# An Economic Analysis of Alternatives to Use of Methyl Bromide for Greenhouse Vegetables (Tomatoes, Cucumbers) and Cut Flowers (Carnation)

Fatma Akkaya, Ali Ozturk
Ahmet Deviren and Adnan Ozcelik
Citrus and Greenhouse
Crops Research Institute
Antalya
Turkey

Burhan Ozkan,
Univ. of Akdeniz, Faculty
of Agriculture, Department
of Agricultural Economics
Antalya
Turkey

**Keywords:** Alternative treatments, yield, cost, dominance analysis, marginal rate of return

## Abstract

**The objective of this study was to make an economic analysis of alternatives to the use of methyl bromide for greenhouse vegetables (tomatoes, cucumbers) and cut flowers. The economic analyses were performed on the results of the experiments conducted in Antalya province of Turkey. Economic feasibility of the alternative treatments (19 treatments for tomatoes, 12 treatments for cucumbers and 9 treatments for carnation) was assessed based on their effects on yield. The results of economic analysis indicates that soilless culture (sand and volcanic tuff + peat), solarization plus biofumigation, 1,3 dichloropropene, and steam sterilisation treatments can be considered as potential alternatives to use of methyl bromide for three crops. However, there is a need for further research to confirm these initial results.**

## INTRODUCTION

Methyl bromide (MB) is one of the most widely used pesticides in the world. It controls a wide range of pests including pathogens, arthropods and weed in soil and stores. MB is mostly used in soil fumigation in Turkey. As of 2000, total MB use in Turkey was about 606 tons (Dogan, 2000) More than 50% of this amount was utilized in greenhouses of Antalya province to control nematodes, soilborne diseases and weeds. Growers prefer to use MB since it is an effective broad-spectrum biocide**.**

However, MB is damaging the ozone layer and also is very toxic to humans and other organisms. Therefore, according to Montreal Protocol (a ban on methyl bromide was proposed at the $5^{th}$ Meeting of the Montreal Protocol in Copenhagen, November, 1992), its use is going to be phased out in 2005 in developed countries and it will be phase out in 2008 in Turkey. Growers are concerned that MB alternatives will be less effective and cause financial losses. It is clear that there is a need to develop alternative treatments that are technically applicable, economically feasible and environmentally friendly. The purpose of this study was to conduct economic analyses of methods or techniques alternative to the use of MB. To this end experimental results were economically analysed.

## MATERIALS AND METHODS

The experiments were conducted in Antalya province in 2000. In the study, MB alternative techniques tested were solarization (SL), SL+resistant varieties (RV), SL+1,3 dichloropropene (DD), SL+metham sodium (MS), SL+Dazomet (DZ), SL+biofumigation (BIO), SL + bio-control-Mycormax (BCM), SL + bio-control-Promot (BCP), soilless culture [sand (S), volcanic tuff (VT) and volcanic tuff + peat (VTP)], methyl bromide full dose with 75 gr/m² (MB100), methyl bromide at half dose with 35 gr/m² (MB50) and a control were applied to media used for greenhouse tomato, cucumber and carnation production.

An economic analysis of the 19 treatments for tomatoes, 12 treatments for cucumbers and 9 treatments for carnation were compared in terms of production cost, yield, and gross benefit and net benefit. Partial budget techniques for each commodity were developed to compare the alternative treatments (CIMMYT,1988; Ozkan,1991).

## RESULTS AND DISCUSSION

The results of economical analysis of tomato experiments indicate that the control plot has the lowest variable cost and bio-control agent (SL+BCM+RV) has the highest variable costs. The cost of SL treatments and chemical applications with low dosage were lower than MB applications (Figure 1). The yield of the control treatment was much lower than the all other treatments used in the experiments. The highest yield was obtained from soilless culture with sand followed by SL+BIO+RV and SL+BIO (Figure 2). Similar results were found in previous studies (Bello et al., 2002). The results show that the highest net benefit was obtained from soilless culture. The treatments of control, control+RV, SL+DD, SL+MS+RV, SL+BIO, SL+BIO+RV and soilless culture with sand were non-dominant (Table 1). The results of marginal rate of return which is a characteristic of the change from one treatment to another indicates that control+ RV has the highest economic benefit and it is followed by soilless culture with sand, SL+BIO and SL+DD. It can be stated that these treatments seem to be promising alternatives (Table 2).

The results of economical analysis of cucumber experiments indicate that the control treatment has the lowest variable cost and SL+BCP, soilless culture with VTP, and MB100 have the highest variable costs (Figure 3). The highest yield was obtained from MB50 applications compared to the other treatments. SL+BCM plot has the lowest yield (Figure 4). The results showed that the highest net benefit was obtained from MB50. SL+DD, SL+MS and SL follow it. Hence, control, SL, SL+DD, MB50 were found to be non-dominated (Table 3). The results of marginal rate of return indicate that SL+DD, and SL was the highest economic benefit. It seems that SL+DD, and SL are feasible alternatives (Table 4).

The results of economical analysis of carnation experiments indicate that the steam treatment has the highest variable costs among all treatments. It is followed by MB100, and soilless culture with VTP (Figure 5). The yield of soilless culture with VTP and sand were higher than MB100 and MB50 applications (Figure 6). The highest net benefit was obtained from soilless culture with VTP followed by soilless culture with sand and MB50. Control, DD, soilless culture with sand and soilless culture with VTP were found to be non-dominated (Table 5). The results indicate that soilless culture with sand showed the best marginal rate of return among the treatments followed by DD and soilless culture with VTP (Table 6).

The results of this study generally consistent with many “MB alternative case studies” produced and distributed by the EPA. However, the yield and costs of the treatments vary depending on the soil type, temperature and production technology.

## CONCLUSIONS

The results of economic analysis indicate that there are alternative treatments to the use of MB for the examined crops in Antalya province. The main results can be summarised as follows:

For tomato: soilless culture with sand, solarization plus bio-fumigation and solarization plus reduced dosage of 1,3 dichloropropene was found to be the most profitable alternatives to use of MB. Bio-fumigation seems to a good alternative particularly when the using local inputs (animal manure, green manure or plant residues). On the other hand the use of resistant varieties can be considered an available alternative to MB.

For cucumber: solarization and solarization plus reduced dosage of 1,3 dichloropropene was found to be the most profitable alternatives to use of MB.

For carnation: soilless culture and reduced dosage of 1,3 dichloropropene was found to be the most profitable alternatives to use of MB. The treatment of steam pasteurisation can be also considered as a viable alternative to MB due environmental concerns. However it is a very expensive treatment compared to the other treatments. If the steam machine were used for larger areas or machine operating expenses were reduced it might be more efficient and economical.

It is suggested that there is need for further research to confirm these initial results for Turkish conditions.

**ACKNOWLEDGEMENTS**

We would like to thank to Mr. M. Keçeci, A. Ünlü, Ş. Çetinkaya, H. Cevri and C.F. Özkan for their valuable help.

**Literature Cited**

Bello, A., Lopez-Perez, J.A. and Garcia-Alvarez, A. 2002. Proceeding of international conference on alternative to methyl bromide. Seville, Spain 206-210.

CIMMYT, 1988. From agronomic data to farmer recommendations. An economics training manual. Completely. Revised edition. Mexico. D.F.

Cook, W.P. and Keinath, A.1994. Metam sodium as an alternative soil fumigant to methyl bromide in fresh market tomatoes. F&N Tests 49:160

Bello, A., Lopez-Perez, J.A. and Garcia-Alvarez A. 2002. Proceeding of international conference on alternatives to methyl bromide. Seville, Spain

Doganay, U. 2000. Methyl bromide kullanimindaki tehlikler. www.tarim.gov.tr. (in Turkish).

Olson, S.M. and Noling J.W. 1994. Fumigation trails for tomatoes and strawberries in Northwest Florida. International Conference on methyl bromide alternatives and emissions reductions. Kissimmee., FL.

Ozkan, B. 1991. Ciftci kosullarındaki arastırmalar. guneydogu anadolu tarimsal arastırma enstitusu yayinlari, Yayin No: 1991-3, Diyarbakir (in Turkish).

## Tables

Table 1. Dominance analysis of various MB alternative treatments for tomato.

| Alternatives | Variable cost ($/1000m²) | Net income ($/1000m²) | Dominance analysis |
|---|---|---|---|
| Control | 43.5 | 3422.7 | -- |
| Control+RV | 56.3 | 4175.4 | -- |
| SL | 85.7 | 3941.0 | D |
| SL+RV | 98.5 | 4154.1 | D |
| SL+DD | 118.3 | 4421.2 | -- |
| SL+DD+RV | 126.8 | 4285.6 | D |
| SL+MS | 165.4 | 4047.1 | D |
| SL+MS+RV | 173.9 | 4501.0 | -- |
| SL+DZ | 189.6 | 4339.3 | D |
| SL+BIO | 192.4 | 4586.2 | -- |
| SL+BIO+RV | 205.2 | 4588.5 | -- |
| SL+DZ+RV | 206.7 | 4499.0 | D |
| Sand | 216.3 | 4670.6 | -- |
| MB50 | 247.7 | 4192.5 | D |
| VT | 276.7 | 4228.8 | D |
| MB100 | 389.3 | 4056.5 | D |
| SL+BCP | 449.0 | 3874.7 | D |
| SL+BCP+RV | 461.8 | 3792.2 | D |
| VTP | 531.3 | 4209.9 | D |
| SL+BCM | 737.9 | 3439.7 | D |
| SL+BCM+RV | 750.7 | 3841.1 | D |

Table 2. Marginal rate of return for tomato.

| Alternatives | Variable cost ($/1000m²) | Incremental variable cost | Net benefit ($/1000m²) | Incremental net benefit | Marginal rate of return (%) |
|---|---|---|---|---|---|
| Control | 43.5 | -- | 3422.7 | -- | -- |
| Control+RV | 56.3 | 12.8 | 4175.4 | 752.7 | 5880 |
| SL+DD | 118.3 | 62.0 | 4421.2 | 245.8 | 396 |
| SL+MS+RV | 173.9 | 55.6 | 4501.0 | 79.8 | 144 |
| SL+BIO | 192.4 | 18.5 | 4586.2 | 85.2 | 461 |
| SL+BIO+RV | 205.2 | 12.8 | 4588.5 | 2.3 | 18 |
| Sand | 216.3 | 11.1 | 4670.6 | 82.1 | 740 |

Table 3. Dominance analysis for cucumber by treatments.

| Alternatives | Variable cost ($/1000m²) | Net income ($/1000m²) | Dominance Analysis |
|---|---|---|---|
| Control | 43.5 | 1458.5 | -- |
| SL | 85.7 | 1594.5 | -- |
| SL+DD | 118.3 | 1708.5 | -- |
| SL+MS | 165.4 | 1654.6 | D |
| SL+DZ | 189.6 | 1397.7 | D |
| SL+BIO | 191.4 | 1582.6 | D |
| Sand | 215.4 | 1585.8 | D |
| MB50 | 247.7 | 1898.1 | -- |
| VT | 274.3 | 1542.2 | D |
| MB100 | 389.3 | 1482.2 | D |
| SL+BCP | 449.0 | 1109.6 | D |
| VTP | 531.3 | 1441.1 | D |
| SL+BCM | 737.9 | 732.3 | D |

Table 4. Marginal rate of return by treatments for cucumber.

| Alternatives | Variable cost ($/1000m²) | Incremental variable cost | Net benefit ($/1000m²) | Incremental net benefit | Marginal rate of return (%) |
|---|---|---|---|---|---|
| Control | 43.5 | -- | 1458.5 | -- | -- |
| SL | 85.7 | 42.2 | 1594.5 | 136 | 322 |
| SL+DD | 118.3 | 32.6 | 1708.5 | 114 | 350 |
| MB50 | 247.7 | 129.4 | 1898.1 | 189.6 | 147 |

Table 5. Dominance analysis for carnation by treatment.

| Alternatives | Variable cost ($/1000m²) | Net income ($/1000m²) | Dominance Analysis |
|---|---|---|---|
| Control | 43.5 | 4843.7 | -- |
| DD | 133.4 | 5391.2 | -- |
| MS | 179.4 | 4805.5 | D |
| Sand | 186.5 | 5992.6 | -- |
| DZ | 189.2 | 5526.7 | D |
| VT | 207.7 | 4862.2 | D |
| MB50 | 247.8 | 5799.6 | D |
| VTP | 298.1 | 6212.5 | -- |
| MB100 | 389.3 | 5645.3 | D |
| Steam | 633.4 | 4980.5 | D |

Table 6. Marginal rate of return for carnation by treatment.

| Alternatives | Variable cost ($/1000m²) | Incremental variable cost | Net benefit ($/1000m²) | Incremental net benefit | Marginal rate of return (%) |
|---|---|---|---|---|---|
| Control | 43.5 | -- | 4843.7 | -- | -- |
| DD | 133.4 | 89.9 | 5391.2 | 547.6 | 609 |
| Sand | 186.5 | 53.1 | 5992.6 | 601.4 | 1133 |
| VTP | 298.1 | 111.6 | 6212.5 | 219.9 | 197 |

**Figures**

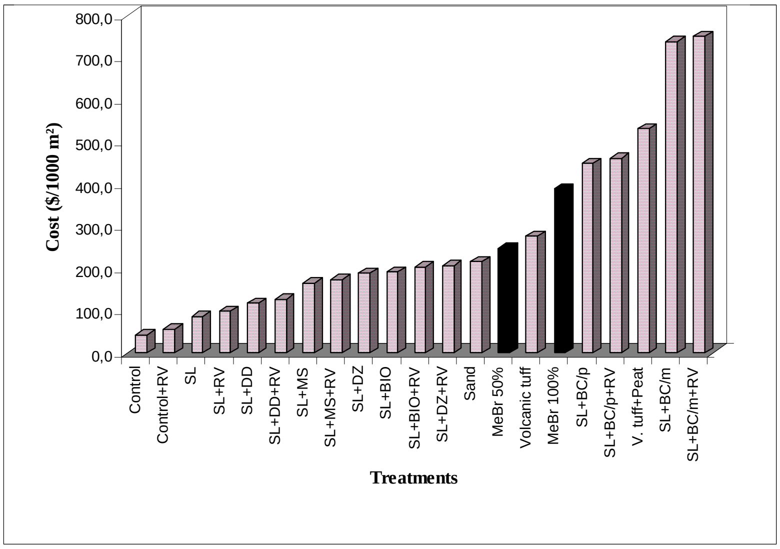



Fig. 1. Treatment costs for tomato by treatments.

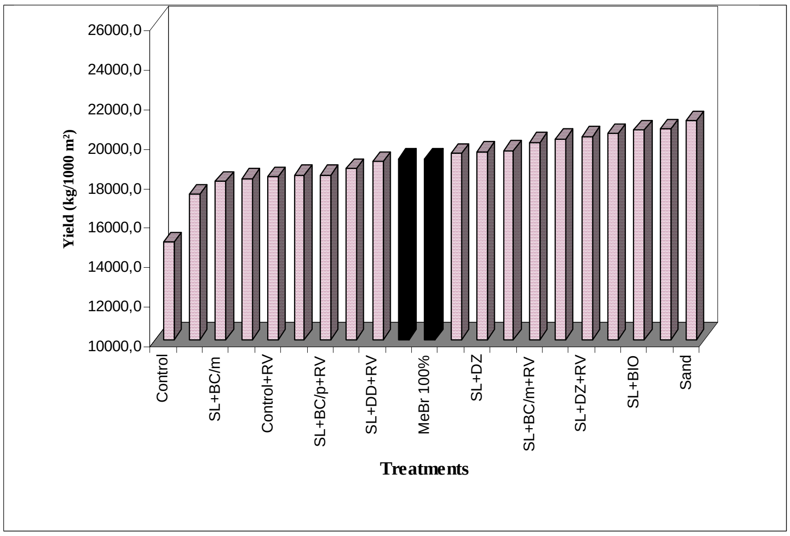
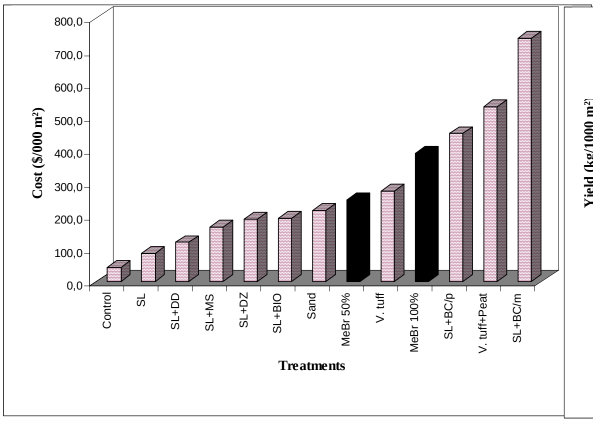



Fig. 2. Tomato yield by treatment.



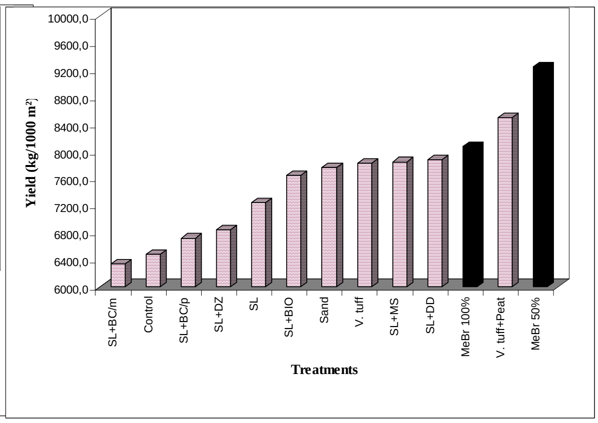
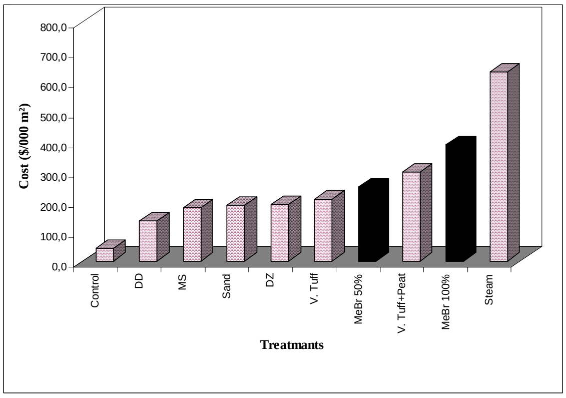




Fig. 3. Treatment costs for cucumber treatment.

Fig. 4. Cucumber yield by treatment.



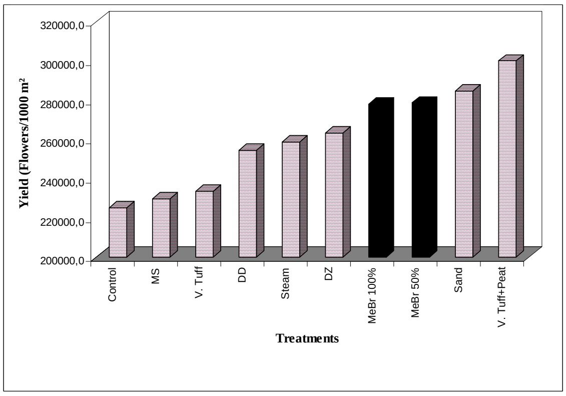




Fig. 5. Treatment costs for carnation treatment.

Fig. 6. Carnation yield by treatment.