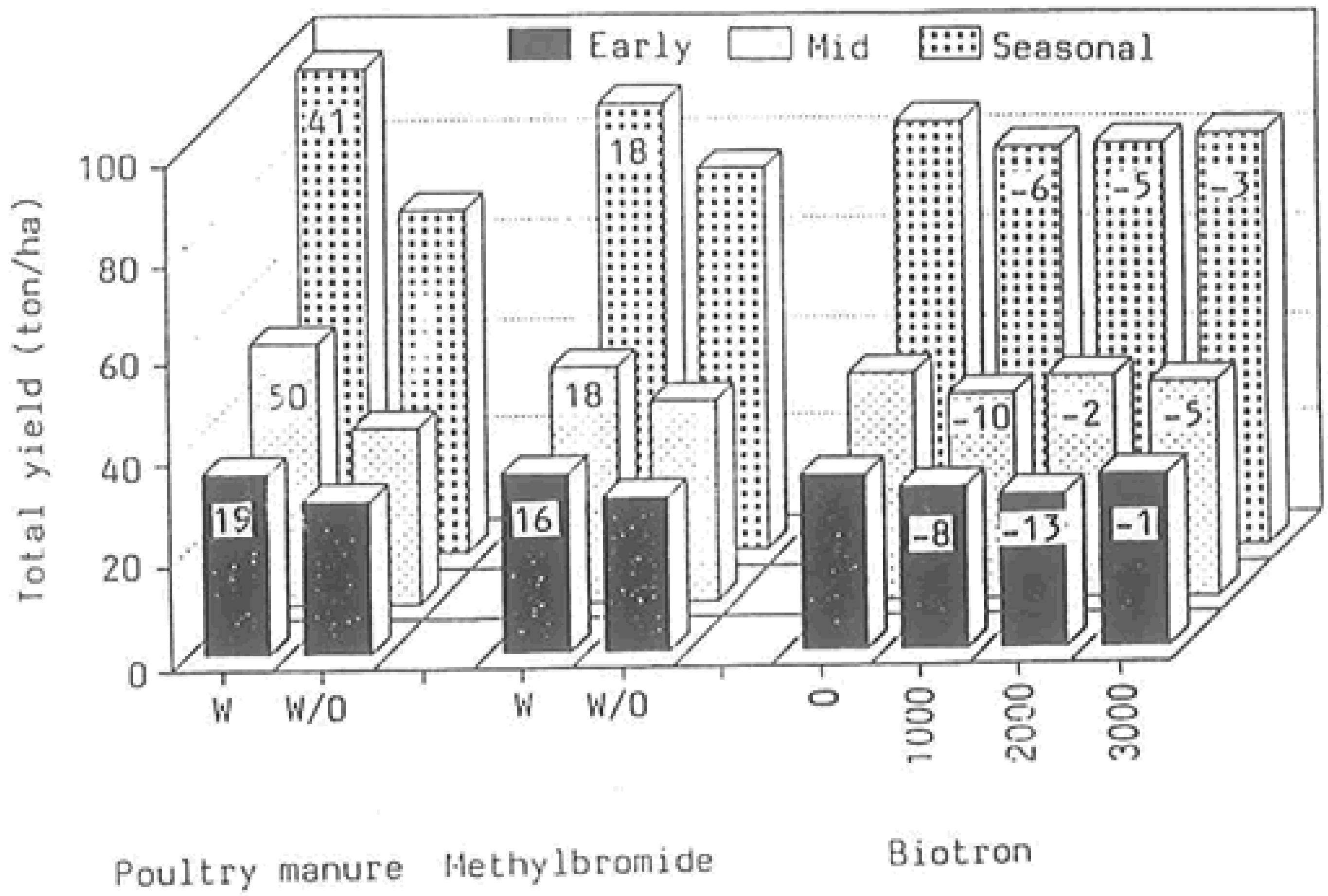

Fig.5: Separate effects of poultry manure, methylbromide and biotron on total yield of plastic house tomato (numbers on columns represent % increase or decrease from the control ;w: with, w/o: without)

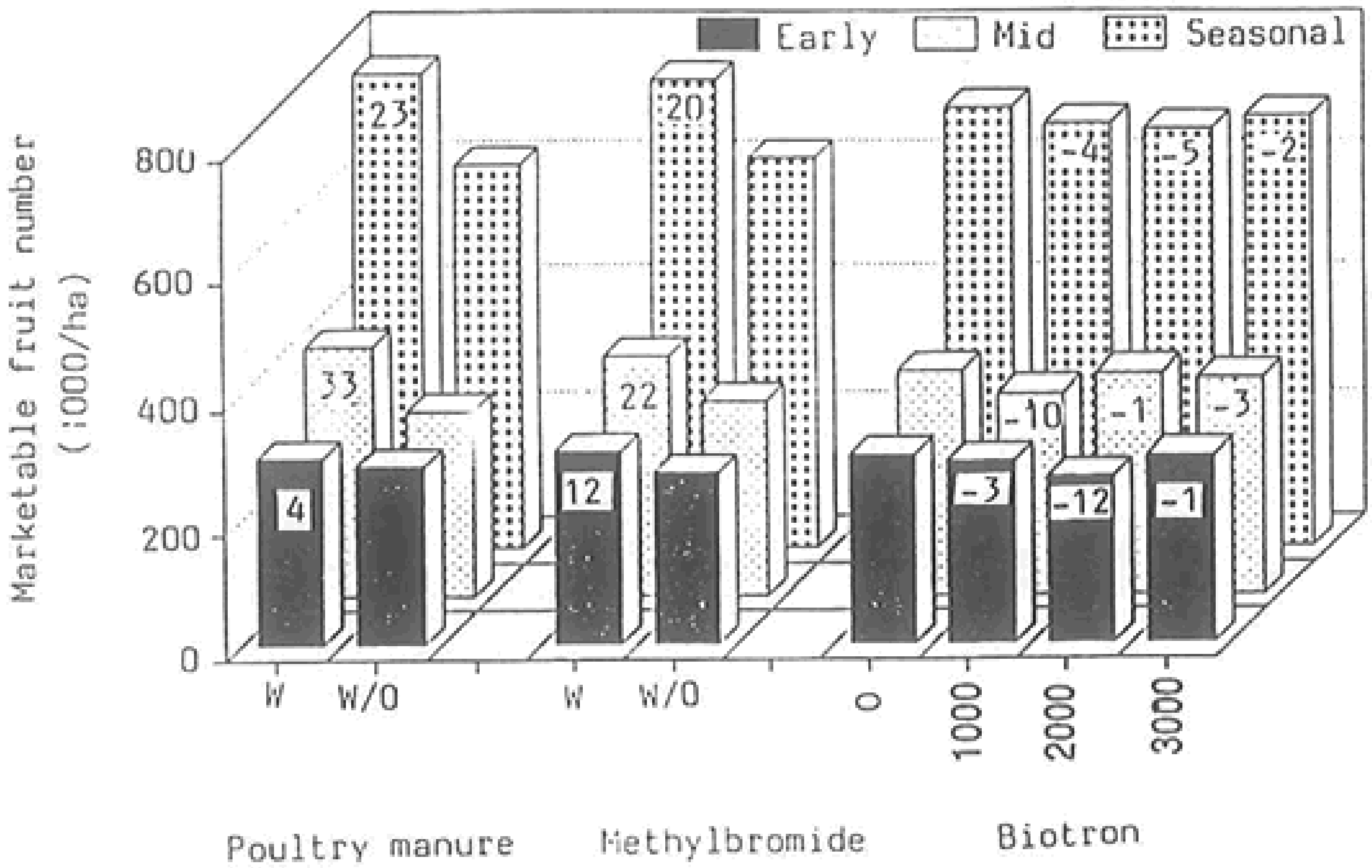

Fig.6: Separate effects of poultry manure, methylbromide and biotron on marketable fruit number in plastic house tomato (numbers on columns represent % increase or decrease from the control; w: with w/o: without)

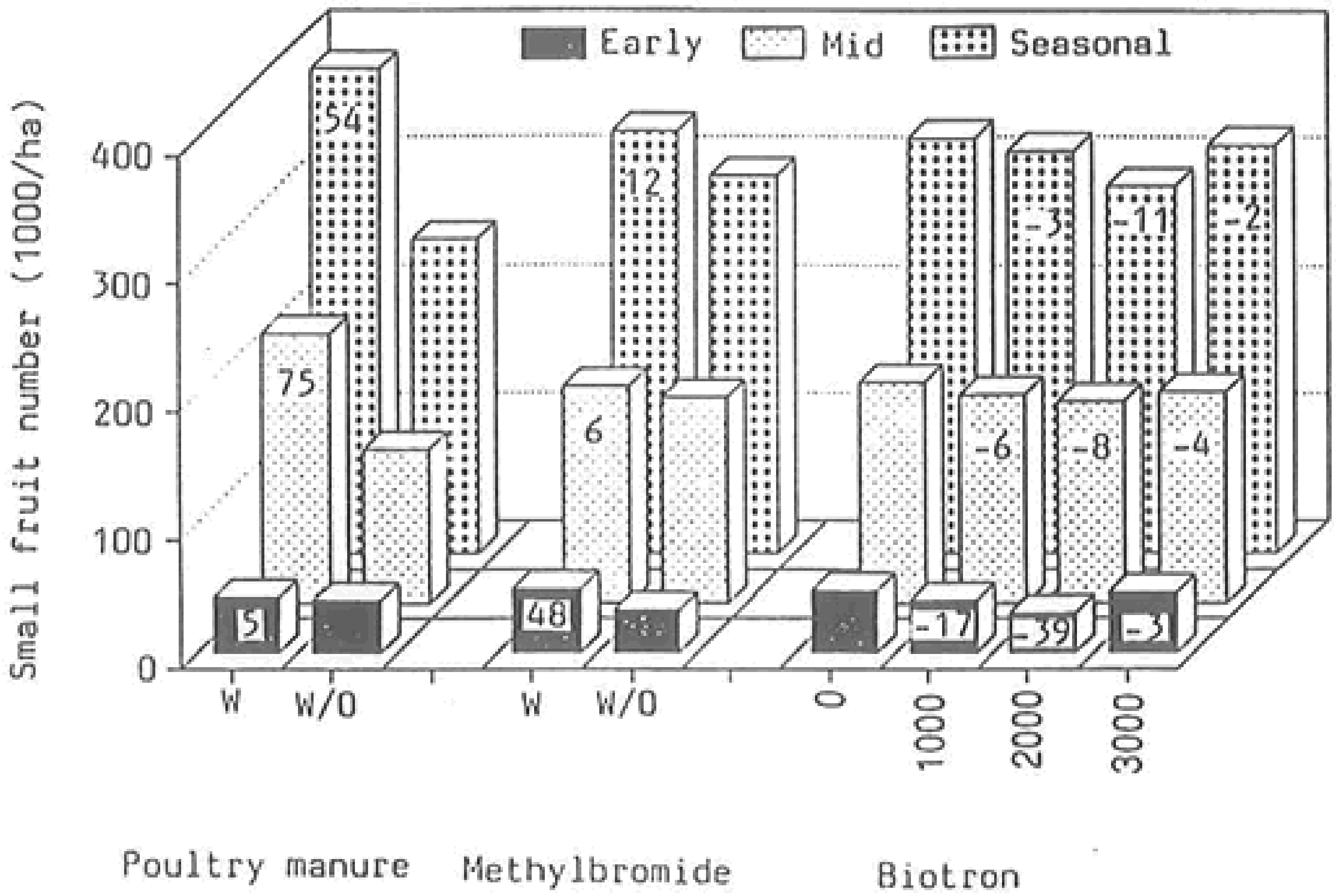

Fig.7: Separate effects of poultry manure, methylbromide and biotron on small fruit number in plastic house tomato (numbers on columns represent % increase or decrease from the control ;w: with w/o: without)

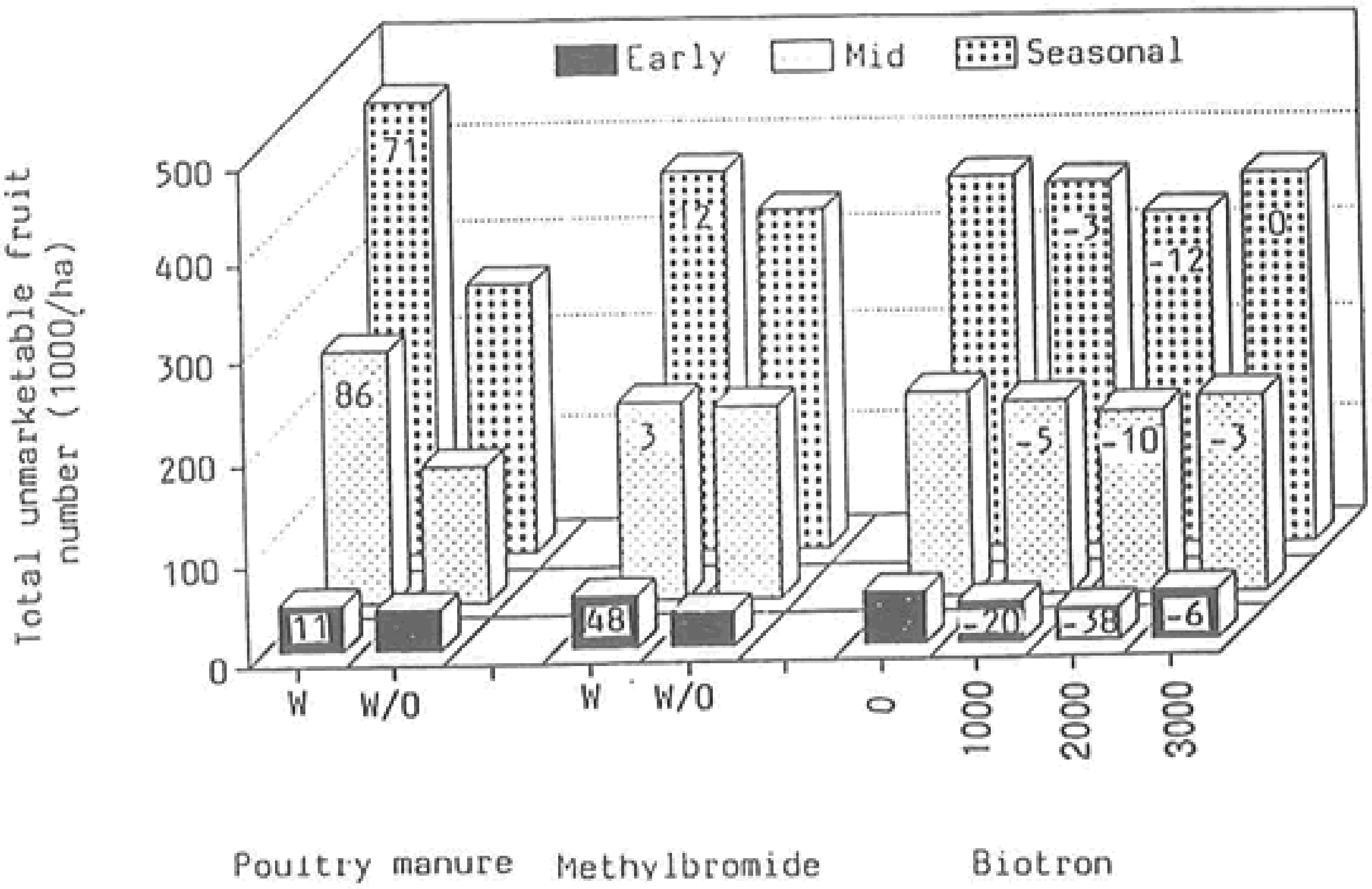

Fig.8: Separate effects of poultry manure, methylbromide and biotron on total unmarketable fruit number in plastic house tomato (numbers on columns represent % increase or decrease from the control; w: with w/o: without)

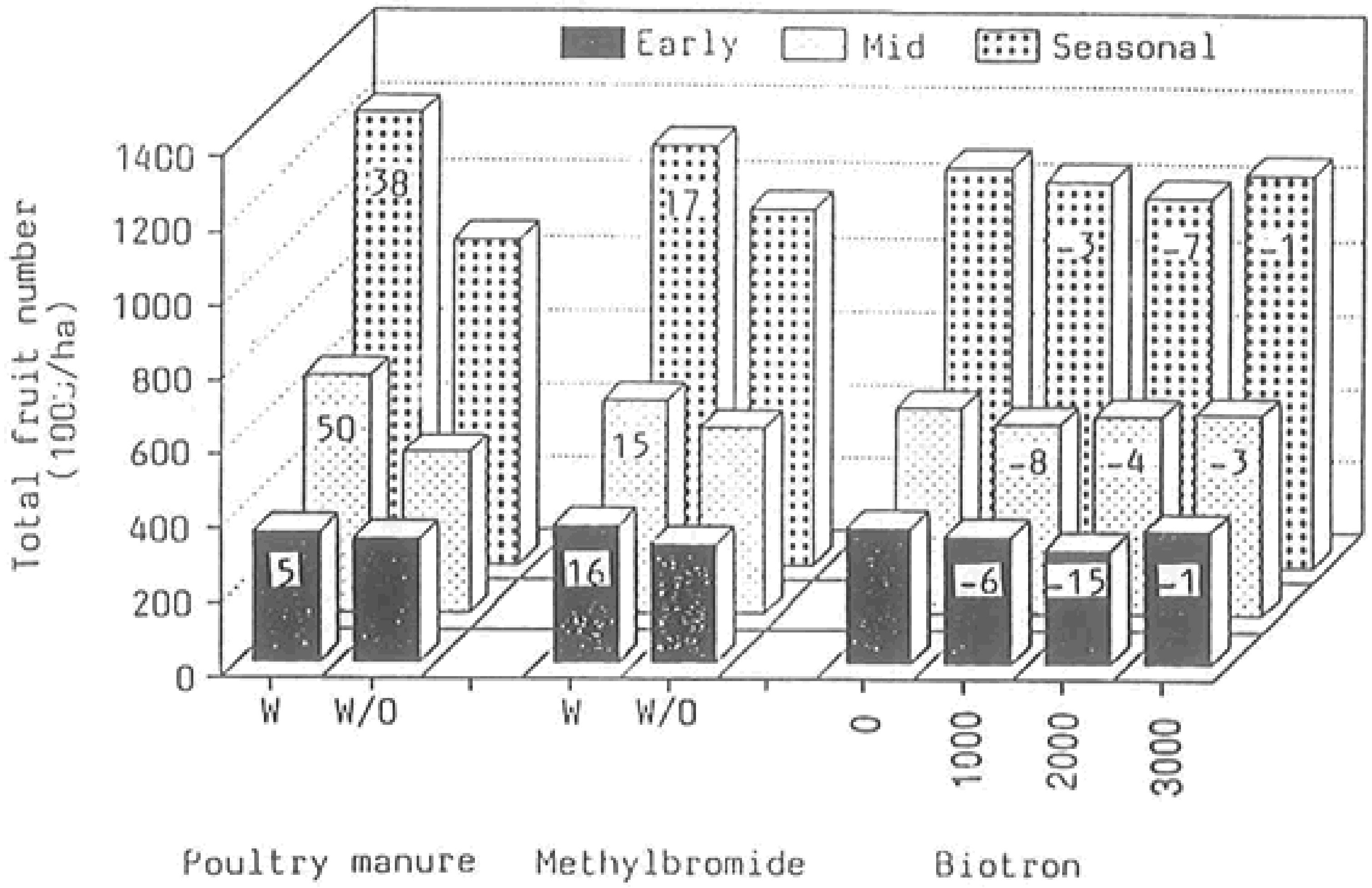

Fig.9: Separate effects of poultry manure, methylbromide and biotron on total fruit number in plastic house tomato (numbers on columns represent % increase or decrease from the control; w: with, w/o: without)

That marketable and unmarketable yields produced by manure, methylbromide and biotron followed patterns almost similar to their corresponding fruit numbers suggests that fruit number is a major yield component in tomato as it has been, previously, reported (Al-Maslamami and Suwwan, 1987; Muhammad and Suwwan, 1988; Suwwan and Hattar, 1987). Further support is derived from the highly significant positive correlations between yields and fruit numbers ($P < 1\%$).

Average weight per fruit

The general effects of manure, methylbromide soil fumigation and biotron on average weight per the marketable (Fig. 10) or the small (Fig. 11) fruit, were insignificant and inconsistant. According to Suwwan and Hattar (1987) poultry manure application produced significantly larger fruits.

Seemingly, as derived from the positive significant correltions ($P < 1\%$) between fruit numbers and average weight per fruit, sufficient photosynthats were available for fruit growth and development avoiding any chances for competition. Nevertheless, contribution of fruit size in yield patterns obtained was major as elecited from the highly positive and significant correltions.

Vegetative growth

Enhanced plant growth, in terms of plant dry weight and height and their components (Table 1) was most pronounced in the manure treated plots. While biotron had no effects (Table 2), soil fumigation with methylbromide produced plants with significantly more dry weight and taller at 80 days from planting with longer internodes (Table 1). Manure enhancement of dry weight in tomato plants has been

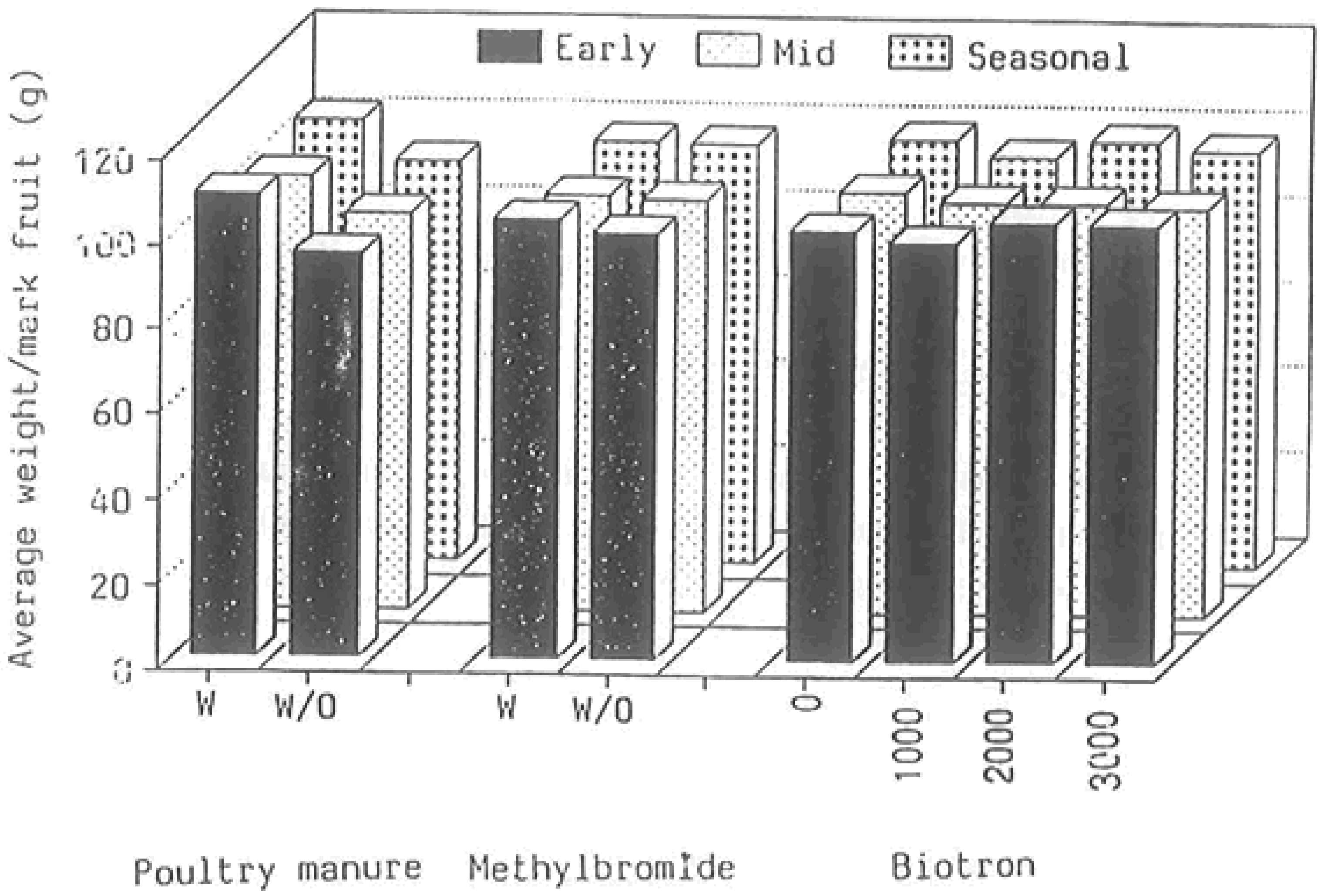

Fig.10::Separate effects of poultry manure, methylbromide and biotron on average weight per marketable fruit in plastic house tomato (w: with, w/o: without)

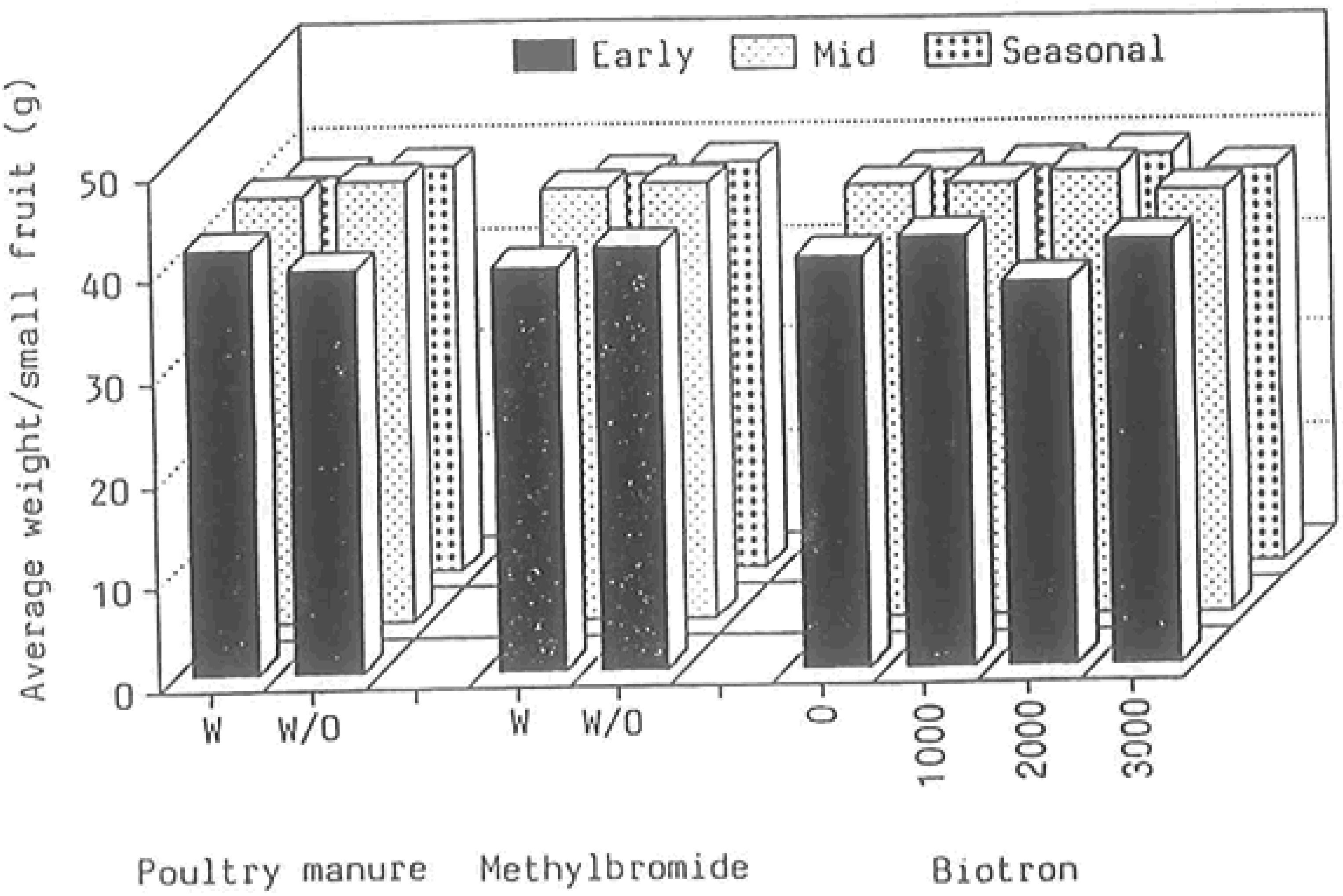

Fig.11: Separate effects of poultry manure, methylbromide and biotron on average weight per small fruit in plastic house tomato (w: with, w/o: without)

Table 1. Separate effects of organic matter and methyl-bromide on vegetative growth of plastic house tomato (1988 season).

Parameter	Poultry manure W (1)	Poultry manure W/O	Fumigation W	Fumigation W/O
Dry weight (g/plant)				
- Leaf	66.64 a (2)	40.86 b	58.66 a	48.85 a
- Stem	54.63 a	36.43 b	50.46 a	40.60 b
- Root	3.31 a	3.12 a	3.29 a	3.14 a
- Plant	124.58 a	80.41 b	112.41 a	92.59 b
Plant height (cm)				
- 40 days	62.31 a	58.32 b	61.14 a	59.28 a
- 80 days	184.40 a	167.27 b	179.01 a	172.67 b
- end of season	282.25 a	254.71 b	281.93 a	255.03 b
Number of internodes	39.04 a	36.98 b	39.20 a	36.82 a
Length of internode (cm)	7.23 a	6.86 b	7.18 a	6.91 b
Number of nodes to flower				
Cluster :				
1	10.53 a	10.62 a	10.71 a	10.44 b
2	13.88 a	13.92 a	14.06 a	13.75 b
3	17.07 a	17.11 a	17.28 a	16.90 a
4	20.14 a	20.25 a	20.35 a	20.04 a
5	23.24 a	23.45 a	23.51 a	23.17 a
6	26.31 a	26.55 a	26.61 a	26.25 a
7	29.38 a	29.88 a	29.72 a	29.54 a
8	32.15 a	32.76 a	32.58 a	32.33 a

(1) W : With, W/O : Without.
(2) Within rows, for each treatment category numbers having different letters differ significantly at 5% level according to Duncan's Multiple Range Test.

Table 2. Separate effects of biotron on vegetative growth of plastic house tomato (1988 season).

Parameter	Biotron 0	Biotron 1000	Biotron 2000	Biotron 3000
Dry weight (g/plant)				
- Leaf	57.92 a (1)	52.70 a	54.35 a	50.04 a
- Stem	47.88 a	44.87 a	43.29 a	46.09 a
- Root	3.30 a	3.09 a	3.10 a	3.26 a
- Plant	109.10 a	100.66 a	100.74 a	99.39 a
Plant height (cm)				
- 40 days	61.71 a	60.82 a	59.12 a	59.59 a
- 80 days	176.66 a	176.03 a	175.24 a	175.43 a
- end of season	276.68 a	264.63 a	271.07 a	261.56 a
Number of internodes	38.85 a	37.49 a	38.42 a	37.28 a
Length of internode (cm)	7.10 a	7.03 a	7.04 a	7.01 a
Number of nodes to flower				
Cluster :				
1	10.49 a	10.42 a	10.83 a	10.56 a
2	13.86 a	13.79 a	14.07 a	13.89 a
3	17.08 a	16.98 a	17.26 a	17.05 a
4	20.20 a	20.03 a	20.33 a	20.23 a
5	23.39 a	23.23 a	23.46 a	23.29 a
6	26.33 a	26.42 a	26.56 a	26.43 a
7	29.50 a	29.50 a	29.60 a	29.92 a
8	32.28 a	32.35 a	32.48 a	32.71 a

(1) Within rows, numbers having different letters differ significantly at 5 % level according to Duncan's Multiple Range Test.

reported earlier (Abdul Rasul and Ndewi, 1988; Suwwan and Hattar, 1987). Methylbromide, however, produced cucumber plants with greater fresh foliage weight (Khtoom, 1981). Soil fumigants, including methylbromide, resulted in marked stimulation of vegetative growth in tomato (McCarter et al; 1976). Growth stimulation by poultry manure and methylbromide are unlikely similar. Under conditions of this investigation, soil analysis before biotron application (Table 3) showed significantly higher levels of N, P, K and O. M. in the manure treated plots. At the end of the season (Table 4) manure proved effective in keeping O. M. and P at significantly higher levels. The highly positive correlation ($P < 1\%$) between any of N, P, K, O. M. and dry plant weight on one hand and yield and yield components on the other hand substantiate favourable effects of manure application through release of N, P and K nutrient elements which enhanced plant growth and yield and their components.

As well, poultry manure could have affected the plant growth by improving the physical properties (i.e. water holding capacity). Soil fumigation eleminated weeds (field notice) which competed with plants on soil nutrients in the nonfumigated plots. Examining the root system in all plots showed no signs of nematode infection even in the control plants, this eleminates the possibility that methylbromide exerted its beneficial effects on growth and yield of tomato through nematode control.

The increase in plant height (Table 1) by manure appliction is due to a significant increase in number of internodes and average internode length. The increase in plant height in the methylbromide treated plots is due to a significant increase in the average internode length and to some extent to increase in number of internodes (Table 2).

Table 3. Separate effects of organic matter, methylbromide (before biotron application) on soil analysis

Treatment	N	O.M.	pH	EC (mmohs/cm)	K (ppm)	P (ppm)
Organic matter						
W[1]	0.12 a[2]	2.60 a	7.88 b	1.92 a	943.3 a	134.8 a
W/O	0.07 b	1.40 b	8.15 a	1.19 a	353.8 b	54.6 b
Fumigation						
W	0.09 a	2.00 a	8.06 a	1.38 a	684.6 a	87.5 a
W/o	0.09 a	1.90 a	7.96 a	1.73 a	612.5 a	101.8 a
Biotron level (ml/ha)						
O	0.09 a	1.90 a	7.98 b	1.63 a	673.3 a	85.2 a
1000	0.09 a	2.00 a	8.07 a	1.59 a	596.7 a	101.0 a
2000	0.09 a	2.10 a	8.02ab	1.54 a	650.6 a	95.6 a
3000	0.10 a	2.00 a	8.01ab	1.46 a	674.2 a	96.9 a

(1) W : With, W/O : Without.

(2) Within each separate treatment columns for each analysis having different letters are significantly different at 0.05 level according to Duncan's Multiple Range Test.

Table 4. Separate effects of organic matter, methylbromide and biotron on soil analysis at the end of the season.

Treatment	N	O.M.	pH	EC (mmohs/cm)	K (ppm)	P (ppm)
Organic matter						
W [1]	0.08 a [2]	1.09 a	7.92 a	0.43 a	385.6 a	316.0 a
W/o	0.06 a	0.77 b	7.98 a	0.34 a	298.3 a	69.2 b
Fumigation						
W	0.07 a	0.93 a	7.95 a	0.39 a	362.3 a	211.9 a
W/O	0.07 a	0.93 a	7.95 a	0.38 a	321.7 a	173.4 a
Biotron level (ml/ha)						
0	0.08 a	0.95ab	7.94 a	0.37 b	337.5 a	198.5ab
1000	0.06 b	0.87 b	7.93 a	0.46 a	368.3 a	158.3 b
2000	0.07 ab	0.85 b	8.00 a	0.35 b	341.7 a	173.2 b
3000	0.08 a	1.05 a	7.93 a	0.36 b	325.4 a	240.6 a

(1) W : With, W/O : Without.

(2) Within each separate treatment columns for each analysis having different letters are significantly different at 0.05 level according to Duncan's Multiple Range Test.

CONCLUSION

It could be concluded that poultry manure application at the rate of 70 ton/ha (23 % moisture) may be practiced for successful plastic house tomato production under conditions similar to those of this investigation. Had the experimental soil been infected with nematode and the tomato cultivar susceptable to this parasite, methylbromide soil fumigation would be inevidible. Biotron, however, is not recommended but further experiments on this soil metabolizer could be suggested.

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مجلة الأمارات للعلوم الزراعية (١٩٩١) ٢، : ١١ - ٣٩

تاثير مخلفات الدواجن والميثيل برومايد والبيوترون على النمو والأنتاجية للطماطم بالبيوت البلاستيكية.

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الخلاصـــــة

زاد الانتاج المسوق لمحصول البندورة خلال الموسم بدرجة معنوية عند اضافة المادة العضوية بواقع ٧٠ طنا للهكتار بينما كانت الزيادة فى الانتاج الكلي الموسمي معنوية ، كما ادت اضافة المادة العضوية الى زيادة معنوية في عدد الثمار الموسمية المسوقة وعدد الثمار الكلي عند منتصف الموسم . اما الانتاج والعدد للثمار الصغيرة والكلية غير المسوقة ، فلم تتاثر باضافة المادة العضوية .

ونتج عن التعقيم بالميثيل برومايد (٨٩ غم / م٢) ميل للزيادة في كل من الانتاج المسوق وعدد الثمار المسوقة طوال الموسم . وعموما لم يكن للتعقيم اى اثر معنوى على الانتاج والعدد لكل من الثمار الصغيرة والكية غير المسوقة فيما عدا عدد الثمار الكلية غير المسوقة حيث زاد بدرجة معنوية مبكرا في الموسم . اما عدد الثمار الكلي فقد زاد بدرجة معنوية مبكرا في الموسم وللموسمي منه .

وعند اضافة البيوترون * (صفر الى ٢٠٠٠ ملليلتر / هكتار) لم يتاثر الانتاج وعدد الثمار المسوقة والانتاج وعدد الثمار الكلية . اما مبكرا في الموسم فقد ادت اضافة ٢٠٠٠ ملليلتر بيوترون للهكتار الى زيادة معنوية في انتاج وعدد الثمار الصغيرة مقارنة مع الشاهد .

وعموما لم يتاثر معدل وزن الثمرة باضافة المادة العضوية او الميثيل برومايد او البيوترون . وفى حين لم يؤثر" البيوترون" على النمو الخضرى للنباتات . ادت اضافة المادة العضوية الى زيادات معنوية في كل من : الوزن الجاف للنبات ومكوناته . طول النبات . عدد السلاميات ومعدل طول السلامية . كما زاد بدرجة معنوية كل من : الوزن الجاف للنبات والساق . طول النبات بعد ٨٠ يوما من الزراعة وفي نهاية الموسم وكذلك معدل طول السلامية عند تعقيم التربة بالميثيل برومايد .

كلمات مفتاحية : بيوترون . البيوت البلاستيكية . مخلفات الدواجن . ميثيل برومايد .

* Biotron (بيوترون) = Microbial enzymtic soil metabolizer.