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INSTITUTO DE CIENCIA Y TECNOLOGÍA AGRÍCOLA ICTA
GUATEMALA

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
(UNIDO)

# DEMONSTRATION PROJECT ON ALTERNATIVES TO THE USE OF METHYL BROMIDE IN SOIL FUMIGATION GUA/97/128

## FINAL REPORT

RESEARCH PROJECTS IN THE HIGH LAND AREA OF
CHIMALTENANGO CUT FLOWERS, BROCCOLI, TOMATO CROPS
AND CABBAGE AND TOMATO SEEDLINGS AND
LA FRAGUA VALLEY, ZACAPA FOR MELON, TOBACCO,
TOMATO INDUSTRIAL CROPS

GUATEMALA DECEMBER 1999

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION (UNIDO)

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**Presentation.** In 1989 the Montreal Protocol was subscribed by Government representatives from 87 countries with the main objective to protect the ozone layer. The Government of Guatemala signed the Montreal Protocol and latter subscribed the London and Copenhagen amendments. In the year 1997 the Legislative body enacted Law 110-97 which regulates and bans the imports of CFC´S and ODS substances.

One of the main activities in the country is agricultural production (27% of GNP). Methyl Bromide is widely used to control soil infestation and protect plant development, in 1994, 95 tons were reported but in 1998 over 900 tons were used. The number of cultivated hectares utilizing Methyl Bromide, increased from 2,500 ha in 1996 to 5,000 ha in 1998. In 1995 the Government in close cooperation with industry, agribusiness, the media, and business representatives started a Country Program to address ODS (ozone depleting substances) consumption and due to the mandates from Law 110-97 and the initiative to participate in research to find alternatives to the use of methyl bromide a demonstration project was organized with the sponsorship from the Multilateral Fund, the Management and Technical Backstopping form UNIDO, and the local support from CONCYT (Science Technology Council), the research capacity from ICTA (Agricultural Research Institute) and the local agribusiness participation (PROTISA, DIMON, KERN´S, AGRIPLAN, PAMPUTIK etc). Institutional support was granted from CONAMA (Environment Commission) and the Ministry of Agriculture.

Two research sites were selected, one in the highlands template area and the other in warm valley of Zacapa. Due to their economic significance several crops were selected melon, tobacco, tomato, cabbage seedling, broccoli, cut flowers and tomato. Final results are presented in this report. There are some promising findings and recommendations regarding the use of alternative products and complementary methods to gradually substitute the use of methyl bromide and improve agricultural methods. The alternatives trials project was developed from January 1998 to December 1999

In this endeavor the participant institutions and agribusiness have demonstrated their best collaborative efforts. A especial recognition has to be extended to Dr. Antonio Sabater de Sabates from the Montreal Protocol Unit at UNIDO, Vienna and to professor Javier Tello Chief Expert for their unconditioned support and willingness to share experience and knowledge .

TASK AND SERVICES
PROVIDED ICTA – UNIDO SUBCONTRACT
GUA/97/128 JANUARY 1,998 TO DECEMBER 1,999.

| # | Description | Duration | Final Date |
|---|---|---|---|
| 1 | MIP specialist coordination 1701 | 24 mo. | Dec 1,999 |
| 2 | Agronomist exports products 17.02 | 24 mo. | Dec 1,999 |
| 3 | Field analysis (2) 17.03 y 17.04 | 24 mo. | Dec 1,999 |
| 4 | Industrial Eng. 17.05 | 6 mo./2 year | Dec 1,999 |
| 5 | Agronomist | 4 mo./2 year | Nov 99 |
| 6 | Transportation to trial sites | 24 mo. | Dec 1,999 |
| 7 | Transportation to trial sites | 24 mo. | Dec 1,999 |
| 8 | International experts field visits transport | 24 mo. | Dec 99 |
| 9 | Fuel, oil, steam boiler | 24 mo. | Dec 99 |
| 10 | Office and secretarial facilities | 24 mo. | Dec 99 |
| 11 | Communications to ICTA´s central office, field stations and UNIDO, Vienna | 24 mo. | Dec 99 |
| 12 | Soil analysis 120, bacteria nematodes | 24 mo. | Dec 99 |
| 13 | Total # of trials melon (4) PROTISA, OASIS + Tobacco (1) Golfito + Tomato (2) + Seedlings (tomato and cabbage) ICTA + Tomato (2) ICTA + Brocoli (2) Agriplan and Flowers (2) PAMPUTIK | 12 mo.<br>12 mo. | Dec 98<br>Dec 99 |
| 14 | Follow-up trials, for the same crops, same sites | 12 mo. | Dec 99 |
| 15 | 15 follow up trials for 15 trials utilizing MeBr. | 12 mo. | Dec 98 |
| 16 | Monitoring and DATA collection, DATA analysis and reports preparation | 12 MO. | DEC 99 |
| 17 | 60 Documents/reports with obtained results | 22 mo. | Oct 99 |
| 18 | International work shop preparation for 21 international participants | 3 mo. | Dec 99 |
| 19 | Grafting trial as one of the alternative, a grafting trial was performed in two sites for melon crops. This is to control melon necrotic spot virus | 2 mo. | Nov – dec 99 |
| 20 | Phase out strategy preparation following Mr. Rassmussen guide lines | 1 mo. | Dec 99 |
| | | | |

ALTERNATIVES TO THE USE OF METHYL BROMIDE IN SOIL FUMIGATION
GUA 97/128 FINAL REPORT DECEMBER 1,999

## PERFORMED ACTIVITIES

| I. Preparatory Activities | Dates | Responsible |
|---|---|---|
| Institutional ARRANGEMENTS | sept 97 | A. Sabater S. |
| Companies and Farmers agreements | Oct 97 | M. Fernández |
| Training sessions experimental design | Dec 1997 | CONCYT /Colombia |
| Protocol preparation | nov – jan 98 | H. Figueroa |
| Steam boiler set up | may – august | H. Figueroa |
| II. Trials | | |
| Protocols review experiments approach | june 1998 | J. Tello |
| Tomato, cabbage seedlings ICTA | april 99 | F. Solis |
| Brocoli AGRIPLAN | july 99 | F. Solis |
| Melon I PROTISA | August 98 | M. Fernández |
| Tomato Sta. Rosalia lost weather | Sept 98 | M. Fernández |
| Tobaco DIMON lost conditions | Sept 98 | M. Fernández |
| Roses NORCAFE steam boiler no ready | Dec 98 | F. Solis |
| Melon I el Oasis | Nov 98 | E. Barrillas |
| Tobacco DIMON | Nov 98 | E. Trabanino |
| Tomato I el Oasis replace sta. Rosalia | Nov 98 | E. Barrillas |
| Tomato I La Alameda | Feb 99 | F. Solis |
| Tomato II La Alameda | June 99 | F. Solís |
| Melon grafting | dec 99 | E. Fernandez |
| Budget and expenditure report | dec 99 | conama/icta |
| Field trip Non Methyl bromide Agricultural practices | nov 1999 | Spain.Almeria, Murcia. |

TRIALS TIME FRAME

| EXPERIMENTS AS JUNE 1998 | | | | |
|---|---|---|---|---|
| CROP | LOCATION | SITE | STATUS | RESEARCHER |
| Cabbage Tomato seedlings | Chimaltenango | ICTA | On going | Fernando Solis |
| Broccoli | El Tejar | AGRIPLAN | On going | Fernando Solis |
| Roses | Parramos | NORCAFE | Not started steam boiler not ready | Fernando Solis |
| Melon | La Fragua | PROTISA | On going | Mario Fernandez |
| Tomato | La Fragua | Sta Rosalia | Lost. Extreme weather conditions. Washed away plots | Mario Fernandez |
| Tobacco | Cabañas | DIMON | Not started extreme weather conditions hinder soil preparation | Mario Fernandez |
| EXPERIMENTS AS DECEMBER 1998 | | | | |
| Cabbage and Tomato seedlings | Chimaltenango | ICTA | Seedlings transplanted to alternatives treatment sites. Six weeks vegetative growth Results evaluation | Fernando Solis |
| Broccoli | El Tejar | AGRIPLAN | From artificial seedlings transplant to open field alternatives treatments 45 days Results evaluations | Fernando Solis |
| Roses | Parramos | NORCAFE | Due to planting out date new sites have been selected MAYACROPS carnations and foliage | Fernando Solis |
| Melon | La Fragua | PROTISA | 45 day pre and post planting data analysis. Harvest out put evaluat. | Eladio Trabanino |
| Tobacco | La Fragua El Golfito | DIMON | Pre planting data for seedlings.Plantules transferred to open field January 1999 .New site to replaced Cabañas | Eladio Trabanino |
| Melon | Estanzuela El oasis | ICTA | New experiment. Pre treat. Samples lternatives 22 sept Field transplant nov 13$^{th}$Vegetative grow 34 days dec 17 | Elmer Barillas |
| Tomato | Estanzuela El Oasis | ICTA | New Experiment replaces Sta. Rosalia. Seedlings oct 20$^{th}$. Transplanted nov 25$^{th}$ . vegetative growth 27 days expected harvest Jan 25$^{th}$ 1999 | Elmer Barillas |

## THIRD PROGRESS REPORT AS AT JUNE 1999 TRIALS SITUATION SUMMARY TABLE

| CROP | SITE | AS AT DECEMBER 1998 | TRIALS AS AT JUNE 1999 |
|---|---|---|---|
| Cabbage and Tomato seedlings | Chimaltenango ICTA | Seedlings transplanted to alternatives treatment sites. 6 weeks vegetative growth | Trials Completed. Final results |
| Tomato 1Phase 1 | Chimaltenango ICTA | ---------- | Soil preparation, planting, agronomic works and crop. Partial Report |
| Tomato 2 | Chimaltenango ICTA | ---------- | Soil preparation, alternatives placed Initial report |
| Broccoli Phase 1 | El Tejar AGRIPLAN | Seedlings transplant to open field alternatives treatments 45 days Results evaluations | Phase 1 Trials Completed Final results. Report trials |
| Broccoli Phase 2 Same experimental unit | El Tejar AGRIPLAN | ---------- | Phase 2 initiated Soil preparation and treatments Transplant to definitive fields |
| Roses<br><br>Cut flowers | Parramos NORCAFE<br><br>PAMPUTIK | Due to planting out date new site was selected mayacrops carnations and Foliage<br><br>New site. Replacement mayacrops | Trial Not Initiated.<br><br>PAMPUTIK CUT FLOWERS Soil treatment steam and other Alternatives |
| Melon 1 Phase 1 E. Trabanino | La Fragua PROTISA | 45 day pre and post planting data analysis. Harvest out put evaluation (August – Dec. 1998) | Trials Results |
| Melon 1 Phase 2 Same experimental unit | La Fragua PROTISA | Planting 19 December 1998. | Agronomic Activities, sampling and Crops Production 16/1/99 |
| Tobbaco | La Fragua El Golfito DIMON | Pre planting data for seedlings Plantules transferred to open field January 1999 new site to replaced Cabañas | Results and trials report |
| Melon 1 Phase 1 | Estanzuela El oasis ICTA | New experiment. Pre treatment samples Treatment Alternatives 22 sept field transplant nov 13th Vegetative grow 34 days dec 17 | Phase 1 Completed Trials Report |
| Melon 1 Phase 2 Same experimental unit | Estanzuela El oasis ICTA | ---------- | Soil Treatment 9 February 1999 Cultivation April 22 1999 Partial Report |
| Tomato 1 Phase 1 | Estanzuela El Oasis ICTA | NEW trial replaces Sta. Rosalia. Seedlings oct 20th. Transplanted nov 25th . vegetative growth 27 days. Harvest Jan 25th 1999 | Phase 1 Completed Trials report |
| Tomato 1Phase 2 Same experimental unit | Estanzuela El Oasis ICTA | ---------- | Soil treatment may 3rd 1999 Planting May 11 1999 |

## SUMMARY TABLE : TRIALS TIME FRAME

| CROP | SITE | TRIALS AS AT JUNE 1999 | TRIAL AS AT NOVEMBER 99 |
|---|---|---|---|
| Cabbage and Tomato seedlings | Chimaltenango ICTA | Trials Completed. Final results APRIL – NOVEMBER 1998 FINAL REPORT | ---------- |
| Tomato 1Phase 1 | Chimaltenango ICTA | Soil preparation, planting, agronomic works and crop. JANUARY – JULY 1,999 | FINAL REPORT |
| Tomato 2 MAY – OCT 99 | Chimaltenango ICTA | Soil preparation, alternatives placed initial report | 25 day pre and post planting data harvest and cost analysis pending FINAL REPORT |
| Broccoli Phase 1 | El Tejar AGRIPLAN | Phase 1 Trials Completed Final results. Report trials JULY 1,998 – JANUARY 1,999 | ---------- |
| Broccoli Phase 2 Same experimental unit | El Tejar AGRIPLAN | Phase 2 initiated Soil preparation and treatments Transplant to definitive fields FEBRUARY – JULY 1,999 | FINAL REPORT and results presentation |
| Cut flowers MAY - SEPT 1,999 | PAMPUTIK | PAMPUTIK CUT FLOWERS Soil treatment steam and other Alternatives | FINAL REPORT and results presentation |
| Melon 1 Phase 1 *E. Trabanino* | La Fragua PROTISA | Trials Results AUGUST – NOVEMBER 1,998 | FINAL REPORT |
| Melon 1 Phase 2 Same experimental unit | La Fragua PROTISA | Agronomic Activities, sampling and Crops Production 16/1/99 DECEMBER 1,998 – MARCH 1,999 | FINAL REPORT |
| Tobbaco | La Fragua El Golfito DIMON | Results and trials report SEPTEMBER 1,998 – AUGUST 1,999 | FINAL REPORT |
| Melon 1 Phase 1 | Estanzuela El oasis ICTA | Phase 1 Completed Trials FINAL REPORT SEPTEMBER 1,998 – FEB 1999 | ---------- |
| Melon 1 Phase 2 Same experimental unit | Estanzuela El oasis ICTA | Soil Treatment 9 February 1999 Cultivation April 22 1999 Partial Report | FINAL REPORT |
| Tomato 1 Phase 1 | Estanzuela El Oasis ICTA | Phase 1 Completed FINAL REPORT OCTOBER 1,998 – MARCH 1,999 | ---------- |
| Tomato 1Phase 2 Same experimental unit | Estanzuela El Oasis ICTA | Soil treatment may 3rd 1999 Planting May 11 1999 APRIL – AUGUST 1,999 | FINAL REPORT |
| MELON GRFTING | Estanzuela AND VIÑAS ICTA/PEGON | | SEEDLINGS IN NOVEMBER GRAFTINGS CONDUCTED NOV DEC FINAL REPORT FEBRURY |

**PROJECT BUDGET EXPENDITURE REPORT AS FOR 1998 AND ESTIMATED AS DECEMBER 31 1999.**

| | Línea Presupuestaria | cantidad | Año 1 | Año 2 | Total |
|---|---|---|---|---|---|
| | **Personal** | **descripción** | | | |
| 0 | Coordinación JC | 2 sesiones/mes | 2,000.00 | 2,400.00 | 4,400.00 |
| 1 | Coordinación CH | 2 sesiones/mes | 2,000.00 | 2,400.00 | 4,400.00 |
| 2 | Coordinador LC | 4hrs/mes 583 | ---------- | 7,000.00 | 7,000.00 |
| 3 | Ing. Agrónomo MF | 8hrs/mes$1400. | 6,400.00 | --------- | 6,400.00 |
| 4 | Ing. Agrónomo FS | 4hrs/mes 585 | 6,435.00 | 7,000.00 | 13,435.00 |
| 5 | Asist. Campo MP | 8hrs/mes 500 | --------- | 6,000.00 | 6,000.00 |
| 6 | Asist. Campo FFC | 8hrs/mes 500 | 6,000.00 | 6,000.00 | 12,000.00 |
| 7 | Ing. Agronomo EB | 4/hrs/mes 580 | 1,750.00 | 7,000.00 | 8,750.00 |
| 8 | Ing Agronomo ET | 4/hrs/mes 580 | 1,750.00 | 7,000.00 | 8,750.00 |
| 9 | Asist Campo AG | 8/hrs/mes 400 | 1,200.00 | 4,800.00 | 6,000.00 |
| 10 | AgroEconomista | 3mes/1,000 | 1,000.00 | 2,000.00 | 3,000.00 |
| 11 | contabilidad auditoria | 18/meses/225 | 1,350.00 | 2,700.00 | 4,050.00 |
| 12 | Camarografo | 6/tomas/120 | ---------- | 720.00 | 720.00 |
| 13 | **Jornales** | 120/mes/12 | --------- | 1,440.00 | 1,440.00 |
| | **SUB TOTAL** | | **29,885.00** | **56,460.00** | **86,345.00** |
| | **Servicios no Personales** | | | | |
| 14 | viaticos 10 x 12 m x Q125 | 144/d/hombre | ------- | 2,600.00 | 2,600.00 |
| 15 | Mantenimiento Caldera | contrato anual | 2,000.00 | 3,000.00 | 5,000.00 |
| 16 | E-mail | 300/m x 12 m | ------- | 600.00 | 600.00 |
| 17 | Telefono/fax/DHL/infor. | $200 x mes | 1,970.00 | 1,000.00 | 2,000.00 |
| 18 | Analisis de Laboratorio | 404 exam/año | ------ | 4,400.00 | 4,400.00 |
| 19 | Servicios vehículos | 6 x año 350 | ------- | 400.00 | 400.00 |
| | SUB TOTAL | | **3,970.00** | **12,000.00** | **15,970.00** |
| | | | | | |
| | **Materiales y Suministros** | | | | |
| 20 | gasolina superv. Campo | 43 viajes x $ 35 | | 1,505.00 | 1,505.00 |
| 21 | Capacitación Local viatico | almuerzo/mats | ------ | 1,000.00 | 1,000.00 |
| 22 | Documentación/Informac. | | 985.00 | ------ | 985.00 |
| 23 | Kerosina o Disel (q.8.25) | 320 gal/32 dias | ----- | 600.00 | 600.00 |
| 24 | Equipo Protector | | | | |
| 25 | Utiles de Aspersión $. 65. | 4 bombas asp* | | 260.00 | 260.00 |
| 26 | transporte de caldera | 8 viajes cabezal | ------ | 1,800.00 | 1,800.00 |
| 27 | termometros 30 x Q200.00 | ----- | ------ | ------ | -------- |
| 28 | bromuro de Metilo 20 latas | Q. 25.00 c/lata | ------- | -------- | --------- |
| 29 | Lona para tunel vaporiz . | ---------- | ------ | ------ | |
| 30 | Sustrato Artificial | ---------- | ------ | 595.00 | 595.00 |
| 31 | Vapan, tellone | | | 500.00 | 500.00 |
| 32 | Semilla certificada 2lbs | repollo/tomate | ----- | ------ | ----- |
| 33 | manguera de lona | ---------- | ----- | 550.00 | 550.00 |
| 34 | conectores y accesorios | | | 200.00 | 200.00 |
| 35 | tubo galvanizado 1pg | ---------- | | ------ | ----- |
| 36 | agro insumos | quimicos/etc | ---------- | 6,350.00 | 6,350.00 |
| 37 | IBM comp. | 1 pc IBM | 1,500.00 | ------- | 1,500.00 |
| 38 | impresora BJ 200 ex | 1 impr. cannon | 250.00 | ------ | 250.00 |
| 39 | cristaleria | | ------ | ----- | ----- |
| 40 | bolsas , envases vidrio | recolec.muestra | ----- | 200.00 | 200.00 |
| 41 | alambre de amarre | sujetar lona | 200.00 | 200.00 | 400.00 |
| 42 | conectores de vinil | -------- | ------ | ------ | ------ |
| 43 | neumaticos 5 x 2 x 2 | Q.500.00 c.u. | | 990.00 | 990.00 |
| | ***subtotal*** | | **2,935.00** | **14,750.00** | **17,685.00** |
| | **TOTAL** | | **36,790.00** | **83,210.00** | **120,00.00** |

## INTRODUCTION

The Montreal Protocol is an International Treaty established to regulate substances that contribute to destroy of the ozone layer. Clorofluorocarbons are widely used substances in the refrigeration and air conditioning sector. In the past 10 years alternative products have been developed and are already being used by the industry and in house holds. Methyl Bromide is widely used in agriculture and produces severe damage to the ozone layer. This fumigant has been used commercially for more that 40 years to control pests such as fungi, bacteria, soil borne viruses, insects, mites, nematodes and rodents. It destroys an ample expectrum of organisms, some of which are not harmful to the soil. Its application is relatively simple; it penetrates soil easily and is quickly eliminated. It has a high toxicity, reduces soil biodiversity and could contaminate underwater reservoirs.

Ozone destruction occurs when MeBr reaches the atmosphere then the solar radiation liberates a bromide atom breaking the link between the bromine atom and the methyl radical. Bromide atom is unstable an causes a large impact in destroying ozone molecules.

## JUSTIFICACION

Seedbeds preparation is a common practice for the small highland farmers in Guatemala. Methyl Bromide is utilized to treat soil borne diseases This are relatively small areas (3.5 sq. Mt) that provide plantules for some 22,000 Ha vegetable crops.

Due to this wide extended use it was necessary to evaluate alternatives for the substitution of methyl bromide for seedbeds preparation. Taking into account that this product will eventually be out of the market due to the Montreal Protocol regulations and the Guatemalan legislation.

| ALTERNATIVES TRIAL |
|---|
| • Hand craft Vapor 90°C/30min |
| • Solarization (6 weeks) |
| • Metham sodio (100cc/m2) |

## FINDINDS

1- Hand craft generated water vapor showed a good impact on weeds and nematodes populations. This alternative was more effective that methyl bromide for nematodes control. Plantules were vigorous, healthy, with good conditions for transplanting.

2- Six weeks solarization trials were less effective for weeds control. Nematodes counts were low. Overall effectiveness was reduced because cloudiness was present 60 5 of the time.

3- Metham Sodium was evaluated as the chemical alternative. It showed good control over weeds populations and less effectiveness on nematodes counts.

4- Solarization and Metham Sodium demonstrated a fine control over weeds count populations and nematodes populations similar to the effect of methyl bromide.

No signiffícative difference was found in comparing this alternatives to methyl bromide for weeds control and nematodes counts. A similar situation was observed with soil solarization and Metham sodium applications in weeds control

For seedbeds preparation MeBr can be easily substituted with the use of artesanal vapor, and the use of solarization + Metham sodium.

Economic analysis shows no signiffícative difference

## INTRODUCTION

The Montreal Protocol is an International Treaty established to regulate substances that contribute to destroy of the ozone layer. Clorofluorocarbons are widely used substances in the refrigeration an air conditioning sector. In the past 10 years alternative products have been developed and are already being used by the industry and in house holds. Methyl Bromide is widely used in agriculture and produces severe damage to the ozone layer. This fumigant has been used commercially for more that 40 years to control pests such as fungi, bacteria, soil borne viruses, insects, mites, nematodes and rodents. It destroys an ample expectrum of organisms, some of which are not harmful to the soil. Its application is relatively simple; it penetrates soil easily and is quickly eliminated. It has a high toxicity, reduces soil biodiversity and could contaminate underwater reservoirs.

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## JUSTIFICATION

Brócoli, is one of the main non-traditional exports in Guatemala, Small farmers and large Broccoli producers use MeBr for seedling production and as a soil fumigant after plantules are transplanted to definitive field.

Early in the year 1990 plamodioforah brassicae was detected and reported in the area (hernia de la col ) such disease parasites plants roots in a way that significantly decreases plant production or even causes plant's death. Large areas have been infected with this pathogen, impairing the culture of Bracicaes. Some preliminary research has advising the use of MeBr in open fields to control this pathology. Leading to an increase in the use of the fumigant.

For such aspects broccoli was included as one of the crops to be evaluated in the alternative trials to the use of Methyl Bromide. This research was conducted under ICTA's protocols (Institute for Science and Technology Agricultural Research), the support of the Science and Technology Secretariat and the United Nations Programme for Industry Development UNIDO. Ample collaboration was provided by the participant agro industries in the areas. AGRIPLAN, NORCAFE, PAMPUTIK, DIMON, PROTISA, KERNS

## ALTERNATIVE TRIALS.

### SEEDLING

### TREATMENTS

| Seedling |
|---|
| - **Peat moss over soil** |
| - **Soil vaporized seedbed** |
| - **Peat moss seed bed tray** |
| - **Vaporized soil seed bed tray** |

| Open fields |
|---|
| - **Solarization** |
| - **Solarization + Metham sodium (1000 l/ha)** |
| - **Biofumigation (solarization + chicken manure)** |

## FINDINGS

1-The best option for the preparation for **seed beds** was peat moss over soil , no trays were required and seedlings were larger root development was prominent.

2-Weeds control was effective with biofumigation, solarization for six weeks an the combination of Metham Sodium plus solarization. Statistical analysis demonstrated that this alternatives were the same as methyl bromide application.

3- Nematodes counts in the fields was not significant the nematodes populations were reduced even more with the biofumigation, solarization, and methamsodium+solarization.

4- Soil solarization provided a good control over Plasmodiophora brassicae, (hernia de la col) it provides a good alternative for the use of methyl bromide for this purpose.

5- some of the applied alternatives generated larger crop's output than methyl bromide.

6. The largest crop output was obtained with the absolute witness, being the most profitable.

## INTRODUCTION

The Montreal Protocol is an International Treaty established to regulate substances that contribute to destroy of the ozone layer. Clorofluorocarbons are widely used substances in the refrigeration and air conditioning sector. In the past 10 years alternative products have been developed and are already being used by the industry and in house holds. Methyl Bromide is widely used in agriculture and produces severe damage to the ozone layer. This fumigant has been used commercially for more that 40 years to control pests such as fungi, bacteria, soil borne viruses, insects, mites, nematodes and rodents. It destroys an ample expectrum of organisms, some of which are not harmful to the soil. Its application is relatively simple; it penetrates soil easily and is quickly eliminated. It has a high toxicity, reduces soil biodiversity and could contaminate underwater reservoirs.

Ozone destruction occurs when MeBr reaches the atmosphere then the solar radiation liberates a bromide atom breaking the link between the bromine atom and the methyl radical. Bromide atom is unstable an causes a large impact in destroying ozone molecules.

## JUSTIFICACION

Short cycle cut flowers production is a non-traditional export product especially for the North American and European market. Depending on the flower type several crop cycles can be obtained.

The SnapDragon variety was utilized for the research trial. Producers are aware of market preferences and regulations regarding the use of Methyl Bromide.

The main problems that have been referred by the planters are weeds presence, soil fungi, especially *phytophtora sp* (mal del tallueo) due to this situation large quantities of MeBr are being utilized

For such reasons flowers were included as one of the crops to be evaluated in the alternative trials to the use of Methyl Bromide. This research was conducted under ICTA's protocols (Institute for Science and Technology Agricultural Research) and the United Nations Programme for Industry Development UNIDO. Ample collaboration has been provided by the participant agro industries in the area mainly PAMPUTIK and NORCAFE,

| ALTERNATIVE TRIALS |
| --- |
| **- Metham Sodio (100 lt/ha)** |
| Water Vapor STEAM BOILER 90°C |
| **-30 minutes** |
| **-45 minutes** |
| **-60 minutes** |

## FINDINGS

1-Metham Sodium (1,000 lt./Ha) was effective for weeds control. It had no effect on soil fungi.

2- Three different time lapses vapor applications were utilized: 30 minutes, 45 minutes, 60 minutes with a median temperature of 90° centigrade. Similar results were obtained for weeds control and phytophtora. Benefits were also obtained in stem structure, high and resilience.

3-Water vapor seems to be a good alternative even doe diesel combustion necessary for its production.

4-Cost benefit. The initial investment constitutes the main constraint for water vapor utilization. Especially with products fluctuating prices. The steam boiler is mounted on a truck structure which possibilities a more flexible use in different sites and crops. ICTA could provide with this service.

## INTRODUCTION

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Ozone destruction occurs when MeBr reaches the atmosphere then the solar radiation liberates a bromide atom breaking the link between the bromine atom and the methyl radical. Bromide atom is unstable an causes a large impact in destroying ozone molecules.

## JUSTIFICATION

Each year in the nor-oriental region of Guatemala (zacapa la fragua) 5,000 melon Hectares are cultivated 3 crop cycles can be obtained in this period. The fields are covered with plastic film (silver-black), mulch preventing weeds development and humidity preservation, to optimize agro chemicals utilization and pest infestation.

The plastic coverage is applied with a special machine, which simultaneously injects methyl Bromide into the soil. The plastic coverage prevents the gas from escaping into the air. More than 900 hundred tons of methyl bromide were applied in 1998. A few of agro industries are aware of the problems related to the use of methyl bromide and the regulations envisaged.

For its economic value and the large area under this single crop, the search for alternatives to the use of methyl bromide becomes of outmost importance. The association of new products and best agricultural practices can help to develop a more sustainable approach that benefits investors, workers and the environment in this area and beyond.

| ALTERNATIVES TRIAL |
|---|
| *- Methyl Bromide half dose (125 kg/ha) |
| *- Metham sodium 200 lts/ha + solarization |
| *- Metham sodium300 lts/ha + solarization/4 weeks |
| *- Biofumigation (4500 kg/ha chicken manure + solarization/4 weeks) |
| *-Basamid 400 kg/ha |

## FINDINGS

1-Weeds control was obtained with the applied alternative trials. This effect was obtained with the plastic transparent film, the solarization process and the white painting of the film, preventing solar radiation into the soil affecting in such way weeds proliferation.

2- Nematodes counts were significantly reduced to non-economic impairment levels with the use of Metham Sodium + solarization (4 weeks and the two applied doses) and biofumigation with chicken manure (4500 kg/ha) + solarization (4 weeks).

3-Crop yield. Trials utilizing Metham Sodium + solarizado are statistically the same as the yields obtained with methyl bromide.

4- In economic terms and as a reduction strategy the utilization of half a dose of methyl bromide (125 kg/ha) shows the highest net benefit in melon crop. The best economic option for MeBr substitution was the treatment with Metham Sodio + solarization (4 weeks) this could improve if when MS prices are lower. Biofumigation with chicken manure + solarization could also be cost effective.

## INTRODUCTION

The Montreal Protocol is an International Treaty established to regulate substances that contribute to destroy of the ozone layer. Clorofluorocarbons are widely used substances in the refrigeration and air conditioning sector. In the past 10 years alternative products have been developed and are already being used by the industry and in house holds. Methyl Bromide is widely used in agriculture and produces severe damage to the ozone layer. This fumigant has been used commercially for more that 40 years to control pests such as fungi, bacteria, and soil borne viruses, insects, mites, nematodes and rodents. It destroys an ample expectrum of organisms, some of which are not harmful to the soil. Its application is relatively simple; it penetrates soil easily and is quickly eliminated. It has a high toxicity, reduces soil biodiversity and could contaminate underwater reservoirs.

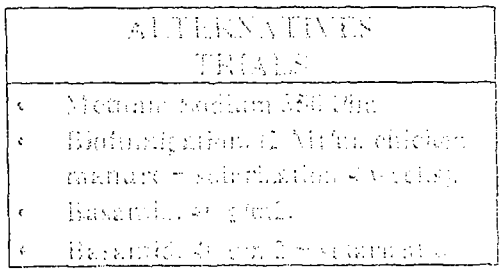
Ozone destruction occurs when MeBr reaches the atmosphere then the solar radiation liberates a bromide atom breaking the link between the bromine atom and the methyl radical. Bromide atom is unstable and causes a large impact in destroying ozone molecules.

## JUSTIFICACION

In Guatemala, Methyl bromide has been used for tobacco production ever since its appearance in the national market. Although several reports indicate that it's main use is for seedbeds preparation.

Methyl bromide is not being used for open field's application. Individual farmers, which are contracted by the large tobacco companies, prepare their own seedbeds. In many of the consultations with farmers they state that Methyl Bromide is a non-substituible product with in their productive system. Large tobacco companies provide with technical assistance to the farmers.

With the perspective of a future elimination of methyl bromide from the market and its widly use in its agronomy this product was selected for the trials research for methyl bromide alternatives.




## FINDINGS

1- The most effective combination for weeds control was Metham Sodium 350 lts /ha + solarization as a potential alternative to substitute the Methyl Bromide a good control was evident for ciperaceas, gramineae, and wide leaf weed.

2- As a chemical alternative Basamid showed a devastating effect over nematodes populations; similar results were obtained when combined with solarization (4 weeks)

3- Healthy plants were obtained from the alternative trials (Metham sodium + solarization, biofumigation, and Basamid + solarization) for transplant (healthy, vital, size, shape).

4- Treatments with Metham Sodium, alone or combined with solarization, biofumigatión or Basamid + solarization; showed the best economic feasibility as compared to the use of Methyl bromide an a capacity for its substitution.

## INTRODUCTION

The Montreal Protocol is an International Treaty established to regulate substances that contribute to destroy of the ozone layer. Clorofluorocarbons are widely used substances in the refrigeration and air conditioning sector. In the past 10 years alternative products have been developed and are already being used by the industry and in house holds. Methyl Bromide is widely used in agriculture and produces severe damage to the ozone layer. This fumigant has been used commercially for more that 40 years to control pests such as fungi, bacteria, and soil borne viruses, insects, mites, nematodes and rodents. It destroys an ample expectrum of organisms, some of which are not harmful to the soil. Its application is relatively simple; it penetrates soil easily and is quickly eliminated. It has a high toxicity, reduces soil biodiversity and could contaminate underwater reservoirs.

Ozone destruction occurs when MeBr reaches the atmosphere then the solar radiation liberates a bromide atom breaking the link between the bromine atom and the methyl radical. Bromide atom is unstable and causes a large impact in destroying ozone molecules.

## JUSTIFICATION

Tomato production is a highly appreciated crop. It is part of the daily diet and large quantities are exported to the neighboring countries. Large tomato plantations occur in the nor eastern part of the country, the highlands region and cost low lands. Methyl Bromide is utilized for seedbeds and in resent years in field applications. Results have been promising in terms of increasing yields and economic benefits. This could led to and increase in the use of methyl bromide.

Taking into account this situation tomato is one of the crops that needs to be evaluated in terms of methyl bromide alternatives This crop is produced in many climates. Findings in this brochure correspond to the nor orient region of Zacapa, Rio Hondo hot climate. Research was also conducted in the west highlands tempered climate.

| ALTERNATIVES TRIALS |
| --- |
| • **Metham Sodium 350 lts/ha** |
| • **Metham Sodium (350 lts/ha + solarizado)** |
| • **Biofumigation, (4545 kg chicken manure + solarization).** |
| • **Basamid, 400 kg/ha.** |

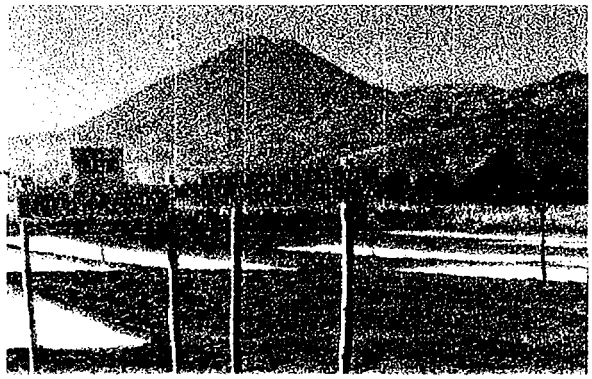
## FINDINGS

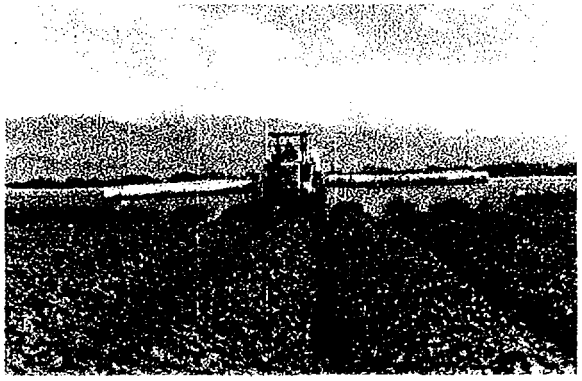
1- The Polyethylene film (silver-black) showed effective weeds control in each one of the alternatives utilized. The same situation was obtained in the solarization areas with clear plastic film. After the disinfecting effect was obtained, a white paint coat was applied as mulch. The durability of the clear film was very short allowing the penetration of solar radiation and the increase of weeds.

2- The greatest nematodes control was obtained in the biofumigated areas with chicken manure + solarization. The combination with Methan Sodium and solarization demonstrated a good control over nematode populations. Basamid as a chemical alternative was effective but its cost constitutes a limitant for its extended use.

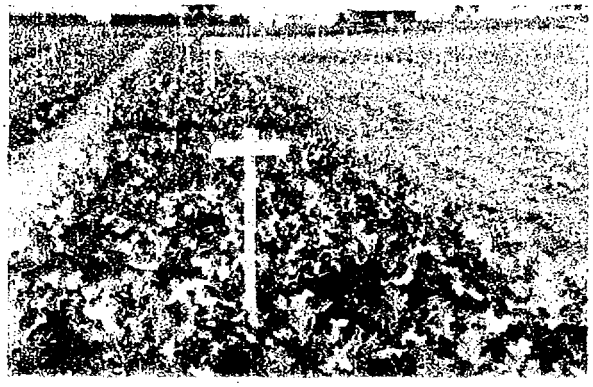
3- Crop yields obtained with Metham Sodium alone and in association to solarization showed similar yields as Methyl Bromide. This is a high alternative for the substitution of Be Mr.

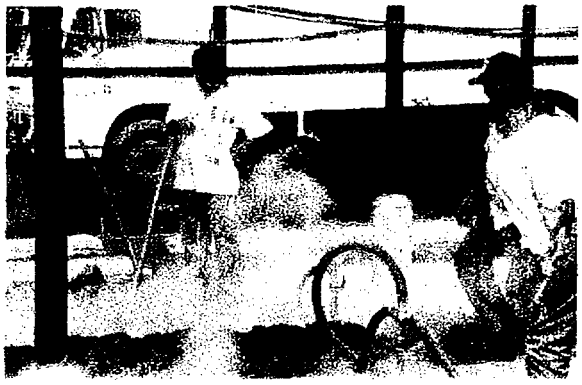
4- The best economic option with a high potential for Me Br substitution is the combination with Metham Sodium + solarization. Biofumigation has to be considered, as an option for Me Br substitution is this crop.





TOMATO RESEARCH, LA ALAMEDA CHIMALTENANGO · MELON CROPS, PROTISA, ZACAPA





BROCCOLI TRIALS, AGRIPLAN, CHIMALTENANGO · CUT FLOWERS STEAM TRIALS, PAMPUTOK, PASTORES, CHIMALTENAGO

# DEMONSTRATION PROJECT ON ALTERNATIVES TO THE USE OF METHYL BROMIDE IN SOIL FUMIGATION GUA/97/128

ICTA

UNIDO

IPM CRSP

CONCYT

CONAMA

TRIALS DESCRIPTION :
HIGH LANDS AREA TOMATO & CABBAGE SEEDLINGS
SITE : " ICTA LA ALAMEDA , CHIMALTENNAGO"

A) Rational : Small and medium size farms in the high lands area use MeBr for soil treatment to produce there own tomatoes, cabbage cauliflower and pepper seedlings. It has been agreed with ICTA to perform the trials as a demonstration and then to transfer this technology and experience to the small farmers in this area.

B) Objectives :
1 To comply with Montreal Protocol regarding the use of Me Br.
2 To scientifically evaluate the use of alternative treatments to the use of Me Br.
3 To determine costs for each of the alternative treatments.

C) Experimental Design : At "La Alameda" ICTA's experimental site, five different treatments were applied for tomato and cabbage seedlings. A random blocks design was applied with 5 treatments and 3 replications. Each experimental unit was 1 meter width and 5 meters long. Each experimental block covered 150 square meters for each crop. Total experimental area 300 sqmts. Experiments started April 2 and were completed in November 15, 1998.

D) Treatments: the following treatments were applied:

1. Steam soil with a metal tray (2m x .90m)
2. Solarization (six weeks) plastic film 000125 of an inch.
3. Metham sodium 100 cc sq mtr. + water 1,000 lts /Ha.
4. Methyl Bromide 45 gms sq. Mtr. (450 Kg/Ha).
5. Absolute witness.

E) Agronomic management. Soil was prepared with plow and rake seed bed were 5 meters long and 1 meter width. Treatments were applied according to pre established methodology. Each week low chemicals dose were applied to control fungi and pests.

FINDINGS : results and comments are summarized for CABBAGE and TOMATO SEEDLINGS respectively.

*Table* 1 Cabbage seedlings, site ICTA la Alameda Chimaltenango dec 1998 – june 99

| Alternatives | Germination % | Weeds/m2 Week 2 | Leaves length 4week | Leaves width 4 week | Plants high 4 weeks |
|---|---|---|---|---|---|
| Vapor | 82 % | 12 | 10.54 A | 7.58 AB | 26.28 A |
| Solarization six weeks | 84 % | 321 | 10.98 A | 8.08 A | 23.72 A |
| Metham Sodium | 79 % | 0 | 10.53 A | 7.63 AB | 25.18 A |
| Methyl bromide | 86 % | 1 | 9.51 AB | 6.79 AB | 24.24 A |
| Absolute witness | 74 % | 750 | 8.20 B | 5.97 B | 20.73 A |

CABBAGE SEEDLINGS COMMENTS:

1. Germination. Measured as the number of germinated plantules. Variance analysis showed statistical difference, for such reason Tukey Median statistical analysis was performed. Alternative treatments with water steam (hand made tray), solarization and Metham Sodium showed no statistical difference. All treatments demonstrated superior results than the absolute witness. Steam , solarization and metham sodium were statistically the same as methyl bromide.

- Medians Test (Tukey) for germinated plants based on 65 seed per row. Germination percentage based on seven consecutive readings. No signiffícative difference at 5 % probability.

2. Weeds population: two weed counts were taken. There was statistical means difference (Tukey variance analysis) between the applied treatments. Steam, Metham Sodium and Methyl Bromide were statistically the same. Weeds counts was insignificant and did not affect the plantules. In the solarization treatment weeds had to be removed in the third week to prevent interference with cabbage plantules. In the absolute witness trial, the great amount of weeds interfered with cabbage plantules. Weeds had to be removed in the 3rd week. Data transformed to the square root of x + 1 Sampling area 0.25 x 0.25 = 0.0625 m2

3. PLANTS GROWTH: Plants development was measured in terms of leaves length, width, plant high, in centimeters during a period of four weeks.

   3.1 Leaves length was the same for each one of the treatments. No statistical difference was shown except for the absolute witness. Steam, solarization and metham sodium were the same as Me. Br .

   At 5% of probability equal letters have no statistical difference

   3.2 Leaves width showed no statistical difference for the different treatments, except for the absolute witness. Steam, solarization and metham sodium were the same as methyl bromide.

   3.3 Plants high. For the first three weeks all treatments showed no statistical difference as compared to methyl Bromide and all surpassed the absolute witness. In the 4th week all treatments were statistically the same. Alternative treatments produced plantules of good quality, vigorous and well developed. No phytotoxicity was present.

FINDINGS : results and comments are summarised for CABBAGE and TOMATO SEEDLINGS respectively.

Table 2. TOMATO seedlings, site ICTA Alameda Chimaltenango dec 1998 – june 99

| Alternatives | Germination % | Weeds/ m2 Week 2 | Leaves length 4week | Leaves width 4 weeks | Plants high Week 4 |
|---|---|---|---|---|---|
| Vapor | 86 % | 28 | 4.08 A | 3.31 AB | 24.37 A |
| Solarization six weeks | 84 % | 449 | 4.21 A | 2.46 AB | 24.13 A |
| Metham Sodium | 93 % | 0 | 4.30 A | 3.13 A | 33.20 A |
| Methyl bromide | 83 % | 9 | 4.47 A | 2.60 AB | 24.11 A |
| Absolute witness | 87 % | 717 | 3.67 A | 1.98 B | 18.70 A |

TOMATO SEEDLINGS COMMENTS:

4 Germination. Measured as the number of germinated plantules. Variance analysis showed no statistical difference for such reason Tukey Median statistical analysis was performed. Alternative treatments with water steam (hand made tray), solarization and Metham Sodium showed no statistical difference. All treatments demonstrated superior results than the absolute witness. Steam, solarization and metham sodium were the same as methyl bromide. At 5% of probability equal letters have no statistical difference
Medians Test (Tukey) for germinated plants based on 65 seed per row. Germination percentage based on seven consecutive readings.

5 Weeds population: two weed counts were taken. There was statistical means difference (Tukey variance analysis) between the applied treatments. Steam , Metham Sodium and Methyl Bromide were statistically the same. Weeds counts was insignificant and did not affect the plantules. In the solarization treatment weeds had to be removed in the third week to prevent interference with cabbage plantules. In the absolute witness trial, the great amount of weeds interfered with cabbage plantules. Weeds had to be removed in the 3rd week. Alternative methods demonstrated comparable results for weeds control.Data transformed to the square root of x + 1 Sampling area 0.25 x 0.25 = 0.0625 m2

6 PLANTS GROWTH: Plants development was measured in terms of leaves length, width, plant hight, in centimeters during a period of four weeks.

6.1 Leaves length was the same for each one of the treatments. No statistical difference was shown except for the absolute witness. Steam , solarization and metham sodium were the same as Me. Br .

6.2 Leaves width showed no statistical difference for the different treatments, except for the absolute witness. Vapor, solarization and metham sodium were statistically the same as methyl bromide.

6.3 Plants high. For the first three weeks all treatments showed no statistical difference as compared to methyl Bromide and all surpassed the absolute witness. In the 4th week all treatments were statistically the same. Alternative treatments produced plantules of good quality, vigorous and well developed. No phytotoxicity was present. In the two first weeks a few plants grown on handcraft water steam plot showed some trace elements deficiency, after this period they recovered.

7. NEMATODES FINDINGS. In line with trials protocols, soil samples were take to AGRILAB before treatments application, after treatments application and after transplant.

Table 3. Cabbage and Tomato Seedlings. INICIAL SOIL SAMPLE NEMATODES COUNT per 100 ml of soil. centrifuged screening. AGRILAB

| Nematodes type | Meloidogyne | | cricone mella | helicotylenchus | aphelenchus | Rabditis | Tylenchus |
|---|---|---|---|---|---|---|---|
| # / 100 ml | Eggs 0 | Larvae 0 | 60 | 20 | -- | -- | -- |

Table 3A cabbage and tomato seedlings. Nematodes Count. Post treatments samples

| Treatment | Meloidogyne | | Criconemella | Helicotylenchus | Aphelenchus | Rabditis | Tylenchus |
|---|---|---|---|---|---|---|---|
| Vapor | 0 | 0 | 0 | 0 | 20 | 60 | 0 |
| Solarization six weeks | 0 | 0 | 20 | 0 | 0 | 60 | 0 |
| Metham Sodium | 0 | 40 | 60 | 0 | 0 | 0 | 0 |
| Methil bromide | 0 | 0 | 0 | 40 | 0 | 60 | 0 |
| Absolute witness | 0 | 0 | 60 | 40 | 0 | 0 | 0 |

Table 3B. cabbage seedlings. Nematodes Count. Final Sampling 30 days after planting.

| Treatment | Meloidogyne | | Criconemella | Helicotylenchus | aphelenchus | Rabditis | Tylenchus |
|---|---|---|---|---|---|---|---|
| Vapor | 0 | 0 | 0 | 0 | 0 | 160 | 0 |
| Solarization six weeks | 0 | 0 | 0 | 0 | 0 | 120 | 0 |
| Metham Sodium | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Methil bromide | 0 | 0 | 0 | 0 | 10 | 130 | 0 |
| Absolute witness | 0 | 0 | 30 | 0 | 30 | 110 | 30 |

Table 3C. tomato seedlings. Nematodes Count. Final Sampling 30 days after planting.

| Treatment | Meloidogyne | | Criconemella | Helicotylenchus | Aphelenchus | Rabditis | Tylenchus |
|---|---|---|---|---|---|---|---|
| Vapor | 0 | 0 | 0 | 10 | 0 | 150 | 0 |
| Solarization six weeks | 0 | 20 | 10 | 0 | 0 | 40 | 0 |
| Metham Sodium | 0 | 0 | 0 | 10 | 0 | 30 | 0 |
| Methil bromide | 0 | 0 | 0 | 0 | 10 | 170 | 10 |
| Absolute witness | 0 | 0 | 10 | 30 | 60 | 70 | 0 |

Nematodes sample interpretation. AGRILAB laboratory chief stated that only Meloidogyne could affect tomato or cabbage plants. Helicotylenchus is and endo and ectoparacite Criconemella is also an ecto parasite that cuases no damage to tomato crops. Thylenchus and Aphylenchus are week parasites with no economic significance for tomato and cabbage crops. Rhabditis is a non parasitic nematode commonly found in soil and organic mater. ( Rodriguez Cabana 1996).

Hand craft Vapor and Me Br treatments kept nematodes counts to their minimal expression, Week non pathogenic parasites ( tylenchus, Aphelenchus and Rhabditis) populations showed some presence. This could be the case for colonizing empty biological space that some of the treatments might create ( Rodriguez Cabana 1996).

Metham Sodium and solarization treatments seems to preserve Meloidogyne larvae, this nematode causes damage to cabbage and tomato crops. The absolute witness showed the largest amounts of nematodes of different types. It is quite important to notice how the nematodes count varies in each sample from the witness plots, even doe no treatments were applied.

8. Treatments costs. for each treatment costs were calculated for a 5 square meters seedlings bed.

| Treatment | direct cost cabbage | Indirect cost Cabbage | Total cost Cabbage | Direct cost Tomato | Indirect costTomato | total cost Tomato |
|---|---|---|---|---|---|---|
| Vapor | 120.37 | 8.42 | 128.78 | 125.45 | 8.78 | 134.24 |
| Solarization | 112.47 | 12.39 | 124.80 | 119.83 | 8.38 | 128.22 |
| Metham sodium | 105.06 | 7.35 | 112.42 | 115.67 | 8.19 | 123.87 |
| Methil bromide | 111.58 | 7.81 | 119.39 | 122.18 | 8.55 | 130.73 |
| Absolute witness | 104.01 | 7.28 | 111.29 | 114.52 | 8.01 | 122.54 |

Cost in US$ ( 1 us$ = 6.60 1998)

The absolute witness reports the lowest costs and compares to the traditional seedling beds prepared by local farmers, it bears the highest risk for being affected by plants diseases and weeds proliferation. Water steam and solarization cost represent an increase of us$ 9. 39 and us$ 5.41 respectively ( 7.86 % and 4.53 %). Metham sodioum shows lowest costs compared to MeBr us$ 6.97; Metham Sodium shows the lowest costs, and handcraft vapor treatment is the most expensive.

9. FINDINGS AND COMMENTS FOR CABAGGE AND TOMATO SEED BEDS :

1. All treatments showed no difference in the germination rate (%). Phytotoxicity was not present in any of the cabbage seedlings.
2. Steam water treatment showed trace elements nutritional deficiency in the first two weeks for the tomato seedlings.
3. Metham sodium and Methyl Bromide showed good results for weeds control. Solarization treatment ( 6 weeks) showed half the count of the witness plot with a low performance.
4. Plant development as compared to the absolute witness shows no difference to any of the applied treatments. Steam , metham sodium, methyl bromide, solarization.
5. Metham sodium treatments and solarization were less effective than the other treatments for nematodes control . Steam and MeBr had the strongest effect on nematodes count.
6. The use of metham sodium is less expensive than methyl bromide with less environmental impact. Solarization is a non chemical alternative at a higher cost. Steam water costs are higher than any treatment. Inicial costs could come lower as this procedure continues to be used.

10. CONCLUSSIONS FOR TOMATO AND CABBAGE SEED BEDS:

1. Metham Sodium can be used as a chemical alternative to the application of Me Br.

2. As a non chemical alternative to the use of Me Br solarization for 6 weeks is a good choice.

3. Hand craft water steam treatment as an alternative is available although it shows higher costs.

4. The production of healthy seed beds is possible without using Methyl Bromide.

LA ALAMEDA ICTA CHIMALTENAGO
TOMATO PRODUCTION PHASE I

TRIALS DESCRIPTION :

A) Rational : Small and medium size farms in the high lands area use MeBr for soil treatment to produce there own tomatoes. Lately they have complaints of nematodes presence affecting their tomato crops. Tomato production is a highly appreciated crop, it is part of the daily diet and the demand is permanent in the highlands region. It has been agreed with ICTA to perform the trials as a demonstration effort and then to transfer this technology and experience to the small farmers in this area.

B) Objectives :

1 To comply with Montreal Protocol regarding the use of Me Br.
2 To scientifically evaluate the use of alternative treatments to the use of Me Br.
3 To establish treatments effectiveness for nematodes control (melondogyne sp)
4 To determine costs for each of the alternative treatments.

C) Experimental Design : the experiment were conducted at La Alameda research site from January 15 to July 20th 1999. Experimental design , six different treatments were applied. A random blocks design was applied with 6 treatments and 4 replications. Each experimental unit was 2 meters width and 15 meters long. Each experimental block covered 250 square meters for each crop. Total experimental area 1,250 sq. mts.

D) Treatments: the following treatments were applied:
For seed beds:

1 Peat moss seedling with wooden frame and plastic film bottom.
2 Steamed Soil seed bed with wood frame and plastic film bottom.
3 Peat moss seedling in plastic tray.
4 Steamed Peat moss seedling in plastic tray
5 Soil bed seedling (witness)

Open field soil treatment:

1. Absolute witness
2. Methyl Bromide (54.4 gr/sq. Mt )
3. Solarization six week 1.25 " / mil.
4. Solarization six week + metham sodium (1,000 lts /Ha)
5. Solarization six weeks + chicken manure ( 5kg 7sq. Mts ) = Biofumigation
6. Metham sodium 1000 lts / Ha)

E) Agronomic management. Soil was prepared with plow and rake seed bed were 5 meters long and 1 meter width. Treatments were applied according to pre established methodology. Each week low chemicals dose were applied to control fungi and pests.

F) Findings : results and comments are summarized for TOMATO SEEDLINGS and open field transplant and growth.

G) AGRONOMIC MANAGEMENT. Soil was plowed once and raked twice. Soil beds were 2.5 mts with and 15 mts long. Low Chemicals treatment were applied weekly, biological products were utilised such as B. Turigiensis, VARS, Kurstaki and Aisawai for lepidopterae control. Low residual effect and toxicity products were applied to control white fly (bemisciae tabaci, aleirodidos and folear fungi, phytoftora infestans and alternaria solany). Flowed irrigation was utilised.

F) TABLE 1 FINDINGS AND RESULTS

| Alternatives | Weeds count 30DATsq mt | Plant high 65 dat | Folicles # 55 dat | Plants weigth in grs | Crops yield tons/Ha |
|---|---|---|---|---|---|
| Absolute witness | 978 A * | 49.04 D | 13.55 C | 220 C | 23.69 C |
| Methyl bromyde | 9 D | 59.48 BC | 14.05 BC | 372 BC | 37.43 BC |
| Solarization(6weeks | 449 B | 55.42 C | 14.00 BC | 383 B | 32.69 BC |
| Solarization+metha m sodium | 11 D | 62.05 B | 14.65 B | 353 BC | 40.91 B |
| Biofumigation | 455 B | 77.21 A | 15.50 A | 699 A | 59.83 A |
| Metham sodium | 136 C | 54.83 C | 13.65 C | 346 BC | 33.12 BC |

1. Weeds count. Two counts were performed at 15 and 30 days after seed beds transplant. Variance analysis showed significant statistical difference. Duncan test were applied. 15 days after transplant treatments solarization + metham sodium, metham sodium with out solarization and methyl bromide are statistically the same. Weeds count was not relevant. Biofumigation treatments and solarization are statistically the same some weed were present 373 and 376 per sq. mtr. Compared to the absolute witness (898 weed s.m.) an acceptable control level was appreciated. The observed type of weed are portulaca oleracea and ciperus sp. 30 days after transplant a similar situation was present for all treatments, except for |metham sodium with more than the double weeds count. Solarization (six weeks) and biofumigation are statistically the same with a high weeds count (449 and 445 per sq. mtr.) no gramineae and wide leave weed were found.

The absolute witness showed a high weeds count. (978 sq. mtr.) which were removed not to interfere with plant's production. These weeds also host bemicia tabaci that strongly affect tomato crops. (*) At 5% of probability equal letters have no statistical difference

2. PLANTS GROWTH: Plants development was measured in terms of leaves length, width, plant high, in centimeters at 25, 45 and 65 days after transplant. Plant Follicles were counted for each plant at two different dates. Plant weight was assessed at crop cut, green and dry

2.1 Leaves HIGH ACCORDING TO SOIL TREATMENT. the Data was collected at 25,45, 65 days after transplant and after harvest time. Biofumigation treatment showed the highest plant growth, solarization treatment (six weeks) and metham sodium + solarization were superior than methyl bromide. Me Br was

statistically the same as metham sodium, absolute witness showed the lowest plant high. At 5% of probability equal letters have no statistical difference

3. Follicles count per plant tomato soil treatment 25 and 50 days after transplant

Data was collected at 25 and 55 days after transplant. Biofumigation treatments showed the highest follicles count, with statistical significance. 25 DAT 6.5 follicles were found, 55 DAT 15.5 follicles were count. Solarization six weeks, solarization + metham sodium were statistically the same as methyl bromide. Metham sodium and total witness showed the lowest count ( 4.65 25 DAT and 13.55 55 DAT). At 5% of probability equal letters have no statistical difference

4. PLANT WEIGHT AT HARVEST TIME

ANDEVA statistical analysis showed a high statistical difference among treatments, Duncan Median test indicates that plants from biofumigation had the highest weight in grams 699 grms, solarization treatments for six weeks 383 grms, Metham sodium + solarization six weeks 353 grms, and metham sodium 346 grms, statistically were the same as methyl bromide 372 grms. The absolute witness plant weight was 220 grms. At 5% of probability equal letters have no statistical difference

5. TOMATO CROP YIELD TNS /Ha soil treatment.

Duncan test analysis established the best yield was obtained with biofumigation 59.83 tn/Ha, solarization six weeks 32.69 tn/Ha, Metham sodium + solarization six weeks 40.91 tn/Ha and metham sodium 33.12 th /Ha, statistically were the same as Methyl Bromide with 47.33 tn/ Ha. The absolute witness with 23.69 tm/Ha.

6. NEMATODES FINDINGS. In line with trials protocols, soil samples were taken before treatments, after treatments application and after harvest time. AGRILAB chief laboratory analyst stated that only meloidogyne could cause damage to tomato crop. Tylenchus and Apelenchus are weak parasites with no economic impact on this crop. Rabhditis is a non parasite nematode it is found in organic matter rich soils. Rabhditis high counts demonstrated the non exploited soils showed great biodiversity

The absolute witness and metham sodium showed some melondogyne population after tretment, never the less in the final sample they have disappeared. Weak nematodes (tylenchus y aphelenchus) appeared in the post treatment samples, colonized the biologic space.

Table 3. NEMATODES SAMPLE ANALYSIS. TOMATO OPEN FIELDS
INICIAL SOIL SAMPLE NEMATODES COUNT per 100 ml of soil. centrifuged screening. AGRILAB

| Nematodes type | Meloidogyne | | Aphelenchus | Helicotylenchus | Rabhditis | Criconemella | Rothylenchulus |
|---|---|---|---|---|---|---|---|
| # per 100 ml | Eggs 0 | Larvae 0 | 10 | -0- | 50 | --- | -- |

Table. 3A Nematodes Count. TOMATO OPEN FIELDS Post treatments samples

| Treatment | Meloidogyne | | Aphelenchus | helycotylenchus | Radhditis | Criconemella | Rothylenchulus |
|---|---|---|---|---|---|---|---|
| Absolute Witness | 0 | 0 | 0 | 10 | 70 | -- | -- |
| Methyl Bromide | 0 | 0 | 0 | 0 | 10 | -- | -- |
| Solarization 6wks | 0 | 0 | 0 | 0 | 70 | -- | -- |
| Solarization + MS | 0 | 0 | 0 | 0 | 10 | -- | -- |
| Biofumigation | 0 | 0 | 20 | 0 | 170 | -- | -- |
| Metham Sodium | 0 | 0 | 0 | 0 | 0 | -- | -- |

Table. 3B Nematodes Count. TOMATO OPEN FIELDS final sample harvest time

| Treatment | Meloidogyne | | Aphelenchus | helycotylenchus | Radhditis | Criconemella | Rothylenchulus |
|---|---|---|---|---|---|---|---|
| Absolute Witness | 0 | 10 | 40 | 0 | 260 | 20 | -0- |
| Methyl Bromide | 0 | 0 | 20 | 0 | 230 | -0- | -0- |
| Solarization 6wks | 0 | 0 | 20 | 0 | 230 | -0- | -0- |
| Solarization + MS | 0 | 0 | 0 | 0 | 200 | -0- | -0- |
| Biofumigation | 0 | 0 | 10 | 200 | 350 | -0- | 20 |
| Metham Sodium | 0 | 0 | 20 | 0 | 270 | -0- | -0- |

* NEMATODES COUNT IN 100 ML SOIL

AFFECTED PLANTS WITH NEMATODE NODULES. Duncan means test demonstrated the absolute witness showed the highest incidence with this pathology (97 % incidence), roots had an average of 50 nodules in each root. Solarization treatment had a 53 % incidence and 4 nodules in each root. Biofumigation treatment showed 30 5 incidence and 9 nodules per root. When this data is compared to crop yield was not affected since this treatment showed the best yields. METHAM SODIUM + WITH AND with out solarization had an incidence of 16 and 27 % incidence with 2 to 4 nodules per plant with no effect over production. Methyl Bromide treatments showed the lower incidence with 1 % incidence and 0.5 nodules per plant

TABLE 4. DUNCAN TEST. nematodes (melondogyne) nodules per plant tomato soil treatment.

| SOIL TREATMENT | NODULES / PLANT | INCIDENCE % |
|---|---|---|
| Absolute witness | 50 A | 97 A |
| Methyl bromide | 0.5 E | 1 D |
| Solarization six weeks | 4 C | 53 B |
| Solarization + metham sodium | 2 D | 16 C |
| Biofumigation metham soduim | 9 B | 30 C |
| Metham sodium | 4 C | 27 C |

7. Treatments costs. Tomato open field. Solarization treatments generated a Marginal rate of return 272 % , Biofumigation treatments MRT 142 % , Solarization + metham sodium 36 % . Any of this alternatives can provide for methyl bromide alternatives.

TABLE 5: total costs for tomato open field one hectare, us$ dollars ( one us $ = local currency 7.25) ICTA La Alameda. 1999.

| | TREATMENTS | | | | | |
|---|---|---|---|---|---|---|
| CONCEPT | Witness (1) | BM (2) | Solarizado (3) | Sol + MS (4) | Biof. (5) | Metam (6) |
| Crop yield (Ton/ha ) | 23.69 | 37.43 | 32.69 | 40.91 | 59.83 | 33.12 |
| Gross income (us $ 165.50Tm) | 3,920 | 6,195 | 5,410 | 6,771 | 9,900 | 5,480 |
| Bromuro de Metilo | - | 2,340 | ---- | ---- | ----- | ---- |
| CHICKEN MANURE | - | - | ---- | ---- | 1,886 | 2,206 |
| Metham Sodio | - | - | ---- | 2,206 | ----- | ---- |
| Plastic film | - | 183 | 362 | 362 | 362 | --- |
| Treatment aplication | - | 86 | 86 | 86 | 86 | 44 |
| Weed cut | 137 | - | 89 | ------ | 86 | 34 |
| Total variable costs | 137 | 2,609 | 537 | 2,655 | 2,421 | 2,286 |
| Net benefit | 3,783 | 3,586 | 4,872 | 4,116 | 7,481 | 3,195 |

Alternative Treatment Total costs and rentability . Tomato open fields.

| Treatments | Total production cost / Ha | % Rentability |
|---|---|---|
| ABSOLUTE WITNESS | 1,218.46 | 77 |
| METHYL BROMYDE | 2,816.15 | 0 |
| SOLARIZATION (6 WEEKS) | 1.738.46 | 35 |
| SOLARIZATION+METHAM SODIUM | 2,892.30 | 7 |
| BIOFUMIGATION | 3,160.10 | 0 |
| METHAM SODIUM | 2,738.46 | 0 |

For each treatment costs were calculated per hectare includes direct and indirect costs. Total witness cost (us$ 1,218.46 ) with a 77 % rentability is similar to a standard farmer using MIP. Higher costs are relevant for Mehtyl Bromide, Metham Sodium + solarization, biofumigation and metham sodium ( 2,816.15 to 2,892.30) with a 35 % rentability. This figures demonstrate that the economic equation is not favorable for the farmer.

FINDINGS AND RESULTS. TOMATO FASE I

1. WEEDS CONTROL IS MORE EFFECTIVE WITH METHAM SODIUM AND SOLARIZATION + METHAM SODIUM SHOWED THE BEST RESULTS AND IS SIMILAR TO METHYL BROMIDE. Biofumigation and solarization six weeks are statistically the same. All performed better than the witness.

2. BIOFUMIGATION TREATMENT SHOWED SUPERIOR PERFORMANCE FOR PLANT GROWTH THAN THE OTHER TREATMENMTS. EVEN THAN METHYL BROMIDE.

3. METHAM SODIUM + SOLARIZATION, FUMIGATION AND METHAM SODIUM SHOWED A MODERATE INCIDENCE OF PLANTS NODULES 16 % TO 30 % . METHYL BROMIDE HAD THE LOWEST INCIDENCE 1 %

4. SOLARIZATION FOR SIX WEEKS SHOWED A HIGH INCIDENCE OF PLANTS WITH NODULES 53 %, ALTHOUGH THE TOTAL WITNESS HAD 97 % INCIDENCE. METHAM SODIUM + SOLARIZATION, BIOFUMIGATION, METHAM SODIUM, SOLARIZATION SIX WEEKS SHOWED HAD AN INCIDENCE OF 4 TO 9 NODULES PER PLANT. ABSOLUTE WITNESS SHOWED 50 NODULES PER PLANT. METHYL BROMIDE HAD 0.4 NODULES PER PLANT.

5. BEST CROP YIELD WAS OBTAINED WITH BIOFUMIGATION, 59.83 TONS / HA.

6. TOTAL PRODUCTION COST ARE HIGHER THAN THOSE OBTAINED FROM THE LOCAL FARMER (WITNESS TRIALS).

7. SOLARIZATION TRETMENTS PRESENT A MRT OF 272 % . Biofumigation MRT 139 % solarization + metham sodium 36 % . dominance treatments are metham sodium and MeBr .

RECOMENDATIONS:

1. TO PERFORM A SECOND CYCLE EXPERIMENTS, IN FIELD WITH NEMATODES PRESENCE. FARMERS SHOULD DECIDE ON THE ALTERNATIVE THAT BEARS THE MOST MANAGEABLE COSTS.
2. METHYL BROMIDE IS NOT NECESSARY TO BY UTILIZED IN FIELDS WITH MELONDOGYNE SP PRESENCE. ANY OF THE ALTERNATIVES COULD BE USED FOR THIS PURPOSE.

HIGH LANDS AREA
ALTERNATIVES TO THE USE OF METHYL BROMIDE
BROCCOLI EXPERIMENT PHASE I AND PHASE II SEEDLINGS AND FIELD TRANSPLANT

SITE : " AGRIPLAN EL TEJAR "

A. Experimental Site :

AGRIPLAN is an agribusiness located in the highlands of El Tejar, Chimaltenango. At present AGRIPLAN cultivates 42 Ha of broccoli and provides technical assistance to a large group of small farmers . DURATION : phase I july 1st 1998 to january 1999. Phase II: februry 3 1999 to july 30 1999

Previous experiences have shown the presence of two soil borne diseases "hernia de la col " caused by Plasmodiophora brassicae and "mal del talluelo" caused by Phythium spp, Rhizoctomia, Fusarius and Phoma, which lately has been propagating to broccoli fields.

B) Objectives :

1. to comply with Montreal Protocol regarding the use of Me Br.
2 To scientifically evaluate the use of alternative treatments to the use of Me Br.
3 To establish treatments effectivity to control *Plasmodiophora brassicae*
2. To determine costs for each of the alternative treatments.

C) Experimental Design :

This experiment includes seedlings production at la Alameda research site and the transplant to open field at AGRIPLAN location. Five alternatives were used for seedlings production with four replications, and six alternative treatments were applied in the open fields. Seedlings were obtained from artificial substrate to guarantee disease free plantules. Experimental units were 2.5 meters wide and 15 meters long for a total of 37.5 sq. mts. Each experimental block was 250 mts for a total area of 1,200 sq. mts.

SEEDLINGS:
A random split blocks design was utilised. The large plot contained 6 treatments. The small plot covered 5 different seedlings and 4 replications. Each experimental unit is 1 meter width and 5 meters long. Each experimental block covered 150 sq m

The following treatments were applied:

a) Peat Moss seedling . The soil covered with plastic film and wood laterals to prevent infestation.
b) Stemed Soil seed beds. soil covered with plastic film and wood laterals to prevent infestation.
c) Peat moss seedling prepared in tray
d) Steamed Soil seed beds in tray.
e) Seed bed on soil as traditionaly prepared no treatments applied(witness)

SEEDLINGS WERE PRODUCED AT ICTAS EXPERIMENTAL SITE.

TRANSPLAN TO AGRIPLAN OPEN FIELDS. A random blocks design was applied with 5 treatments and 3 replications. Each experimental unit was 2.50 meters width and 15 meters long. Each experimental block covered 150 square meters for a total area 37.7 square meters. Each block was 250 square meter. Total experimental area 1,200 s.m.

Soil Treatments
The following treatments were applied to transplanting sites in AGRIPLAN fields.

1. Absolute witness
2. Methyl bromide (54.4 gr/s.m)
3. Solarization 6 weeks/plastic film 1.25"/1,000
4. Solarization 6 weeks + metham sodium 1,000Lt/Ha
5. Solarization 6 weeks + chicken manure (5Kg/M2) =Biofumigation
6. Mehtam sodium 1000Lts/Ha

Five materials were selected as artificial substrates, and six alternatives for soil treatment. Four random blocks were defined (5 square meters each).

AGRONOMIC MANAGEMENT. Soil was plowed once and raked twice. Soil beds were 2.5 mts with and 15 mts long. Low Chemicals treatment were applied weekly, biological products were utilised such as B. Turigiensis, VARS, Kurstaki and Aisawai. Low residual effect and toxicity products were applied to comply with EPA regulations for export vegetable products. Sprinkle irrigation was utilised. Bed seedlings started the 20th of September and transplant was done to the open fields in AGRIPLAN on October 17th. Plant development is pertaining to 45 days after the transplant

RESULTS PRESENTATION:
BROCCOLI PHASE 1 SEEDLINGS AND FIELD TRANSPLANT AGRIPLAN EL TEJAR
Sept. 1988 July 1999
TABLE 1

| ALTERNATIVES Soil treatment | Weeds count 25DAT | Leaves length 45 DAT | Leaves width 45 DAT | plants high harvest time | inflorescence diameter | crop yield tns / ha |
|---|---|---|---|---|---|---|
| ABSOLUTE WITNESS | 484.4 A | 25.0 D | 13.14 B | 59 NS | 10.7 C | 15.13 C |
| METHYL BROMYDE | 5.97 B | 28.0 C | 14.44 A | 60 NS | 11.1 BC | 16.43 BC |
| SOLARIZATION (6 WEEKS) | 30.2 B | 29.0 BC | 14.15 A | 63 NS | 12. AB | 18.90 AB |
| SOLARIZATION+ Me Na | 4.67 B | 31.0 B | 14.55 A | 63.4 NS | 12.7 A | 20.78 A |
| BIOFUMIGATION | 24.0 B | 33.0 A | 14.67 A | 62 NS | 12.3 AB | 20.78 A |
| METHAM SODIUM | 5.3 B | 28.0 C | 14.46 A | 61 NS | 11.1 BC | 16.62 BC |

Findings and results

1 WEEDS POPULATION: two weed counts were taken at 15 and 25 days after transplant. There was no statistical means difference (Tukey variance analysis) between the applied treatments. Solarization, Biofumigation, solarization + Metham Sodium, Metham Sodium with out solarization and Methyl Bromide were statistically the same. Weeds counts was insignificant and did not affect the broccoli plantules. The absolute witness showed 697 and 484 weed count per square meter. They had to be removed to prevent interference with plant development

At 5% of probability equal letters have no statistical difference

2. PLANTS GROWTH: Plants development was measured in terms of leaves length, width, plant high, in centimeters at 20 and 45 days after transplant.

2.1 Leaves length according to soil treatment. 20 days after tramsplant showed that biofumigation and solarization+metham sodium aare statistically the same and are superior to methyl bromide. Readings after 45 days biofumigation was superior to the other treatments INCLUDING METHYL BROMIDE

2.2 Leaves width after 20 days transplant metham sodium+solarization and biofumigation were statistically the same. The other treatments were surpassed. Transplants from solarization and metham sodium were statistically the same as methyl bromide, all treatments were superior to absolute witness.

At 5% of probability equal letters have no statistical difference

2.3 Leaves width according to seedling treatment. After 20 and 45 days from transplant date. Plants from peat moss seedlings (see item B) were statistically the same and superior to seedlings produced in styro foam trays. This is due to the fact that vaporized soil once set into the niche becomes to hard preventing plants to develop . Biofumigation were statistically the same. The other treatments were surpassed. Transplants from solarization and metham sodium were statistically the same as methyl bromide, all treatments were superior to absolute witness

2.4 Plants high according to soil treatment . AGRIPLAN BROCCOLI. Measures taken 20 and 45 days after transplant. Biofumigation treatment plants were the tallest 20 DAT . Solarization and metham sodium + solarization were superior to Methyl Bromide. Metham sodium was statistically the same as methyl bromide. The absolute witness showed the least plant development. All treatments at harvest time were statistically the same.

3. INFLORESCENCE DIAMETER. This parameter was taken at harvest time. The largest diameter was shown for the solarization + metham sodium treatment.The biofumigation and solarization treatments are statistically the same. Solar radiation seems to indicate that the solarization effect with or without metham sodium provides adequate nutrients to the plant. Metham sodium treatment and methyl bromide are statistically the same and lower than the other treatments. Absolute witness shows the lowest readings. Taking into account the trials results and the agronomic conditions in Guatemala Me Br is not needed for broccoli production in the highland area.

4. CROP YIELD. This variable is recorded in pounds per hectare. Biofumigation, solarization + metham sodium showed the highest yields ( 20.84 tns/Ha and 20.78 ). Six weeks solarization produced 18.90 tns / Ha. Solarization treatments showed the best results. Metham sodium and methyl bromide are statistically the same ( 16.62 and 16.43 tns/ Ha ). All treatments are superior to absolute witness. The absolute witness shows 92 % output as compared to methyl bromide and 72.6 % out put compared to the biofumigation treatment.

PLASMODIOPHORA BRASICAE INCIDENCE :

5. Plasmodiophora brassicae incidence. In the experimental plots the disease was presented in all the cultivar. Three focci were outstanding. Sampling was done by cutting the plants after the crop. Direct roots observation was done to assess the presence of ear lobes /gallnut produced by P. Brassicae. Treatments with solarization (six weeks), solarization + metham sodium and biofumigation showed the lowest incidence of the disease with a 2.5 %; 4.8% and 7.5 % presence. The three treatments bear in common the use of the plastic film cover. This cultural practice shows a good control over the pathogen.

Methyl Bromide, Metham sodium and the absolute witness showed similar incidence percentages as: 16.4 %, 20.8 % and 20.2 % respectively. The treatments did not affect the Pathogen presence, Me Br should not be used in fields with plasmodiofora brassicae

Plasmodiphora Brassicae incidence. BROCOLI open field, density 28,000 plants/Ha

| | INCIDENCE PER HECTARE | |
|---|---|---|
| SOIL TREATMENTS | Density 28,000 plants/Ha | Percent % |
| Absolute witness | 5,656 | 20.2 |
| Methyl bromyde | 4,592 | 16.4 |
| Solarization (6 weeks) | 700 | 02.5 |
| Solarization+metham sodium | 1,344 | 04.8 |
| Biofumigation | 2,100 | 07.5 |
| Metham sodium | 5,824 | 20.8 |

6. NEMATODES FINDINGS. In line with trials protocols, soil samples were take before treatments application, after treatments application and after harvest time. AGRILAB chief laboratory analyst stated that only meloidogyne could cause damage to broccoli plantation. Tylenchus and Apelenchus are weak parasites with no economic impact on this crop. Rabhditis is a non parasite nematode it is found in organic matter rich soils.

The absolute witness and metham sodium showed some melondogyne population after tretment, never the less in the final sample they have disappeared. Weak nematodes (tylenchus y aphelenchus) appeared in the post treatment samples. Dorylemus colonized the biologic space. (Rodriguez Cabana 1997)

Table 6. BROCCOLI OPEN FIELDS INICIAL SOIL SAMPLE NEMATODES COUNT per 100 ml of soil. centrifuged screening. AGRILAB

| Nematodes type | Meloidogyne | | Aphelenchus | Tylenchus | Rabditis | Dorylimus |
|---|---|---|---|---|---|---|
| # per 100 ml | Eggs 0 | Larvae 0 | 20 | --- | 80 | -- |

Table. 6A BROCCOLI OPEN FIELDS. Nematodes Count. Post treatment samples

| Treatment | Meloidogyne | | Aphelenchus | Tylenchus | Rabditis | Dorylimus |
|---|---|---|---|---|---|---|
| Absolute Witness | 0 | 20 | 70 | 100 | 530 | 0 |
| Methyl Bromide | 0 | 0 | 10 | 10 | 310 | 0 |
| Solarization 6wks | 0 | 0 | 10 | 20 | 10 | 10 |
| Solarization + MS | 0 | 0 | 0 | 0 | 20 | 0 |
| Biofumigation | 0 | 0 | 10 | 0 | 40 | 10 |
| Metham Sodium | 0 | 20 | 0 | 30 | 370 | 0 |

Table 6B. brocoli open fieldsoil sample after crop. Nematodes Count. Final Sampling

| Treatment | Meloidogyne | | Aphelenchus | Tylenchus | Rabditis | Dorylimus |
|---|---|---|---|---|---|---|
| Absolute Witness | 0 | 0 | 0 | 190 | 50 | 0 |
| Methyl Bromide | 0 | 0 | 0 | 0 | 220 | 0 |
| Solarization 6wks | 0 | 0 | 0 | 0 | 90 | 0 |
| Solarization + MS | 0 | 0 | 30 | 0 | 110 | 0 |
| Biofumigation | 0 | 0 | 20 | 0 | 200 | 20 |
| Metham Sodium | 0 | 0 | 0 | 0 | 320 | 0 |

7. Partial costs analysis in us $ . ( one us$ to 6.50 quetzales )Brocoli open field Fase I.
ICTA UNIDO CONAMA CONCYT. Con Empresa AGRIPLAN. 1998-99.

| | TREATMENTS | | | | | |
|---|---|---|---|---|---|---|
| CONCEPT | Witness( 1) | BM (2) | Solarizat (3) | Sol + MS (4) | Biof. (5) | Metam (6) |
| Crop yield (Mt/ha ) | 15.13 | 16.43 | 18.90 | 20.78 | 20.84 | 16.62 |
| Gross income (us$ 203 ) | 3,072 | 3,336 | 4,606 | 4,219 | 4,032 | 3,422 |
| Methyl Bromide | ---- | 2,609 | ---- | ---- | ---- | ---- |
| Chicken manure | ---- | ---- | ---- | ---- | 2,604 | 3,484 |
| Metham Sodio | ---- | ---- | ---- | 3,384 | ---- | ---- |
| Plastic film | ---- | 204 | 403 | 403 | 403 | --- |
| Treatment aplication | ---- | 96 | 96 | 969 | 96 | 50 |
| Weeds cut | 153 | ---- | ---- | ---- | ---- | ---- |
| Variable cost Total | 153 | 2,910 | 500 | 3,884 | 3,103 | 3,534 |
| Net income | 2,918 | 426 | 3,337 | 335 | 929 | -112 |

Fase I ALTERNATIVE TREATMENTS with metham sodium, biofumigation and solarization are more expensive due to costs specificaly related to alternative treatment.

PHASE II
RESULTS PRESENTATION:

RESULTS PRESENTATION:
BROCCOLI PHASE II SEEDLINGS AND FIELD TRANSPLANT AGRIPLAN EL TEJAR
Sept. 1988 July 1999
*TABLE* 1

| ALTERNATIVES Soil treatment | Weeds count 35DAT | Leaves length 35 DAT | Leaves width 45 DAT | plants high harvest time | Inflorescence diameter | crop yield tns / ha |
|---|---|---|---|---|---|---|
| ABSOLUTE WITNESS | 412 A | 25.24 D | 12.90 B | 61.0 C | 12.4 B | 14.81 C |
| METHYL BROMYDE | 22 C | 28.59 BC | 14.34 A | 64.4 C | 13.3 BC | 17.99 B |
| SOLARIZATION (6 WEEKS) | 133 B | 28.90 BC | 13.63 A | 64.7 C | 13.3 AB | 18.51 B |
| SOLARIZATION+ Me Na | 19 C | 30.69 AB | 13.89 AB | 71.6 AB | 14.9 A | 22.99 A |
| BIOFUMIGATION | 51 BC | 33.34 A | 14.48 A | 77.8 A | 15.0 A | 23.38 A |
| METHAM SODIUM | 57 BC | 28.09 C | 14.25 A | 66.3 BC | 13.6 BC | 17.60 BC |

1. WEEDS POPULATION: two weed counts were taken at 15 and 35 days after transplant. Weeds count for the different treatments were statistically the same (Tukey variance analysis) Solarization 29 , Biofumigation, solarization+Metham Sodium 7, Metham Sodium with out solarization and Methyl Bromide 7 were statistically the same. Six weeks solarization showed 82 weeds per sq. mt. (Portulaca oleraceae )Weeds counts was insignificant and did not affect the broccoli plantules.

The absolute witness showed 755 and 412 weed count per square meter. They had to be removed to prevent interference with plant development

At 5% of probability equal letters have no statistical difference

2. PLANTS GROWTH: Plants development was measured in terms of leaves length, width, plant high, in centimeters at 20 and 45 days after transplant.

2.1 Leaves length according to soil treatment. 20 days after tramsplant showed that biofumigation and solarization+metham sodium aare statistically the same and are superior to methyl bromide. Readings after 45 days biofumigation was superior to the other treatments INCLUDING METHYL BROMIDE

Leaves width after 20 and 45 days after transplant metham sodium+solarization and biofumigation were statistically the same. The other treatments were surpassed. Transplants from solarization and metham sodium were statistically the same as methyl bromide, all treatments were superior to absolute witness.

2.2 Leaves width according to seedling treatment. After 20 and 45 days from transplant date. Plants from peat moss seedlings (see item B) were statistically the same and superior to seedlings produced in styro foam trays. This is due to the fact that steamed soil once set into the niche becomes too hard, preventing plants to develop . Biofumigation were statistically the same. The other treatments were surpassed. Transplants from solarization and metham sodium were statistically the same as methyl bromide, all treatments were superior to absolute witness

2.5 Plants high according to soil treatment . AGRIPLAN BROCCOLI. PHASE II Measures taken 20 and 45 days after transplant. Biofumigation treatment plants were the tallest 20 DAT . Solarization and metham sodium + solarization were superior to Methyl Bromide. Metham sodium was statistically the same as methyl bromide. The absolute witness showed the least plant development. All treatments at harvest time were statistically the same.

3 INFLORESCENCE DIAMETER. This parameter was taken at harvest time. The largest diameter was shown for the solarization + metham sodium treatment. The biofumigation and solarization treatments are statistically the same. Solar radiation seems to indicate that the solarization effect with or without metham sodium provides adequate nutrients to the plant. Metham sodium treatment and methyl bromide are statistically the same and lower than the other treatments. Absolute witness 12.4 CENTIMETRES shows the lowest readings. Taking into account the trials results and the agronomic conditions in Guatemala Me Br is not needed for broccoli production in the highland area.

4. CROP YIELD. This variable is recorded in TONS per hectare. Biofumigation, solarization + metham sodium showed the highest yields ( 23.38 tns/Ha and 22.99 TNS / Ha ). Six weeks solarization produced 18.51 tns / Ha. Solarization treatments showed the best results. Metham sodium and methyl bromide are statistically the same ( 16.62 and 17.99 tns/ Ha ). All treatments are superior to absolute witness. The absolute witness shows 92 % output as compared to methyl bromide and 72.6 % out put compared to the biofumigation treatment.

PLASMODIPHORA BRASSICAE

5. Plasmodiophora brassicae incidence. Sampling was done by cutting the plants after the crop. Direct roots observation was done to assess the presence of ear lobes /gallnut produced by P. Brassicae. Treatments with solarization (six weeks), solarization + metham sodium and biofumigation showed the lowest incidence of the disease with a 2.1 %; 0.8% and 0.4 % presence. The three treatments bear in common the use of the plastic film cover. This cultural practice shows a good control over the pathogen.
Metham sodium showed 5.1 % incidence. The absolute witness showed similar incidence as Methyl Bromide : 16.4 % and 19.4 % . Me Br shows no incidence over this pathogen.

Table 5. Plasmodiphora Brassicae percentage (%) incidence. BROCOLI open field. population density 28,000 plants / Ha.

| SOIL TREATMENTS | Percent % |
|---|---|
| Absolute witness | 16.4 |
| Methyl bromyde | 19.4 |
| Solarization (6 weeks) | 02.1 |
| Solarization+metham sodium | 0.8 |
| Biofumigation | 0.4 |
| Metham sodium | 5.1 |

6. NEMATODES FINDINGS. In line with trials protocols, soil samples were take before treatments application, after treatments application and after harvest time. AGRILAB chief laboratory analyst stated that only meloidogyne could cause damage to broccoli plantation. Tylenchus and Apelenchus are weak parasites with no economic impact on this crop. Rabhditis is a non parasite nematode it is found in organic matter rich soils.

The absolute witness and metham sodium showed some melondogyne population after tretment, never the less in the final sample they have disapeared. Weak nematodes (tylenchus y aphelenchus) appeared in the post treatment samples. Rabditys colonized the biologic space. (Rodriguez Cabana 1997)

Table 6. BROCCOLI OPEN FIELDS. PHASE II Nematodes sample analysis. INICIAL SOIL SAMPLE NEMATODES COUNT per 100 ml of soil. centrifuged screening. AGRILAB

| Nematodes type | Meloidogyne | | Aphelenchus | Tylenchus | Rabditis | Dorylimus |
|---|---|---|---|---|---|---|
| # per 100 ml | Eggs 0 | Larvae 0 | 0 | 190 | 50 | -- |

Table. 6 A. BROCCOLI OPEN FIELDS. Nematodes Count. Post treatment samples

| Treatment | Meloidogyne | | Aphelenchus | Tylenchus | Rabditis | Dorylimus |
|---|---|---|---|---|---|---|
| Absolute Witness | 0 | 10 | 90 | 0 | 250 | 0 |
| Methyl Bromide | 0 | 0 | 10 | 0 | 110 | 0 |
| Solarization 6wks | 0 | 0 | 40 | 0 | 50 | 0 |
| Solarization + MS | 0 | 0 | 10 | 0 | 80 | 0 |
| Biofumigation | 0 | 0 | 0 | 0 | 1,800 | 0 |
| Metham Sodium | 0 | 20 | 0 | 0 | 100 | 0 |

Table 6B. brocoli open fieldsoil sample after crop. Nematodes Count. Final Sampling phase II

| Treatment | Meloidogyne | | Aphelenchus | Tylenchus | Rabditis | Dorylimus |
|---|---|---|---|---|---|---|
| Absolute Witness | 0 | 0 | 0 | 150 | 250 | 0 |
| Methyl Bromide | 0 | 0 | 0 | 0 | 20 | 0 |
| Solarization 6wks | 0 | 0 | 10 | 0 | 50 | 0 |
| Solarization + MS | 0 | 0 | 0 | 0 | 30 | 0 |
| Biofumigation | 0 | 0 | 20 | 0 | 1200 | 0 |
| Metham Sodium | 0 | 0 | 0 | 0 | 220 | 0 |

8. Partial costs analysis in us $ . ( one us$ to 6.50 quetzales )Brocoli open field Fase II.
ICTA UNIDO CONAMA CONCYT. Con Empresa AGRIPLAN. 1998-99.

| | TREATMENTS | | | | | |
|---|---|---|---|---|---|---|
| CONCEPT | Witness (1 | BM (2) | Solarizat (3) | Sol + MS (4) | Biof. (5) | Metam (6) |
| Crop yield (Mt/ha ) | 14.81 | 17.99 | 18.51 | 22.94 | 23.38 | 17.68 |
| Gross income (us$ 203 ) | 3.000 | 3,653 | 3,759 | 4,668 | 4,748 | 3,588 |
| Methyl Bromide | | 3,070 | | | | |
| Chicken manure | | | | | 2,104 | 2,461 |
| Metham Sodio | | | | 2,461 | | |
| Plastic film | | 205 | 403 | 403 | 403 | |
| Treatment aplication | | 96 | 96 | | 96 | 50 |
| Weeds cut | 153 | | | | | |
| Variable cost Total | 153 | 3,371 | 499 | 2961 | 2,604 | 2,511 |
| Net income | 2,853 | 282 | 2,250 | 1,707 | 2,143 | 1,062 |

PHASE II ALTERNATIVE TREATMENTS with metham sodium, biofumigation and solarization are more expensive due to costs specifically related to alternative treatment.

8. FINDINGS PHASE I AND PHASE II :

1. Plant development was superior with the metham sodium + solarization and biofumigation treatments. Inflorescence was superior in the solarization, solarization + metham sodium and biofumigation treatment.

2. Methyl bromide, metham sodiun, solarization + metham sodium showed the best results for weeds control. Biofumigation and solarization statistically as comparable to methyl bromide.

3. Damage by plasmodiphora brassicae was less severe in the Solarization 6 weeks, metham sodium + solarization and biofumigation treatments. Solar radiation and plastic film impose control over the pathogen.

4. Best out put (yield) was obtained with biofumigation, solarization + metham sodium

5. Production cost are higher than the total witness.

6. Solarization treatment has a rentability of 35 % as compared to other treatments.

7. result from the two consecutive trials are consistent. The following statements can be addressed.

10. CONCLUSSIONS :

1. Infested fields with brassicae six week solarization is highly advised.

2. Biofumigation treatments, metham sodium (with or without solarization) and methyl bromide present higher costs.

3. Integrated Pest Management are recommended to continue to be used and to comply with EPA regulations.

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PAMPUTIK CUT FLOWERS
ALTERNATIVE TO THE USE OF METHYL BROMIDE IN CUT FLOWERS
PASTORES, SACATEPEQUES

A. Experimental Site : PAMPUTYK is a cut flowers agribusiness located in the proximity of PASTORES a village near Chimaltenango. At present PAMPUTYK cultivates 30 Ha of FLOWERS and exports to the US, EUROPE and Central America. In resent years they have diversify to different flower types. Snapdragons were chosen to conduct this trial. starting in may 15 and finishing in September 15, 1999.

B) Objectives :

1. to comply with Montreal Protocol regarding the use of Me Br.
2. To scientifically evaluate the use of alternative treatments to the use of Me Br.
3. To establish treatments effectively to control PHYTIUM sp, N. Meloydogine and weeds.
4 To determine costs for each of the alternative treatments.

C) Experimental Design :

Six treatments were applied in a randomised plots design with 4 replications. Each experimental unit measured 1m. wide and 10 m. long . Each block had 90 sq. m. for a total area of 400 sq. m. Planting distance was 15 cm. Between each row and 5 cm between each plant for a total of 75 plants per sq. m. (750 plants in each treatment). The experiments was conducted under plastic green house.

D Treatments:

1. Steam for 30 minutes at 80 cms depth.
2. Steam for 45 minutes at 80 cms depth.
3. Steam for 60 minutes at 80 cms depth.
4. Metham sodium 100cc sq. mt. (1,000 lt Ha)
5. Methyl Bromide 46.4 grs / square meter (460 Kg / Ha)
6. Methyl Bromide 23.3 grs / square meter (232 Kg / Ha)

Methodology Description : Water vapor is generated by a steam boiler (Fulton ICS-30) mounted on a flat platform over a truck. It generated 30 HP, consumes 9.5 gallons per hour for steam treating a 140 square meters area at 90° centigrade. Hoses had been adapted to easily reach the experimental site and design. The steam boiler is protected by a roofing structure to prevent from rain and weather conditions.

A valve connects the steam boiler out let to a flexible canvas tube which is connected to a 10 meters long, perforated carbon steel pipe. For steam application it is necessary to remove 30 cms of soil depth by one meter wide and ten meters long, Pipes are introduced in the bottom of the ditch and then covered with the remaining soil and a plastic heat resistant spread shit to cover the area and prevent steam from escaping into the air. The borders are covered to sealed and prevent steam release. Temperature readings were be taken at the centre and sides of the experimental plot. Soil must be removed 24 hours after steam application, to take out the steel carbon pipes. Treated soil must rest on plastic film bed.

Metham Sodium (sodium monomethyl carbamate) . This treatment has been chosen following the reported results as a chemical soil fumigant ( Layta de la Rica 1996). 1,000 lts/ Ha were applied covered with plastic film for 4 days . Methyl bromide treatment was used as a powerful fumigant with toxic characteristics. Usual dose is applied at 464 Kg- / Ha. Half dose MeBr treatments was also used to evaluate its effectiveness. Me Br is applied in a covered area after 24 hours it is removed. Between 25 and 90 of MeBr injected into the soil is released into the atmosphere ( B. Thomas 1996).

RESULTS AND DISCUSSION

1. PLANTS GROWTH: Plants development was measured in terms of leaves plant high, stem diameter in centimetres at 20, 30, 38, 45, 50,and 65 days after transplant.

1.2 Plant high. 10 days after transplant showed no significant difference. 20, 30, 38, 45 50, and 65 days after transplant and at harvest time statistical difference was

observed for the MeBr half dose treatment and the other treatments. MeBr shows less plant high (98.9 centimetres). Steam treatment 30. 45 and 60 minutes showed to be statistically the same as Mebr at full dose and to metham sodium. Alternative treatments show a clear plant high difference to meBr.

TABLE 1. DUNCAN TEST . PLANTS HIGH CENTIMETRES open field. 10 to 65 days after transplant. SNAP DRAGON CUT FLOWERS SOIL TREATMENT. PAMPUTIK

| SOILTREATMENTS | PLANTS high IN CM. /DAYS AFTER TRANSPLANT (DAT) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 10 DAT | 20 DAT | 30 DAT | 38 DAT | 45 DAT | 50 DAT | 65 DAT | HARVEST TIME |
| Steam 30 minutes | 8.5 NS | 16.3 A* | 25.2 AB | 40.4 A* | 57.3 A* | 80.7 A* | 99.7 A* | 106.3 A* |
| Steam 45 minutes | 8.7 NS | 16.4 A | 24.5 AB | 39.5 AB | 56.3 A | 78.9 AB | 99.8 A | 106.4 A |
| Steam 60 minutes | 8.6 NS | 16.3 A | 26.7 A* | 41.1 A | 59.4 A | 77.0 AB | 102.5 A | 109.2 A |
| Metham sodium | 7.9 NS | 16.4 A | 25.5 AB | 38.8 AB | 55.5 A | 76.4 AB | 99.2 A | 105.9 A |
| Methyl Bromide 464 kg/ha | 8.5 NS | 16.7 A | 26.4 A | 39.9 AB | 57.4 A | 78.1 AB | 100.4 A | 107.1 A |
| Methyl Bromide 232 kg/ha | 7.8 NS | 13.6 B | 22.3 B | 34.4 B | 53.1 B | 74.2 B | 92.3 B | 98.9 B |

At 5% of probability equal letters have no statistical difference

2. STEM DIAMETER. 45 days after transplant plats were 50 cm high. Records were kept in the next weeks at 55 y 65 days ( table 2). At the begining no statistical difference was present. Steam treatments at different lapses, metham sodium and methyl bromide (464 Kg /Ha) a larger stem diameter was obtained. (8.18 mm to 6.48 mm) than those plants treated with Me Br at half a dose, 5.8 mm wide.

Records taken after 10 days demonstrated that no statisticall diffrence was evident. After 55 days diámeters progressed from 8.65 mm to 9.55 mm. After 65 days DAT diámeters were 9.05 mm to 9.93 mm. At harvest time diameters were 9.55 mm to 10.45 mm. This demonstrates that any of the alternative treatments can produce equal diameters than MeBr for commercial purpose.

Table 2 : DUNCANS MEDIAN TEST: STEM DIAMETER IN MM. 45 TO 65 DAT SNAP DRAGON CUT FLOWER SOIL TRETAMENT IN GREEN HOUSE PAMPUTIK.

| ALTERNATIVES | STEM DIAMETRE mm. / DAT | | | |
|---|---|---|---|---|
| | 45 DDT | 55 DDT | 65 DDT | AT CUT |
| STEAM 30 minutes | 8.18 A* | 8.65 NS | 9.05 NS | 9.55 NS |
| Steam 45 minutes | 7.9 A | 8.65 NS | 9.05 NS | 9.55 NS |
| Steam 60 minutes | 7.85 A | 9.18 NS | 9.58 NS | 10.07 NS |
| Methan sodium | 7.13 AB | 9.53 NS | 9.93 NS | 10.42 NS |
| Me Br full dose 464 Kg /Ha | 6.48 AB | 8.65 NS | 9.05 NS | 9.55 NS |
| Me Br half dose 232 Kg / Ha | 5.8 B | 9.55 NS | 9.95 NS | 10.45 NS |

At 5% of probability equal letters have no statistical difference

1 Weeds population: two weed counts were taken at 10 and 25 days after transplant. Weeds count for the STEAM TREATMENTS and metham sodium were statistically the same as Methyl Bromide at full dose. Steam treatments showed 20,18, and 5 weed per sq. mt. Respectively. Metham Sodium presented 12 weed per square meter . No weeds were present with methyl bromide. Me Br at half dose showed 1,360 weed per square meter. 25 days after transplant the previusly recorded parameters showed no statistical variation.

Table 3 : DUNCANS MEDIAN TEST: WEEDS COUNT. 10 AND 25 DAYS AFTER TRANSPLANT SNAP DRAGON CUT FLOWER SOIL TREATMENT IN GREEN HOUSE PAMPUTIK.

| ALTENATIVES | 10 DDDT | 25 DDT |
|---|---|---|
| | WEEDS / $m^2$ | WEEDS / $m^2$ |
| Steam 30 minutes | 20 B* | 27 B* |
| Steam 45 minutes | 18 B | 19 B |
| Steam 60 minutes | 5 B | 10 B |
| Methan sodium | 12 B | 19 B |
| Me Br full dose 464 Kg /Ha | 0 B | 9 B |
| Me Br half dose 232 Kg / Ha | 1,360 A | 1,695 A |

At 5% of probability equal letters have no statistical difference

PITHIUM SP

The incidence of the pathology (mal del Talluelo) in one of the reasons to apply Me Br. Plant mortality tends to be very high. Records were taken at 10, 25, 15, and 65 days after transplant (DAT). Steam Tretments were statistically the same as Methyl bromide. 10 days after transplant steam treatments showed a lower incidence of infected plants than MeBr at full dose. Methyl Bromide at half a dose showed a 4 % incidence. Trend incidence was permanent with a slight increase for any of the treatments. After 65 days steam treatments showed a similar increase as Methyl Bromide full dose. Metham sodium treatments showed a 10 % incidence of pithium sp. This figure is not acceptable for economic loss.

Table 4 : DUNCANS MEDIAN TEST: PERCENTAGE (%) PLANTS DISEASE PATHOLOGY PITHIUM SP INCIDENCE WEEDS COUNT. 10 AND 25 DAT SNAP DRAGON CUT FLOWER SOIL TREATMENT IN GREEN HOUSE PAMPUTIK

| ALTENATIVES | (%) diseased plants (pithium sp ) / 10 to 65 days (DAT ) | | | |
|---|---|---|---|---|
| | 10 DAT | 25 DAT | 50 DAT | 65 DAT |
| Steam 30 minutes | 0.10 % C* | 0.95 % C* | 1.2 % C* | 3.2 % C* |
| Steam 45 minutes | 0.17 % BC | 0.91 % C | 1.9 % C | 3.5 % C |
| Steam 60 minutes | 0.2 % BC | 1.3 % BC | 1.9 % C | 3.7 % C |
| Methan sodium | 3 % AB | 5 % AB | 7.3 % B | 10.2 % B |
| Me Br full dose 464 Kg /Ha | 0.4 % BC | 1.4 % BC | 2 % C | 3.3 % C |
| Me Br half dose 232 Kg / Ha | 4 % A | 6 % A | 11% A | 14.8 % A |

At 5% of probability equal letters have no statistical difference

NEMATODES FINDINGS. In line with trials protocols, soil samples were take before treatments application, after treatments application and after harvest time. AGRILAB chief laboratory analyst stated that only meloidogyne could cause damage to snap dragon cut flowers. Tylenchus and Apelenchus are weak parasites with no economic impact on this crop. Rabhditis is a non parasite nematode it is found in organic matter rich soils.

Meloidogyne count were present at post treatment sample and at harvest time. Roots nodules were not present for that reason it cannot be considered as a *pathological condition.*

TABLE 5 : NEMATODES COUNT LABORATORY ANALYSIS. SNAP DRAGON CUT FLOWER. INICIAL SOIL SAMPLE NEMATODES COUNT *per 100 ml of soil.* centrifuged screening. AGRILAB

| NEMATODES | Meloidogyne | | *Aphelenchus* | Rhabditis |
|---|---|---|---|---|
| | Eggs | Larvae I | | |
| INITIAL sample | 0* | 0 | 20 | 200 |
| POST TREATMENT SAMPLES | | | | |
| Steam 30 minutes | 0 | 0 | 0 | 20 |
| Steam 45 minutes | 0 | 50 | 0 | 40 |
| Steam 60 minutes | 0 | 10 | 0 | 20 |
| Metham sodium | 0 | 0 | 0 | 20 |
| Me Br 464 kg/ha | 0 | 40 | 0 | 30 |
| Me Br 262 kg/ha | 0 | 0 | 0 | 70 |
| HARVEST TIME SAMPLES | | | | |
| Steam 30 minutes | 0 | 0 | 190 | 830 |
| Steam 45 minutes | 0 | 0 | 210 | 690 |
| Steam 60 minutes | 0 | 0 | 100 | 980 |
| Metham sodium | 0 | 10 | 60 | 670 |
| Me Br 464 kg/ha | 0 | 0 | 10 | 870 |
| Me Br 262 kg/ha | 0 | 20 | 30 | 480 |

Fuente: PROYECTO UNIDO ICTA CONCYT CONAMA. 1998-1999.

FLOWERS YIELD.

Cut flowers are the final product in this crop . Flowers were counted for the different alternative treatments. Plants loss % was higher for Methyl Bromide at half dose 21 % thenmetham sodium with a 14 %. Stean treatments and methyl Brobide compare substantially. Cut flowers percentaje for metham sodium (86 %) and Methyl Bromide half dose (79 %) compared low to the percentaje obtained with Steam treatments and methyl bromide full dose.

Table 6: cut flower production percentaje (%) and BM. Alternative treatments SNAP DRAGON. PAMPUTIK. SACATEPÉQUEZ.

| ALTENATIVES | (%) cut flowers produced | (%) cut flowers loss |
|---|---|---|
| Steam 30 minutes | 95 % | 5 % |
| Steam 45 minutes | 94 % | 6 % |
| Steam 60 minutes | 94 % | 6 % |
| Methan sodium | 86% | 14% |
| Me Br full dose 464 Kg /Ha | 94% | 6% |
| Me Br half dose 232 Kg / Ha | 79% | 21% |

Fuente: PROYECTO UNIDO ICTA CONCYT CONAMA. 1998-1999.

PRODUCTION QUALITY :

PAMPUTIK has its own quality standards. Three cathegories are utilezed for export market. Steam length : 85 cm ; 75 cm and 65 cm .

Cut flowers were classified by PAMPUTIK personnel.Steam treatments and Methyl Bromide full dose showed the same production percentaje (85 cm). Methyl Bromide at half dose performed poorly at 30 % production. Steam treatments equaly performed as Me Br full dose for the select quality production (24 % 25 % and 26 %l). Steam treatments, metham sodium and methyl bromide full dose in the fancy cathegory (65 cm tall) were 30 to 33 %. Methyl bromide at half dose was 37 %

Steam treatments, metham sodium and MeBr full dose showed a 7% to 9% cut flowers production for local market standards ( less than 65 cm tall )

Half a dose Me Br treatment allowed weeds population to incease with an adverse effect over plant development. This standard is not accepted to the company.

Steam treatments and metham sodium equally perform as compared to Me Br full dose. Steam quality standard are fully met. Half a dose BM does not performs accordingly. estudiados.

Table 7 :cut flowers Quality Percentaje (%) and alternative treatment SNAP DRAGON PAMPUTIK

| ALTENATIVES | SUPER (85 Cm tall) | SELECT (75 Cm tall) | FANCY (65 Cm tall) | LOCAL MARKET |
|---|---|---|---|---|
| Steam 30 minutes | 36 % | 24 % | 32 % | 8 % |
| Steam 45 minutes | 35 % | 26 % | 30 % | 9 % |
| Steam 60 minutes | 36 % | 26 % | 30 % | 8 % |
| Methan sodium | 35 % | 25 % | 31 % | 9 % |
| Me Br full dose 464 Kg /Ha | 36 % | 24 % | 33 % | 7 % |
| Me Br half dose 232 Kg / Ha | 30 % | 23 % | 37 % | 10 % |

Fuente: PROYECTO UNIDO ICTA CONCYT CONAMA. 1998-1999.

TREATMENTS COST :

Costs were assessed for each treatment. Total cost were not disclosed by the company as they privilege to reserve this information. The lowest cost was for methyl bromide at half a dose. -----Q. 1.88 per $m^2$ Two deficiencies were found : weeds control was not effective and phytium incidence was higher. It is not advisable to lower MeBr at half a dose. 262 Kg/ha (table 8).

Methyl Bromide treatment ( 464 Kg/Ha) was Q. 2.61 per $m^2$ it showed weeds control and for pithium The company feels comfortable with these results

Metham sodium treatment at 1,000 Lt/ha had a Q. 2.60 cost per $m^2$ . It is not effective for pithium control. With a loss of 14% of plants inside the green house. For weeds control it is very effective. From previous experiences when the dose is increased to 1,500 ts / Ha it has been effective to control pithium but the costs are increased substantially to Q 3.40 per $m^2$ , which is not accepted by the company.

Steam treatments cost for 30 minutes were : Q. 2.40 / $m^2$, for : 45 minutes Q. 2.61 / $m^2$ and for 60 minutes Q. 2.93 / $m^2$, . Weeds control, fungi population (*Pithium* sp.) and stem quality were as good as Me Br application. Steam application is considered a good alternative for cut flowers production.

Experimental units were only 10 square metres. Temperatures easily reached 90° degree. In larger areas 150 square meters (same area as methyl bromide application) Steam has to be applied for 60 minutes to reach pasteurization effects to control weeds control and soil fungi.

A balance must be reached between higher costs with steam application and environmental compliances and product acceptance in sophisticated markets.

Table 8: Treatment costs per square meters snap dragon greenhouse. PAMPUTIK. SACATEPEQUEZ.

| ALTENATIVES | TREATMENT COSTS PER SQUARE METER | TREATMENT COST PER GREEN HOUSE 2,550 sq.mt. |
|---|---|---|
| Steam 30 minutes | Q. 2.40 | 6,120 |
| Steam 45 minutes | Q. 2.61 | 5,872 |
| Steam 60 minutes | Q. 2.93 | 6,592 |
| Methan sodium | Q. 2.60 | 6,630 |
| Me Br full dose 464 Kg /Ha | Q.2.61 | 6,655 |
| Me Br half dose 232 Kg / Ha | Q. 1.88 | 4,794 |

Fuente: PROYECTO UNIDO ICTA CONCYT CONAMA. 1998-1999.

FINDINGS AND RECOMENDATIONS SNAP DRAGON PRODUCTION

1.- Weeds control is effective with steam treatments, metham sodium and are as effective as Me Br full dose application (464 Kg / Ha)

2.- Steam treatment is effective to control pithium, soil fungi and equaly performs as compared to MeBr (464 Kg / Ha) Metham sodium at applied dose iwas not effective to control pithium sp.

3.- Me Br application at half a dose is not effective for weeds control and soil fungi.

4.- Steam quality is the same with steam treatments or Me Br application (464 Kg /ha) Metham sodium and Me Br half a dose shows a poor performance

5.- Stem cuts quality production with steam treatments and metham sodium applications is the same as the one obtained with Me Br full dose.

6.- Steam treatments is 14 % more costly than Me Br full dose. Considerations should be explored as the international market privileges ecology oriented produts

7.- Metham sodium and Me Br costs were very low, but cut flowers quality is seriusly affected and si not accepted by the company.

SUGGESTIONS

1.- steam treatments is envisaged as a sound alternative to the use of methyl bromide

2.- A second experimental study is advised to comfir initial findinding.

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PAMPUTIK CUT FLOWERS Phase II
ALTERNATIVE TO THE USE OF METHYL BROMIDE IN CUT FLOWERS
PASTORES, SACATEPEQUES

A. Experimental Site : PAMPUTYK a cut flowers agribusiness located in the proximity of PASTORES a village near Chimaltenango. PAMPUTYK cultivates 30 Ha of FLOWERS and exports to the US, EUROPE and Central America. In resent years they have diversify to different flower types. Snapdragons were chosen to conduct this trial. The first phase was initiated on may 15 and was concluded in September 15, 1999.

The second stage to validated obtained results started on september 1st and concluded in November 30 1999. The same methodology and experimental design was utilized as in the first stage.

DATA ANALYSIS AND FINDINGS:

TABLE 1. DUNCAN TEST . PLANTS HIGH CENTIMETRES open field. 10 to 65 days after transplant. SNAP DRAGON CUT FLOWERS SOIL TREATMENT. PAMPUTIK

| SOILTREATMENTS | PLANTS high IN CM. /DAYS AFTER TRANSPLANT (DAT) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 10 DAT | 20 DAT | 30 DAT | 38 DAT | 45 DAT | 50 DAT | 65 DAT | HARVEST TIME |
| Steam 30 minutes | 8.6 NS | 13.8 NS | 24.9 A | 41.2 A | 54.9 A | 77.4 A | 87.6 A | 105.6 A |
| Steam 45 minutes | 8.6 NS | 13.9 NS | 23.7 AB | 39.4 AB | 54.8 A | 77.6 A | 85.4 A | 105.7 A |
| Steam 60 minutes | 8.8 NS | 13.8 NS | 25.2 A | 40.6 AB | 57.1 A | 79.6 A | 86.8 A | 105.6 A |
| Metham sodium | 8.6 NS | 14.5 NS | 23.4 B | 37.9 BC | 56.9 A | 75.8 A | 85.6 A | 104.9 AB |
| Me Br 464 kg/ha | 8.6 NS | 14.5 NS | 22.8 B | 36.5 C | 55.4 A | 77.1 A | 87.7 A | 103.4 B |
| Me Br 232 kg/ha | 8.7 NS | 14.4 NS | 20.4 C | 31.7 D | 48.8 B | 68.3 B | 81.4 B | 98.3 C |

At 5% of probability equal letters have no statistical difference

Plants high was the same for steam treatments and for methyl bromide full dose. It showed statistical difference with metham sodium and half dose for mel br.

Table 2 : DUNCANS MEDIAN TEST: STEM DIAMETER IN MM. 45 TO 65 DAT SNAP DRAGON CUT FLOWER SOIL TRETAMENT IN GREEN HOUSE PAMPUTIK.

| ALTERNATIVES | STEM DIAMETRE mm. / DAT | | | |
|---|---|---|---|---|
| | 45 DDT | 55 DDT | 65 DDT | AT CUT |
| STEAM 30 minutes | 6.25 NS | 7.55 NS | 8.95 NS | 10.25 NS |
| Steam 45 minutes | 6.6 NS | 7.9 NS | 9.03 NS | 10.32 NS |
| Steam 60 minutes | 6.5 NS | 7.8 NS | 9.20 NS | 10.50 NS |
| Methan sodium | 6.4 NS | 7.6 NS | 9.05 NS | 10.35 NS |
| Me Br full dose 464 Kg /Ha | 6.2 NS | 7.8 NS | 9.05 NS | 10.35 NS |
| Me Br half dose 232 Kg / Ha | 6.3 NS | 7.8 NS | 9.03 NS | 10.32 NS |

At 5% of probability equal letters have no statistical difference

2. FINDINGS : STEM DIAMETER. No statistical difference was evident.

Table 3 : DUNCANS MEDIAN TEST: WEEDS COUNT. 10 AND 25 DAYS AFTER TRANSPLANT SNAP DRAGON CUT FLOWER SOIL TREATMENT IN GREEN HOUSE PAMPUTIK.

| ALTENATIVES | 10 DDDT | 25 DDT |
|---|---|---|
| | WEEDS / $m^2$ | WEEDS / $m^2$ |
| Steam 30 minutes | 8.5 B | 16 B |
| Steam 45 minutes | 6.24 B | 28 B |
| Steam 60 minutes | 22.4 B | 12 B |
| Methan sodium | 5.12 B | 10 B |
| Me Br full dose 464 Kg /Ha | 6.24 B | 12 B |
| Me Br half dose 232 Kg / Ha | 2,400 A | 2 560 A |

At 5% of probability equal letters have no statistical difference

Weeds population: STEAM TREATMENTS WERE AS EFFECTIVE AS THE METHYL BROMIDE AT FULL DOSE. HALF DOSE OF ME BR IS STATISTICALLY DIFFERENT.

PITHIUM SP

Table 4 : DUNCANS MEDIAN TEST: PERCENTAGE (%) PLANTS DISEASE PATHOLOGY PITHIUM SP INCIDENCE WEEDS COUNT. 10 AND 25 DAT SNAP DRAGON CUT FLOWER SOIL TREATMENT IN GREEN HOUSE PAMPUTIK

| ALTENATIVES | (%) diseased plants (pithium sp ) / 10 to 65 days (DAT ) | | | |
|---|---|---|---|---|
| | 10 DAT | 25 DAT | 50 DAT | 65 DAT |
| Steam 30 minutes | 0.8 B | 1.22 C | 3.33 C | 5.4 C |
| Steam 45 minutes | 1.2 B | 1.44 C | 3.11 C | 5.9 C |
| Steam 60 minutes | 0.9 B | 1.99 C | 3.77 C | 6.7 C |
| Methan sodium | 3 B | 4.22 B | 7.31 B | 12.9 B |
| Me Br full dose 464 Kg /Ha | 0.8 B | 1.33 C | 2.44 C | 4.9 C |
| Me Br half dose 232 Kg / Ha | 9 A | 12.44 A | 17.33 A | 22.2 A |

At 5% of probability equal letters have no statistical difference

PITHIUM SP

The incidence of THIS pathology (mal del Talluelo) in one of the reasons to apply Me Br. Plant mortality tends to be very high. Records were taken at 10, 25, 15, and 65 days after transplant (DAT). Steam Treatments were statistically the same as Methyl bromide. 10 days after transplant steam treatments showed a lower incidence of infected plants than MeBr at full dose. Methyl Bromide at half a dose showed a 4 % incidence. Trend incidence was permanent with a slight increase for any of the treatments. After 65 days steam treatments showed a similar increase as Methyl Bromide full dose. Metham sodium treatments showed a 12.9 % incidence of pithium sp. This figure is not acceptable for economic loss.

FLOWERS YIELD.

Cut flowers are the final product in this crop . Flowers count was performed for each of the alternative treatments. Plants loss % was higher for Methyl Bromide at half dose 27 % than metham sodium with a 14 %. Stean treatments and methyl Brobide compare substantially. Cut flowers percentaje for metham sodium (86 %) and Methyl Bromide half dose (73 %) compared low to the percentaje obtained with Steam treatments and methyl bromide full dose.

Table 6: cut flower production percentaje (%) and BM. Alternative treatments SNAP DRAGON. PAMPUTIK. SACATEPÉQUEZ.

| ALTENATIVES | (%) cut flowers produced | (%) cut flowers loss |
|---|---|---|
| Steam 30 minutes | 94 % C | 6 % C |
| Steam 45 minutes | 93 % C | 7 % C |
| Steam 60 minutes | 93 % C | 7 % C |
| Methan sodium | 86% B | 14% B |
| Me Br full dose 464 Kg /Ha | 94% C | 6% C |
| Me Br half dose 232 Kg / Ha | 73% A | 27% A |

Fuente: PROYECTO UNIDO ICTA CONCYT CONAMA. 1998-1999.

PRODUCT QUALITY :

PAMPUTIK has its own quality standards. Three cathegories are utilezed for export market. Steam length : 85 cm ; 75 cm and 65 cm .

Cut flowers were classified by PAMPUTIK personnel.Steam treatments and Me Br full dose showed the same production percentage (85 cm). Methyl Bromide at half dose performed poorly at 25 % production. Steam treatments equally performed as Me Br full dose for the select quality production (33 % 36 % and 34 % AND Me Br 33 % ). Steam treatments, and methyl bromide full dose in the fancy category (65 cm tall) were 26 %, 27 % 24 % to 26 % for Me Br. Methyl bromide at half dose was 32 %

Percentage for local market estándar decresed for all treatments. Except for Me Br half dose. This standard is not accepted to the company.

Table 7 :cut flowers Quality Percentaje (%) and alternative treatment SNAP DRAGON PAMPUTIK

| ALTENATIVES | SUPER (85 Cm tall) | SELECT (75 Cm tall) | FANCY (65 Cm tall) | LOCAL MARKET |
|---|---|---|---|---|
| Steam 30 minutes | 37.25 % | 33 % | 27 % | 3 % |
| Steam 45 minutes | 32.25 % | 36 % | 27 % | 4 % |
| Steam 60 minutes | 37.25 % | 35 % | 24 % | 4 % |
| Methan sodium | 35.00 % | 31 % | 31 % | 3 % |
| Me Br full dose 464 Kg /Ha | 38.00 % | 33 % | 26 % | 3 % |
| Me Br half dose 232 Kg / Ha | 25.01 % | 29 % | 32 % | 14 % |

Fuente: PROYECTO UNIDO ICTA CONCYT CONAMA. 1998-1999.

## TREATMENTS COST :

Steam treatments cost for 30 minutes were Q. 2.40 / $m^2$, For 45 minutes Q. 2.61 / $m^2$ and for 60 minutes Q. 2.93 / $m^2$, . Weeds control, fungi population (*Pithium* sp.) and stem quality were as good as Me Br application. Steam application is considered a good alternative for cut flowers production.

Experimental units were only 10 square meters. Temperatures easily reached 90° degree. In larger areas 150 square meters (same area as methyl bromide application) Steam has to be applied for 60 minutes to reach pasteurization effects to control weeds control and soil fungi.

A balance must be reached between higher costs with steam application and environmental compliance and product acceptance in sophisticated markets.

**Table 8: Treatment costs per square meters snap dragon greenhouse. PAMPUTIK. SACATEPEQUEZ.**

| ALTENATIVES | TREATMENT COSTS PER SQUARE METER | TREATMENT COST PER GREEN HOUSE 2,550 sq.mt. |
|---|---|---|
| Steam 30 minutes | Q. 2.40 | 6,120 |
| Steam 45 minutes | Q. 2.61 | 5,872 |
| Steam 60 minutes | Q. 2.93 | 6,592 |
| Methan sodium | Q. 2.60 | 6,630 |
| Me Br full dose 464 Kg /Ha | Q. 2.61 | 6,655 |
| Me Br half dose 232 Kg / Ha | Q. 1.88 | 4,794 |

Fuente: PROYECTO UNIDO ICTA CONCYT CONAMA. 1998-1999.

## FINDINGS AND RECOMENDATIONS SNAP DRAGON PRODUCTION

1.- **Weeds control is effective with steam treatments, metham sodium are as effective as Me Br full dose application (464 Kg / Ha)**

2.- **Steam treatment is effective to control pithium, soil fungi and equaly performs as compared to MeBr (464 Kg / Ha) Metham sodium at applied dose was not effective to control pithium sp.**

3.- **Me Br application at half a dose is not effective for weeds control and soil fungi.**

4.- **Stem quality is the same with vapor treatment or Me Br application (464 Kg /ha) Metham sodium and Me Br half a dose showed a poor performance**

5.- **Stem cuts quality production with vapor treatment or metham sodium applications is the same as the one obtained with Me Br full dose.**

6.- Vapor treatment is 14 % more expensive than Me Br full dose. Considerations should be explored as the international market privileges ecology oriented products

7.- Metham sodium and Me Br costs were very low, but cut flowers quality is seriously affected and is not accepted by the company.

## CONCLUSSIONS

1. - Vapor effectivenes is confirmed as it performed the same in the two trials. It is a good alternative to the use of methyl bromide.

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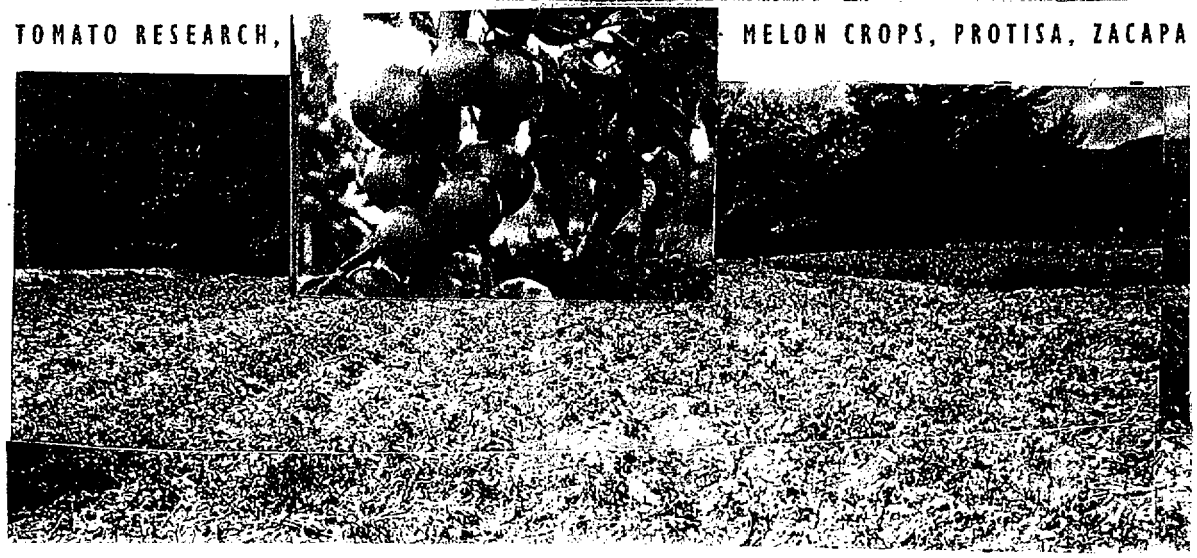
TOMATO RESEARCH, MELON CROPS, PROTISA, ZACAPA



# DEMONSTRATION PROJECT ON ALTERNATIVES TO THE USE OF METHYL BROMIDE IN SOIL FUMIGATION GUA/97/128

ICTA

UNIDO

IPM CRSP

CONCYT

CONAMA

**ALTERNATIVES TO THE USE OF METHYL BROMIDE**
**PHASE I MELON TRIAL # 1 at PROTISA LA FRAGUA ZACAPA**
DATE: FROM AUGUT 1998 TO NOVEMBER 1998

**PHASE I MELON TRIAL # 1 at EL OSASIS,LA FRAGUA ZACAPA**
*DATE* :SEPTEMBER 1998 TO JANUARY 1999

**Experimental Site Description.** La Fragua, Zacapa is a high temperature low precipitation valley which offers good conditions for export crops. There are 8 larger agro business in the area. 4,000 Ha. are cultivated for melon. The first cycle is fully treated with Methyl Bromide as a soil biocide. The research sites are located in PROTISA one of the agro business exporters in this valley.

**Objectives:** To comply with the Montreal Protocol, signed by the Government of Guatemala and ratified by the National Congress. The objective is to prevent the use of CFC's and Methyl Bromide and implement alternatives which are economic and technically feasible to apply.

**Crop Cycle:** PROTISA a melon producer offered to collaborate with the research trials. The first crop cycle was defined from August 1998 to January 1999.The second crop cycle starts in January 1999 and it will last until May. Planting : Durango seedlings october 3, 1998. Eng. Eladio Trabanino field research agronomist.

**Methodology:** Experimental design. random plots, six alternatives treatments and 4 replications was defined for this experiment . Each experimental units is 36 $m^2$ for a total area 864 $m^2$.

**1. Treatments**

| No. | PROTISA | ICTA, OASIS |
|---|---|---|
| 1 | Absolute witness (only plastic film ) | Absolute witness (only plastic film ) |
| 2 | Methyl Bromide 250 kg./ha | Methyl Bromide 250 kg./ha |
| 3 | Methyl Bromide 125 kilos/ha | Methyl Bromide 125 kilos/ha |
| 4 | Metham sodium 200 liters/ha + solarization | Metham sodium 350 liters/ha |
| 5 | Metham sodium 300 liters/ha + solarization | Metham sodium 350 liters/ha + solarization |
| 6 | Metham sodium 400 liters/ha | Chicken manure (biofumigatión) 4545.45 kilos/ha + solarization |
| 7 | | Basamid (Dazonet) 267 kilos/ha |

**Period of time for treatment applications:** Solarization + Metham Sodium; 18 days from initial soil application until field transplant.

**Soil sampling for nematodes** : a) before treatments applications b) 5 days after transplant c) soil and roots sampling after 62 days from transplant.

**Variables Under study:**

- Nematodes count laboratory analysis
- Nematodes presence roots nodules. Laboratory analysis
- Phytotoxisity in transplanted plants.
- weeds population
- Fruits out put (units per hectare) Export quality A and B
- Economic analysis cost- benefit.

**Table 1 nematodes count and treatments effects over N. Rotylenchulus sp. melón crops PROTISA fields, Zacapa.**

| Tretments | Sample | | | |
|---|---|---|---|---|
| | Soil | | | Root |
| | Days after transplant | | | |
| | 0 | 5 | 62 | 62 |
| | Nematodes count (per 100 ml of soil) | | | |
| Absolute witness | 1693 | 1320 | 4490 | 70 |
| Methyl bromide 250 Kg./ha | 1693 | 220 | 0 | 0 |
| Methyl Bromide 125 Kg./ha | 1693 | 280 | 10 | 0 |
| Metham sodium 200 l/ha + solarization | 1693 | 1850 | 990 | 0 |
| Metham sodium 300 l/ha + solarization | 1693 | 900 | 150 | 0 |
| Metham sodium 400 l/ha | 1693 | 1850 | 30 | 10 |

*** under laboratory analysis. * # of Nematodes per 100 L of soil**

**Table 1:** Laboratory results presented in table one reflect the presence of Rotilenchulus . The first sampling was performed before film covering and treatment applications. Twelve soil samples were taken nematodes count was 1,693 per 100ml. The second sample taken 5 days after the transplanting (18 and 33 days after metham sodium and methyl bromide applications) reveals the following results MeBr, solarization and metham sodium (300 lts) have the lowest Nematodes count. Meloidogyne was not found in this samples Methyl Bromide shows effective control over Meloidogyne. In other fields Meloidogyne has not been present and Me Br was applied.

Table 2: Main Sprout Growth (melon 1). PROTISA LA FRAGUA ZACAPA 1998

| Alternatives | Days after transplant | | | 16 DDT |
|---|---|---|---|---|
| | 5 | 10 | 16 | Duncan 0.01 |
| 1. witness | 5.25 cm | 9.13 cm | 16.13 cm | C |
| 2. Me.Br. 250kg/ha | 5.50 cm | 10.63 cm | 22.75 cm | A |
| 3. Me.Br. 125 kg/ha | 5.25 cm | 10.38 cm | 20.75 cm | A B |
| 4. Solarization + MS. 200 L/ha | 4.00 cm | 9.63 cm | 21.38 cm | A B |
| 5. Solarization + MS. 300 L/ha | 4.00 cm | 9.50 cm | 18.63 cm | B C |
| 6. Metham Sodium 400 L/ha | 5.00 cm | 10.00 cm | 21.75 cm | A B |

Table 2. summarizes main sprout growth at different days (5,10,16) after the transplant DAT. 5 days after the transplant. Major differences were shown for the solarization alternatives this was because plastic film was not painted due to heavy rains in the area (Mitch tropical storm) . 16 DAT heavy weeds populations affected the absolute witness. Treatments 2,3,4,5, showed no significant difference.

Table 3. Percent of weeds 19 days After the Transplant
MELON 1 EXPERIMENT PROTISA LA FRAGUA ZACAPA

| Treatment | Graminea | Duncan 0.01 | wid leaf | Duncan 0.01 | Cipheracea | No. Sig duncan |
|---|---|---|---|---|---|---|
| 1. Witness | 72.08 | A | 35.90 | A | 8.35 | NS |
| 2. Me.Br. 250 kg/ha | 17.48 | B | 16.65 | B | 0.00 | NS |
| 3. Me.Br. 125 kg/ha | 22.28 | A B | 23.65 | A B | 2.03 | NS |
| 4. Solarization +MS 200 l/ha | 24.08 | B | 10.33 | B | 3.23 | NS |
| 5. Solarization + MS 300L/ha | 20.03 | B | 7.28 | B | 2.50 | NS |
| 6. Metham Sodium 400L/ha | 13.95 | B | 14.10 | B | 0.00 | NS |

Table 3 Summarizes the presence of weeds 19 DAT. When the inspection was performed weeds were 30 cm tall. 60 percent of the area was invaded with weeds. Metham sodium treatments, are a viable alternative for weeds control. The absolute witness plot had the largest percent of weeds. **Other treatments compared similarly. (A : highest population )**

Table 4 percentage of infected plants pathogens at the base of the stem(fungi and bacteria) melon I experiment PROTISA LA FRAGUA ZACAPA

| | DAYS AFTER TRANSPLANT DAYS T | | | |
|---|---|---|---|---|
| Treatments | 32 | Duncan 0.1 | 41 | Duncan 0.01 |
| 1. witness | 13.20 | A B | 21.53 | B C |
| 2. Me.Br. 250 kg/ha | 19.45 | A | 32.63 | A |
| 3. Me.Br. 125 kg/ha | 18.05 | A | 31.25 | A B |
| 4. Solarization + MS 200 L/ha | 14.58 | A B | 19.45 | C |
| 5. Solarization +MS 300L/ha | 7.63 | B | 13.88 | C |
| 6. Metham Sodium 400 L/ha | 18.75 | A | 24.30 | A B C |

Table 4. The % of infected plants is less with solarization + Metham Sodium and the absolute witness. Treatments with Me.Br. present the highest %s of infected plants. Other treatments are viable alternatives to the use of Me Br. For steam early infection (fungi and bacteria)

Table 5 Crop Yield Boxes/Ha. Grade "A" MELON 1 EXPERIMENT PROTISA LA FRAGUA 1998

| | Grade "A" | | | | | Best Class | | | |
|---|---|---|---|---|---|---|---|---|---|
| Treatments | 9 | 12 | 15 | 18 | 23 | 12+15 | duncan 0.1 | Total | Duncan 0.1 |
| 1. witness | 0 | 58 | 130 | 154 | 0 | 188 | B | 344 | C |
| 2. Me.Br. 250 kg/Ha. | 0 | 87 | 241 | 212 | 3 | 328 | A | 543 | A |
| 3. Me.Br. 125 kg/Ha. | 0 | 75 | 241 | 208 | 3 | 316 | A B | 527 | A B |
| 4. Solarization + MS 200 L/Ha. | 8 | 87 | 130 | 143 | 6 | 217 | A B | 373 | B C |
| 5. Solarization + MS 300 L/Ha. | 8 | 116 | 195 | 177 | 3 | 310 | A B | 498 | A B C |
| 6. Metham Sodium 400 L/Ha. | 8 | 58 | 153 | 151 | 6 | 211 | A B | 375 | B C |

**Melon products classified by fruit size. waxed box 9, 12, 15, 18, 23 and 30. The average weight is 18 Kg.**

**Table 5 Compiles** Grade "A" Export boxes (8-10lbs). Median size (12-15) yield compared very similar for all treatments except for witness. Total grade "A" yield is highest for MeBr (250 kg/Ha) and solarization + metham sodium (300 kg/Ha). All treatments performed equally the same except the absolute witness. Total export quality fruit are MeBr treatments and solarization + metham sodium at 300 lt Ha.

Table 6. Crop Yield. Boxes/Ha. Grade "B"MELON 1 EXPERIMENT PROTISA LA FRAGUA 1998

| | Grade | | | | | Best Class | | | |
|---|---|---|---|---|---|---|---|---|---|
| Treatments | 9 | 12 | 15 | 18 | 23 | 12+15 | duncan 0.5 | Total | Duncan 0.5 |
| 1. witness | 0 | 0 | 56 | 204 | 118 | 568 | B | 344 | B |
| 2. member. 250 kg/Ha. | 0 | 29 | 176 | 370 | 136 | 205 | A | 543 | A |
| 3. Me.Br. 125 kg/Ha. | 0 | 46 | 148 | 401 | 142 | 194 | A | 527 | A |
| 4. Solarization + MS 200 L/Ha. | 8 | 23 | 111 | 370 | 115 | 134 | A B | 373 | A |
| 5. Solarization + MS 300 L/Ha. | 8 | 43 | 79 | 413 | 187 | 122 | A B | 498 | A |
| 6. Metham Sodium 400 L/Ha. | 8 | 12 | 115 | 366 | 148 | 127 | A B | 375 | A |

Table 6 There is no statistical difference when comparing size (12+15) and total yield in grade "A" yield for all treatments, except the total witness.

Table 7 Crop Yield Total # of Boxes/Ha. MELON 1 PROTISA LA FRAGUA ZACAPA

| | Grade A + B | | | | | | |
|---|---|---|---|---|---|---|---|
| Treatments | 9 | 12 | 15 | 18 | 23 | TOTAL | Duncan 0.01 |
| 1. witness | 0 | 58 | 186 | 358 | 118 | 720 | B |
| 2. Me.Br. 250 kg/Ha. | 0 | 116 | 417 | 582 | 139 | 1,254 | A |
| 3. Me.Br. 125 kg/Ha. | 0 | 121 | 389 | 609 | 145 | 1,264 | A B |
| 4. Solarization + MS 200 L/Ha. | 8 | 110 | 241 | 513 | 121 | 993 | A |
| 5. Solarization + MS 300 L/Ha. | 16 | 159 | 274 | 590 | 190 | 1,229 | A |
| 6. Metham Sodium 400 L/Ha. | 8 | 70 | 268 | 517 | 154 | 1.017 | A B |

Table 7 Total yield Methyl bromide treatments and metham sodium treatments have no statistical difference.

TABLE 8 TOTAL COST. US$ /HECTARE MELON 1 PROTISA LA FRAGUA ZACAPA

| Variable | TREATMENTS | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| OUTPUT * BOXES/Ha | 720 | 1,250 | 2,264 | 993 | 1,229 | 1,017 |
| GROSS INCOME / BOX | 2,880 | 5,016 | 5,056 | 3,972 | 4,916 | 4,068 |
| Me Br | -- | 551 | 276 | -- | -- | -- |
| Metham sodium | -- | -- | -- | 340 | 510 | 680 |
| Plastic film | 465 | 465 | 465 | 490 | 490 | 465 |
| Treatments aplication | 20 | 25 | 25 | 30 | 30 | 25 |
| Additives ++ | -- | -- | -- | 200 | 200 | -- |
| Variable cost | 485 | 1,041 | 766 | 1,060 | 1,230 | 1,170 |
| Net income | 2,395 | 3,975 | 4,290 | 2,912 | 3,686 | 2,898 |

* Melon box price at packaging site. ++ uv paint

**Table 8. variable cots for each treatment (metham sodium + solarization) compared to methyl bromide showed a negative rate for the additional costs from ultraviolet paint + adhesive film.**

TABLE 9 TREND ANALYSIS dominance analysis

| Variable COSTS | TREATMENTS | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 3 | 2 | 4 | 6 | 5 |
| Variable cost | 481 | 766 | 1,041 | 1,060 | 1,170 | 1,230 |
| Net income ($4 per box) | 2,385 | 4,290 | 3,975 D | 2,912 D | 2,898 D | 3,686 D |

TABLE 9 variable cost and net benefit. Me Br half dose treatment is higher than absolute witness. Treatments have DOMINANCE since they increment their variable cost and diminish net benefits.

## TABLE 10. MARGINAL RATE OF RETURN.

| | CV | CV | BL | BL | BN/CV |
|---|---|---|---|---|---|
| ABSOLUTE WITNESS | 481 | -- | 2,395 | -- | -- |
| METHYL BROMIDE 125 K/Ha | 766 | 285 | 4,920 | 1,895 | 695.65 |

TABLES. 8, 9 and 10. Summarized cost benefit analysis, variable cost for metham sodium + solarization treatment show a slight increase due to the extra additive applied. This coating has to be applied to preserve mulch. When variable costs are compared only the half dose Me Br treatment shows and increase regarding the absolute witness. . The other treatments variable costs increase and the net income diminishes. (table 9) The best alternative (with out methyl Bromide ) is metham sodium + solarization (300 lt / ha)

When MeBr is use at 125 Kg /Ha dose, the rate of capital return is 6.65 that is the one invested US $ is recovered plus a $ 6.65 gain, being the highest marginal rate of return. Metham sodium at 300 lt / Ha shows the best net benefit

11. FINDINGS:

- Rotylenchulus Nematodes count were reduced 85 % by Methyl Bromide as compared to other treatments.
- Melon seedling were transplanted at 18 days after treatments. No phytotoxicity was present in the Metham Sodium treated area.
- Weed counts (graminae and siperacea) were found 19 days after transplant. The highest counts were observed for the absolute witness. Me Br and metham sodium showed the lowest counts. The highest count are shown for solarization treatments.
- Methil bromide treatment shows the highest incidence of infection at the base of the steam (enfermedad del talluelo). Metham sodium had a lower rate of incidence. Being a viable substitute to the use of Me Br.
- Vanriance analysis demonstrated than Me Br and Metham Sodium + solarization are statistically the same, the output is the same boxes per hectare. First and Second cut.

- Economic analysis. uv paint negatively affects variable cost for metham sodium plus solarization.
- Dominance analyisis and economic rate of return analysis MROR. Methyl Bromide at half dose shows the lowest increment in variable costs and the highest net income. With a 6.65 MROR regarding the absolute witness. The second best choise is Metham Sodium + solarization 300 lt / Ha.

12 RECOMENDATIONS :

- To analyze both crop cycles being planted in the same row with the same plastic coverage.
- To evaluate different uv paint additives to reduce variable costs. Since this treatment bears a strong possibility for permanent use with common agricultural practices in use.
- To evaluate for several years metham sodium + solarization and regular plastic film in the same fields to determine the stability of this system and its impact on weeds, nematodes, stem disease and olpydium to prevent Melon Necrotic Spot Virus MNSUV (virus del crivado).

**AFTER THE FIRST TRIALS WERE PERFORMED, A SECOND SET OF EXPERIMENTS WERE CARRIED OUT IN THE SAME EXPERIMENTAL PLOTS, UNDER THE NAME OF: MELON SECOND (II) STAGE. PROTISA.**

**The second planting in the same experimental units was done on December 19th 1998. The output estimate was performed the 16th of February 1999. No extra investment was required; the same infrastructure was utilized. The same day of transplant vidate (nematicide) was applied.**

**TABLE NUMBER 1. NEMATODES COUNTS**

| Treatments | 30 and 60 DAT | | Rooot 60 days after transplant Meloidogyne | | rotylenchus |
|---|---|---|---|---|---|
| | Rotylenchulus | | Eggs | Larvae | |
| 1. absolute witness | 2,800 | 1,850 | 150 | 25 | 25 |
| Member. 250 kg/Ha. | 20 | 180 | 0 | 0 | 0 |
| 3. Me.Br. 125 kg/Ha. | 140 | 350 | 0 | 0 | 0 |
| 4. Solarization + MS 200 L/Ha. | 940 | 1,890 | 0 | 0 | 175 |
| 5. Solarization + MS 300 L/Ha. | 140 | 330 | 0 | 0 | 100 |
| 6. Metham Sodium 400 L/Ha. | 330 | 340 | 0 | 0 | 175 |

Nematodes count in 100 ml of diluted soil , Nematodes count in 25 grs of roots soil

Treatments with methyl bromide bears the most effective control on menatodes. Metham sodium plus solarization is the second best. Absolute witness and metham sodium at 200 lt / Ha + solarization report highest rotylenchulus counts. Melondogyne is only reported in roots samples 60 DAT.

TABLE 2 MAIN SPROUT DEVELOPMENT 18 AND 30 DAYS AFTER TRANSPLANT

| Treatments | 18 dat | Duncan | 30 dat | Duncan |
|---|---|---|---|---|
| 1. absolute witness | 20 | A | 68 | BC |
| 2. member. 250 kg/Ha. | 21 | A | 97 | A |
| 3. Me.Br. 125 kg/Ha. | 18 | A | 80 | ABC |
| 4. Solarization + MS 200 L/Ha. | 21 | A | 82 | AB |
| 5. Solarization + MS 300 L/Ha. | 19.25 | A | 94 | AB |
| 6. Metham Sodium 400 L/Ha. | 13.25 | B | 54 | C |

Metham sodium treatments (400 lt 7 Ha) shows the least development followed by the absolute witness.

TABLE 3 WEEDS 18 DAYS AFTER TRANSPLANT

| Treatments | Graminea | Duncan 0.01 | Wide leave | Duncan 0.01 | ciperacea | Duncan 0.05 |
|---|---|---|---|---|---|---|
| 1. absolute witness | 75.75 | A | 77 | A | 24 | A |
| 2. member. 250 kg/Ha. | 2.50 | D | 56 | AB | 0.00 | B |
| 3. Me.Br. 125 kg/Ha. | 3.75 | D | 55 | AB | 1.25 | B |
| 4. Solarization + MS 200 L/Ha. | 43.25 | B | 27 | C | 12.25 | AB |
| 5. Solarization + MS 300 L/Ha. | 19.25 | C | 15 | C | 7.50 | AB |
| 6. Metham Sodium 400 L/Ha. | 9.00 | CD | 33 | BC | 0.75 | B |

weeds largest count occurred in the witness trial. the lowest count of graminae and ciperaceae shows in methyl bromide and metham sodium (400 lt / ha). Metham sodium shows the lowest counts for wide leave weeds methyl bromide ranks below.

TABLE 4. PERCENTAGE OF PLANTS WITH FUNGI EARLY STEM DISEASE.

| TREATMENT | 44 DAT | DUNCAN 0.1 |
|---|---|---|
| 1. absolute witness | 4.17 | AB |
| 2. member. 250 kg/Ha. | 2.90 | BC |
| 3. Me.Br. 125 kg/Ha. | 4.17 | AB |
| 4. Solarization + MS 200 L/Ha. | 2.90 | ABC |
| 5. Solarization + MS 300 L/Ha. | 2.10 | C |
| 6. Metham Sodium 400 L/Ha. | 4.57 | A |

Treatments with the least presence of languid plants was observed with Me Br 250 kg/ha and Metham sodium + solarization. Results at this stage SHOW A LOWER INCIDENCE than in the first stage in the same experimental site.

TABLE 5 YIELD FOR EXPORT. BOXES PER HECTARES.

| | Grade "A" | | | | | Total | | | |
|---|---|---|---|---|---|---|---|---|---|
| Treatments | 9 | 12 | 15 | 18 | 23 | Grade A | Grade B | Grand total | Duncan 0.05 |
| 1. witness | 16 | 133 | 153 | 212 | 109 | 474 | 149 | 623 | C |
| 2. Me.Br. 250 kg/Ha. | 38 | 336 | 453 | 398 | 154 | 1,108 | 288 | 1,374 | A |
| 3. Me.Br. 125 kg/Ha. | 54 | 300 | 366 | 394 | 157 | 1,009 | 263 | 1.272 | A |
| 4. Solarization + MS 200 L/Ha. | 31 | 179 | 268 | 250 | 139 | 592 | 276 | 868 | B |
| 5. Solarization + MS 300 L/Ha. | 85 | 162 | 232 | 278 | 188 | 640 | 304 | 944 | B |
| 6. Metham Sodium 400 L/Ha. | 8 | 162 | 190 | 320 | 169 | 584 | 264 | 848 | B |

**Production at the second stage, Grade A and Total production (grade a + b ) reflects the best results for methyl bromide. Metham sodium rated second at 300 lts per hectare. Taking into account agricultural practices and the presence of MNSV ( melon sudden collapse) it is suggested to study and apply other cultural practices including the use of mucuna, root cucurbitae grafting , and different dose of metham sodium.**

TABLE 6 TOTAL COST FOR THE TWO MELON CROPS IN THE SAME EXPERIMENTAL AREA. By yield and treatment (us $ / Ha)

| Variable | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| OUTPUT * BOXES/Ha | 1,343 | 2,633 | 2,536 | 1,861 | 2,173 | 1,865 |
| GROSS INCOME / BOX | 5,372 | 10,532 | 10,144 | 7,444 | 8,692 | 7,468 |
| Me Br | -- | 551 | 276 | -- | -- | -- |
| Metham sodium | -- | -- | -- | 340 | 510 | 680 |
| Plastic film | 465 | 465 | 465 | 490 | 490 | 465 |
| Treatments aplication | 20 | 25 | 25 | 30 | 30 | 25 |
| Additives ++ | -- | -- | -- | 200 | 200 | -- |
| Variable cost | 485 | 1,041 | 766 | 1,060 | 1,230 | 1,170 |
| Net income | 4,887 | 9,491 | 9,378 | 6,384 | 7,462 | 6,290 |

**Partial costs continue to be the same as in the first trials, some change depend on the net benefits for each treatment.**

Table 7 DOMINCE ANALYSIS

| Variable | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Variable costs | 485 | 766 | 1,041 | 1,060 | 1,170 | 1,230 |
| net benefit $ 4 per box | 4,887 | 9,378 | 9,491 | 6,384 D | 6,290 D | 7,462 D |

Methyl Bromide at half a dose obtained the highest rate of capital return us $ 15.98 and Me Br at 250 lt / Ha the marginal rate of return diminishes to us $ O.41 . se table 7 and 8.

TABLE 8 INCOME MARGINAL RATE OF RETURN.

| TREATMENTTS | VC | VC | NI | NI | NI/VC |
|---|---|---|---|---|---|
| METHYL BROMIDE 250 KG/Ha | 1,041 | 275 | 9,491 | 113 | 0.41 |
| METHYL BROMIDE 125 K/Ha | 766 | 281 | 9,378 | 4,491 | 15.98 |
| ABSOLUTE WITNESS | 485 | -- | 4,887 | -- | -- |

after considering output from the second yield variable costs remain the same. net benefits(ni) are the ones to vary with this second economic approximation. Only Me Br shows an increase in variable costs and net benefits as compared to the witness. Treatments with Metham Sodium with or with out solarization rise the costs thus lowering the benefits. The reason was explained in the first stage presentation.

Half a dose with Me Br gives the biggest rate of return ( 15.98. When utilizing Me Br at 250 Kg /Ha the rate drops to 0.41 ( table 8)

9. FINDINGS

Treatments with Me Br and Metham Sodium 300 lts / Ha + solarization provide a better control for rotylenchulus and meloidogyne.

Phytotoxicity was not observed with Metham Sodium Treatments

Gramineaceas were reduced in the second stage with Me Br tretaments. Wide leave weed were sensible to Metham sodium but not to Me Br. Both products are effective for ciperaceas control. Out puts in the second stage are superior with me Br and metham sodium (300 lt /Ha + solarization)

Economic analysis for the two stages with Me Br treatments increased variable costs going from a lower dose to the estándar dose this lead to an increase in the net income. Changing Me Br from 125 Kg per Ha is the one that has shown the highest benefits and the lower variable cost. With a higher marginal rate of return. Changing Me Br dose to 250 Kg / Ha to Metham sodium 300 lt / Ha + solarization there is an 18 % increase in variable costs.

Metham sodium treatment 300 lt / Ha + solarization increses its variable cost 20 % due to the additives cost other alternatives should be used. It is expected that Metham Sodium market prices lower as demand increases.

10. RECOMENDATIONS :

- to reduce in the short term me br dose to 125 kg in heavely overworked areas.
- to use metham sodium ( 600 lt / ha + solarization) in new agricultural areas.
- to evaluate other additives to lower solarization costs.
- in the near future to evaluate the use of metham sodium at 400 lt / ha as me br substitute.

## MELON PHASE 1 EL OASIS ICTA ESTANZUELA, ZACAPA

**Site Description.** La Fragua, Zacapa is a high temperature (18- 40° C) low precipitation (660 mm) valley which offers good conditions for export crops. There are 8 larger agro business in the area. 4,000 Ha. are cultivated for melon. The first cycle is fully treated with Methyl Bromide as a soil biocide. The research site is located in EL OASIS – ICTA. The experimental station is under the field management of PROTISA. This land has not been used for intensive agriculture crops. PROTISA a melon producer offered to collaborate with the research trials within ICTA's fields. Engineer Elmer Barrillas from ICTA was in charge of phase I .

**General Objective:** To comply with the Montreal Protocol, signed by the Government of Guatemala and ratified by the National Congress. The objective is to prevent the use of CFC's and Methyl Bromide and implement alternatives which are economic and technically feasible to apply. The contribution of this project is fundamental to strengthening the sustainability of the agricultural production in a hot dry weather area. To preserve the production of such crops and to comply with international regulations including the Montreal Protocol.

**Specific objectives:**
To determine the effect of products over soil born pathogens populations.
To determine treatments effect over weeds populations
To determine treatments effect over total yield
To establish production costs for aech alternative treatment

**Trial lapse : September 1998 to January 30, 1999**

**Methodology:** Experimental design has been defined with randomized blocks, four replications and variance analysis utilizing university of Michigan statistics analysis: MSTAT. If significance is found at 5%, median analysis will be applied Duncan's. Test. Plots are 5.4 mts wide and 10 mts long, for a total area of 54 square meters. Total area 1,500 square meters

| No. | ICTA, OASIS |
|---|---|
| 1 | Testigo (solamente cobertura plásticas) |
| 2 | Bromuro de metilo dosis 250 kilos/ha |
| 3 | Bromuro de metilo dosis 125 kilos/ha |
| 4 | Metam sodio dosis 350 litros/ha |
| 5 | Metam sodio dosis 350 litros/ha + solarizado |
| 6 | Gallinaza (biofumigación) dosis 4545.45 kilos/ha + solarizado |
| 7 | Basamid (Dazonet) dosis 267 kilos/ha |

**Soil analysis :**

1. **previous to treatments**
2. **post treatments samples**

Soil samples collected previously to the treatments applications (nematodes counts). Every four days physical inspections will be performed to assess plant disease. By the end of the crop 10 plants will be sampled from each one of the replications to evaluate the presence of meloidogyne. Economic analysis will be performed to assess benefits and variability of the experiments. Research Protocols, selected sites and coordinating activities were presented and discussed with Dr. Hugo Figueroa, UNIDO's supervisor and Dr. Javier Tello Senior Consultant from the University of Almería and Chief Expert from UNIDO.

**Results and Discussion:** *After performing* preparatory activities and applying treatments to the melon experimental plots , partial results were reported at 31 days and post harvest results are completed in the following tables ( 1 to 9)

**table 1. nematodes population . MELON phase 1 ICTA EL OASIS ZACAPA**

| Treatments | Meloidogyne | | | Rotilenchulus | | | Rhabditis | | |
|---|---|---|---|---|---|---|---|---|---|
| | Pretreat | Postrea | Pharvest | Pretreat | Postrea | Pharvest | pretreat | postrea | Pharvest |
| 1. witness | 0 | 0 | | 40 | 40 | 1,680 | 40 | 20 | 125 |
| 2. Me.Br. 250 kg/Ha | 0 | 0 | | 40 | 20 | 910 | 40 | 20 | 25 |
| 3. Me.Br. 125 kg/Ha | 0 | 0 | | 40 | 30 | 0 | 40 | 20 | 0 |
| 4. MS 350Lts/Ha | 0 | 0 | | 40 | 20 | 270 | 40 | 20 | 0 |
| 5. MS 350Lts/Ha + solarizat. | 0 | 0 | | 40 | 0 | 329 | 40 | 0 | 100 |
| 6. Chicken compost 4545.45Kg/Ha + solarizt. | 0 | 0 | | 40 | 0 | 1040 | 40 | 50 | 275 |
| 7. Basamid 267 kg/Ha | 0 | 0 | | 40 | 0 | 2940 | 40 | 40 | 150 |

Findings: nematodes counts were reduced for each treatment. 50% reduction was obtained with Me.Br. (250kg/Ha) and Metham sodium (350 Lts/Ha). **Reductions with Metham sodium, chicken manure and Basamid reduced rotilenchulus count by 100 % Meloidogyne was not found in soil samples. Methyl Bromide at 250 kg/Ha and metham sodium diminished 50 % of the initial count . The third sample was performed 60 days after harvest time rotilenchulus count highly were incremented : Basamid, witness chicken manure and methyl bromide at 250 Kg/Ha rotilenchulus count were higly increased.**
**Methyl Bromide at 125 Kg /ha rotilenchulus count was cero.**

Table 2 MAIN SPROUT DEVELOPMENT. MELON phase I el oasis icta

| Treatments | Days | Replications | | | | Median |
|---|---|---|---|---|---|---|
| | | I | II | III | IV | |
| 1. Witness | 10DDT | 9.86 | 9.87 | 9.93 | 9.5 | 9.79 |
| | 25DDT | 83.2 | 79.6 | 79.6 | 87 | 86.20 |
| 2. MeBr 250 kg/ha | 10DDT | 10.31 | 10.58 | 10.58 | 10.41 | 10.44 |
| | 25DDT | 84.6 | 91.8 | 91.8 | 96.4 | 91.20 |
| 3. MeBr. 125 kg/ha | 10DDT | 10.24 | 10.02 | 10.02 | 10.05 | 10.13 |
| | 25DDT | 78.2 | 83.8 | 83.8 | 92.8 | 87.45 |
| 4. Methan S 350lts/ha | 10DDT | 9.63 | 9.71 | 9.71 | 9.73 | 9.71 |
| | 25DDT | 78 | 78.8 | 78.8 | 97.2 | 85.00 |
| 5. Methan S 350 Lts/Ha + Solarization | 10DDT | 10.41 | 10.56 | 10.56 | 10.64 | 10.54 |
| | 25DDT | 78.2 | 98.4 | 98.4 | 101.6 | 94.00 |
| 6. Chicken 4545.45 Kg/ha + solarization | 10DDT | 10.71 | 10.86 | 10.86 | 10.87 | 10.82 |
| | 25DDT | 97 | 104 | 104 | 103.2 | 104.15 |
| 7. Basamid 400 kg/Ha | 10DDT | 10.69 | 10.72 | 10.72 | 10.78 | 10.74 |
| | 25DDT | 82.2 | 107.8 | 107.8 | 93.6 | 94.45 |

Comments: highly significant lecture (p.o1) was obtained with the application of metham sodio + solarization; biofumigation + solarization and basamid (400 kg/Ha).

**Table 3** WEEDS POPULATION 25 DAT MELON. ICTA EL OASIS ZACAPA

| Treatments | Cyperacia | Graminidae | Wide leaf | Total |
|---|---|---|---|---|
| 1. Witness | 2 | 1.25 | 5.5 | 8.75 |
| 2. MeBr 250 kg/ha | 0.25 | 0 | 1 | 1.25 |
| 3. MeBr. 125 kg/ha | 0.5 | 0 | 0.75 | 1.25 |
| 4. Methan S 350lts/ha | 0 | 0 | 1.75 | 1.75 |
| 5. Methan S 350 Lts/Ha + solarizt. | 0 | 0 | 0 | 0 |
| 6. Chicken 4545.45 Kg/ha + solar. | 0.25 | 0 | 0.5 | 0.75 |
| 7. Basamid 400 kg/Ha | 0.25 | 0 | 0.5 | 0.75 |

**Weeds count.** Comments The total witness shows the highest weeds count Metham + solarization shows the best performance. Alltreatments showed control.

**Table 4. infected plants.(bacterial and fungi )melón phase I ICTA, El Oasis**

| Tratamientos | Plantas enfermas de marchitamiento | | | |
|---|---|---|---|---|
| | 35 ddt | 45 ddt | 41 ddt | Duncan |
| | (% ) | (%) | (%) | (P<0.01) |
| 1. witness | 3.33 | 3.33 | 25 | Ns |
| 2. MeBr 250 kg/ha | 3.33 | 8.33 | 28 | Ns |
| 3. MeBr. 125 kg/ha | 0.00 | 5.00 | 21 | Ns |
| 4. Methan S 350lts/ha | 0.00 | 5.00 | 21 | Ns |
| 5. Methan S 350 Lts/Ha + solarizt. | 0.00 | 5.83 | 28 | Ns |
| 6. Chicken 4545.45 Kg/ha + solar. | 0.00 | 9.17 | 29 | Ns |
| 7. Basamid 400 kg/Ha | 0.00 | 2.50 | 36 | Ns |

**Table 4 A** Comments: Findings results witness (86.2 cm). DUNCAN B Highest figure treatments # 6 (104.15) DUNCAN A followed by treatment 7 and 5. MeBr. # 2, # 3 and 91.20 and 87.45 cm. length respectability.

**Table 5. %** PLANTS AFFECTED WITH GOMOSIS 55 DAYS AFTER TREATMENT

| Treatments | % INFECTED PLANTS |
|---|---|
| 1. Witness | **25** |
| 2. MeBr. 250 kg/Ha | **28** |
| 3. Metham Sodio 350 Lts/Ha | **21** |
| 4. Metham Sodio 350 Lts/Ha | **28** |
| 5. Metham Sodio 350 Lts/Ha + solarization | **29** |
| 6. Chicken 4545.45 kg/Ha + solarization | **36** |
| 7. Basamid 267 kg/Ha. | **23** |

**Table 5** Comments: percentage of infected plant 21 –36 % the main problem addressed by melon growers. The incidence of the disease is not controled by soil treatments.

**CROP YIELD**

**Table. 6. Crop yield and applied treatments grade A, ICTA, El Oasis,Zacapa.**

| TREATMENTS | Grade according to size and quality | | | | | Grade A | Duncan (P<0.01) |
|---|---|---|---|---|---|---|---|
| | Fruits per box | | | | | | |
| | 9 | 12 | 15 | 18 | 23 | | |
| WITNESS | 0 | 46 | 556 | 409 | 260 | 1271 | NS |
| Methyl Bromide 250 kg/ha | 0 | 185 | 407 | 463 | 66 | 1121 | NS |
| Methyl Bromide 125 kg/ha | 0 | 127 | 389 | 455 | 248 | 1219 | NS |
| Methm sodio 350 l/ha | 0 | 139 | 296 | 625 | 193 | 1253 | NS |
| **Metham sodio 350 l/ha+ solarization** | 8 | 232 | 259 | 479 | 175 | 1145 | NS |
| Chicken manure 4546 Kg./ha + solarization | 0 | 174 | 379 | 463 | 103 | 1119 | NS |
| Basamid (dazonet) 267 Kg./ha | 16 | 58 | 398 | 448 | 163 | 1083 | NS |

Fuente: Proyecto ICTA-Unido-IPM CRSP. 1998-99.

Cuadro 7. **Crop yield and applied treatments grade B boxes per hectare. MELON PHASE I ICTA, El Oasis,Zacapa.**

| TREATMENTS | Grade by fruit size. | | | | | Total Grade B | Duncan (P<0.01) |
|---|---|---|---|---|---|---|---|
| | Fruits per box | | | | | | |
| | 9 | 12 | 15 | 18 | 23 | | |
| Witness | 0 | 12 | 9 | 108 | 182 | 311 | NS |
| Methyl Bromide 250 kg/ha | 0 | 0 | 56 | 216 | 151 | 423 | NS |
| Methyl Bromide 125 kg/ha | 0 | 0 | 56 | 209 | 223 | 488 | NS |
| Metham sodium 350 l/ha | 0 | 23 | 28 | 178 | 194 | 423 | NS |
| **Metham sodium 350 l/ha+ solarization** | 0 | 23 | 37 | 185 | 151 | 396 | NS |
| **Chicken manure 4546 Kg./ha + solarization** | 0 | 12 | 111 | 170 | 169 | 462 | NS |
| Basmid (Dazonet) 267 Kg./ha | 0 | 0 | 28 | 178 | 212 | 418 | NS |

Fuente: Proyecto ICTA-Unido-IPM CRSP. 1998-99.

Cuadro 8. Total crop yield by treatments (grade A + grade B) boxes per hectare export quality MELON PHASE I . **ICTA, El Oasis, Zacapa.**

| Treatments | Total grade A + B quality by fruit size | | | | | Total | Duncan (P<0.01) |
|---|---|---|---|---|---|---|---|
| | Fruits per box | | | | | | |
| | 9 | 12 | 15 | 18 | 23 | | |
| Witness | 0 | 58 | 565 | 517 | 442 | 1582 | NS |
| Methyl Bromide 250 kg/ha | 0 | 185 | 463 | 676 | 217 | 1544 | NS |
| MethylBromide 125 kg/ha | 0 | 127 | 445 | 664 | 472 | 1707 | NS |
| Metham sodium 350 l/ha | 0 | 162 | 324 | 803 | 387 | 1676 | NS |
| **Metham sodium 350 l/ha+ solarizat.** | 0 | 255 | 296 | 664 | 326 | 1541 | NS |
| Chicken manure 4546 Kg./ha + solarizat. | 0 | 186 | 490 | 633 | 272 | 1581 | NS |
| Basamid (Dazonet) 267 Kg./ha | 16 | 58 | 426 | 626 | 375 | 1501 | NS |

**Crop yield Total yield obtained by witness trial could be attributed to the soil since this is a virgin soil.**
**Variance analysis shows no statistical difference. This could indicate that any treatment could be used when fields have not been used intensively.**

VARIABLE COST ANALYSIS

**Table 9 variable cost us $ per hectare. Melon crop. MELON I**

| Treatment | Plástic film* | Additives ** | Active product | labor *** | Total |
|---|---|---|---|---|---|
| 1. testigo | 465.00 | 0.00 | 0.00 | 20.00 | 485.00 |
| 2. BrMe 250 K/ha | 465.00 | 0.00 | 551.00 | 25.00 | 1,041.00 |
| 3. BrMe 125 K/ha | 465.00 | 0.00 | 276.00 | 25.00 | 766.00 |
| 4. Metam Sodio 350Lt/ha | 465.00 | 0.00 | 595.00 | 25.00 | 1,085.00 |
| 5. Metam Sodio 350 Lt/ha + solarizat. | 490.00 | 200.00 | 595.00 | 30.00 | 1,315.00 |
| 6. gallinaza 4,545.45 K/ha + solarizat . | 490.00 | 200.00 | 454.50 | 35.00 | 1,180.00 |
| 7. Basamid 267 K/ha | 465.00 | 0.00 | 1,869.00 | 30.00 | 2,364.00 |

**Basamid cost is the highest it duplicates Me Br costs. Witness cost includes the plastic film and labor.**

Table 9 DIRECT COST FOR ACTIVE PRODUCT NO OTHER COSTS ARE INCLUDED

| PRODUCTS | US $ / Ha. |
|---|---|
| Methyl Bromide 250 KG/Ha | **550.00** |
| Methyl Bromide 125 KG/Ha | **275.00** |
| Metham Sodium 350 lts/Ha | **625.00** |
| Chicken compost 4545.45 KG/Ha. | **515.00** |
| Basamid 400 KG/Ha | **2,800.00** |

table 9 direct cost. variance analysis demonstrated statistical difference between treatments.

## Table 10 . cost analysis by treatment melon crop.

| Treatment | Out put boxes/ per Hectare | Gross Income | Variable cost | Net Income |
|---|---|---|---|---|
| 1. testigo | 1,582 | 6,328 | 485 | 5,843 |
| 2. BrMe 250 K/ha | 1,544 | 6,176 | 1,041 | 5,135 |
| 3. BrMe 125 K/ha | 1,707 | 6,828 | 766 | 6,062 |
| 4. Metam Sodio 350Lt/ha | 1,676 | 6,704 | 1,085 | 5,619 |
| 5. Metam Sodio 350 Lt/ha + solarization | 1,541 | 6,164 | 1,315 | 4,849 |
| 6. gallinaza 4,545.45 K/ha + solarization | 1,581 | 6,324 | 1,180 | 5,144 |
| 7. Basamid 267 K/ha | 1,501 | 6,004 | 2,364 | 3,640 |

Table 10 comments : Methyl Bromide ($. 6,062), absolute witness ($.5,843) Metham Sodium ($.5,619) are the treatments with the highest benefits. **Methyl Bromide 125 Kg7Ha and metham Sodium 350 lt / Ha are an option for standard Me Br dose.**

## Table 11 . cost analysis DOMINANCE ANALYSIS by treatment melon crop.

| Treatment | Variable cost | Net income | Dominance |
|---|---|---|---|
| 1. testigo | 766 | 6,062 | -- |
| 2. BrMe 250 K/ha | 485 | 5,843 | -- |
| 3. BrMe 125 K/ha | 1,085 | 5,619 | D |
| 4. Metam Sodio 350Lt/ha | 1,180 | 5,144 | D |
| 5. Metam Sodio 350 Lt/ha + solarization | 1,041 | 5,135 | D |
| 6. gallinaza 4,545.45 K/ha + solarization | 1,315 | 4,849 | D |
| 7. Basamid 267 K/ha | 2,364 | 3,640 | D |

Comments: existing local prices for alternative products are affecting the possibilities of the alternative treatments.

## Table 12 Marginal rate of return by treatment. In us $ dollars Melon crop.

| Treatment | Variable cost | Net income | Incremetal net income | Incremental Variable cost | MR of return |
|---|---|---|---|---|---|
| 1. testigo | 485 | 5,843 | -- | -- | -- |
| 2. BrMe 250 K/ha | | | | | |
| 3. BrMe 125 K/ha | 766 | 6,062 | 219 | 281 | 77.94 |
| 4. Metam Sodio 350Lt/ha | | | | | |
| 5. Metam Sodio 350 Lt/ha + solarization | | | | | |
| 6. gallinaza 4,545.45 K/ha + solarization | | | | | |
| 7. Basamid 267 K/ha | | | | | |

MRT = (net income/variable cost) x 100 . Methyl Bromide 125 Kg / Ha shows a MRT of .78 in respect to the absolute witness.

13. FINDINGS:

Evaluated treatments have statistically the same effect on weed control, except for the absolute witness, which shows statistical difference.

For nematodes control, BASAMID (2677 KG / Ha), chicken manure 4,545 KG / Ha * solarization and Metham sodium 350 lt / Ha * solarization offer the best alternative treatment. Me Br does not present a good control over Rotilenchulus.

Plants affected by gomosis ranges from 21 to 36 % there is no relation ship between soil treatments and the presence of the disease.

The average fruit out put (boxes / Ha ) is 1,590 boxes. There is no statistical difference between the different treatment. The experimental site is located on fertile soils non intensively cultivated.

Methyl Bromide (125 KG / Ha) shows the largest net benefit us $ 6,060 as compared to the absolute witness ( us $ 5,843) Metham Sodium net benefit is us$ 5,619.00

The Marginal Rate of Return for Methyl Bromide (125 KG7Ha) is .78 over the absolute witness. Some of the alternative products are not competitive because of their higher local prices. In the near future this condition has to be evaluated.

With a second phase trials variables under study and results could be validated.

In non intensive exploited fields lower doses of Methyl bromide could be used (125 KG/Ha) or Metham Sodium at 350 lt / Ha.

## 14. RECOMMENDATIONS:

**To perform a second trial, to validate preliminary results, sine plastic film is utilized for two consecutive crops.**

**To incorporate crops remains into the soil to prevent soil degradation.**

**AFTER THE FIRST TRIALS WERE PERFORMED IN THIS AREA A SECOND SET OF EXPERIMENTS WAS CARRIED OUT IN THE SAME EXPERIMENTAL PLOTS, UNDER THE NAME OF ICTA EL OASIS : MELON SECOND STAGE, summary is presented in the following pages :**

**ALTERNATIVES TO THE USE OF METHYL BROMIDE**
**MELON phase 2 EL OASIS ICTA ESTANZUELA, ZACAPA**

**Site Description .** La Fragua, Zacapa is a high temperature (18- 40° C) low precipitation (660 mm) valley which offers good conditions for export crops. There are 8 larger agro business in the area. 4,000 Ha. are cultivated for melon. The first cycle is fully treated with Methyl Bromide as a soil biocide. The research site is located in EL OASIS – ICTA s experimental station under the field management of PROTISA. This land has not been used for intensive agriculture crops. PROTISA supports this activity applying their own cultural practices,

**General Objective:** To comply with the Montreal Protocol, signed by the Government of Guatemala and ratified by the National Congress. The objective is to prevent the use of CFC's and Methyl Bromide and implement alternatives which are economic and technically feasible to apply.

The contribution of this project is fundamental to strengthening the sustainability of the agricultural production in a hot dry weather area. To preserve the production of such crops and to comply with international regulations including the Montreal Protocol.

**Specific objectives:**

To determine the effect of products over soil born pathogens populations.
To determine treatments effect over weeds populations
To determine treatments effect over total yield
To establish production costs for aech alternative treatment

**Trial lapse: february 9, 1999 to april 20$^{th}$ 1999.**

**Methodology:** Experimental design has been defined with randomized blocks and four replications. Each experim3ental plot is 5.4 mts wide and 10 mts long. Statistical analysis: variance analysis utilizing university of Michigan statistics analysis: MSTAT. If significance is found at 5%, median analysis will be applied Duncan's Test.

**Soil analysis :** Soil samples were collected previously to the treatments applications (nematodes counts). Every four days physical inspections will be performed to assess plant disease. By the end of the crop 10 plants will be sampled from each one of the replications to evaluate the presence of meloidogyne. Economic analysis will be performed to assess benefits and variability of the experiments. Research Protocols, selected sites and coordinating activities were presented and discussed with Dr. Hugo Figueroa, UNIDO's

supervisor and Dr. Javier Tello Senior Consultant from the University of Almería and Chief Expert from UNIDO.

**Economic analysis : variable costs were be established for each treatment. The Marginal Rate of Return considers : Gross income, variable costs, net income dominance analysis and MRT analysis.**

## Results and Discussion:

**The trials were conducted under plastic coverage and dripping irrigation. Once the soil treatments were applied melon seedling were transplanted to the fields on February 9, 1999. Overall a good plat development was observed. 56 days after transplant harvested out put was evaluated. Due to severe weather condition (excess of rain fall) large population of bemisia tabacci (mosca Blanca) originated.**

TABLE NUMBER 1. NEMATODES COUNTS

| TREATMENT | soil and root samples/ DAYS AFTER TRANSPLANT | | | |
|---|---|---|---|---|
| | 1DBT | 30 DAT | 65 DAT | ROOTS |
| 1. absolute witness | 1,680 | 570 | 930 | 0 |
| 2. Me Br 250 kg/Ha. | 910 | 230 | 1,300 | 225 |
| 3. Me.Br. 125 kg/Ha. | 0 | 0 | 400 | 25 |
| 4 Metham sodium 350 lt/ha | 270 | 670 | 4,380 | 575 |
| 5. Metham sodium 300 lt /ha + Solarizat | 320 | 950 | 2,410 | 175 |
| 6.chicken manure 4545 Kg /ha + solariz | 1.040 | 1,500 | 2,800 | 250 |
| 7. Basamid dazonet 267 kg /ha | 2,040 | 1,800 | 4,130 | 275 |

**Nematodes count in 100 ml of diluted soil , Nematodes count in 25 grs of roots soil at 30 days.** Treatments with methyl bromide bears the most effective control on menatodes. Metham sodium 350 lt/Ha was the second best (670 menatodes). Basamid had the overall highest count No phytotoxisity was present.

TABLE 2 main sprout development 18 and 30 days after transplant in cms

| Treatments | 30 dat | Duncan |
|---|---|---|
| 1. absolute witness | 98 | NS |
| 2. Me Br 250 kg/Ha. | 97 | NS |
| 3. Me.Br. 125 kg/Ha. | 105 | NS |
| 4. Metham Sodium 350 l/ha | 102 | NS |
| 5. Solarization + MS 350 L/Ha. | 90 | NS |
| 6.chicken manure 4546 kg7ha Solarizat | 91 | NS |
| 7. basamid 267 kg /ha | 93 | NS |

No statistical difference was shown

TABLE 3 WEEDS 18 DAYS AFTER TRANSPLANT

| Treatments | Graminea | Wide leave | ciperacea | Total | Duncan 0.05 |
|---|---|---|---|---|---|
| 1. absolute witness | 1.2 | 2.0 | 1.3 | 4.5 | NS |
| 2. Me Br 250 kg/Ha. | 1.3 | 1.6 | 0.9 | 3.8 | NS |
| 3. Me.Br. 125 kg/Ha. | 0.8 | 1.1 | 1.3 | 3.3 | NS |
| 4. Metham Sodium 350 /h | 1.0 | 1.5 | 0.7 | 3.3 | NS |
| 5. Solarization + MS 350 l/h | 1-2 | 1.2 | 1.1 | 3.5 | NS |
| 6.chicken manure 4546 kg7ha | 1.3 | 1.9 | 0.7 | 4.0 | NS |
| 7. basamid 267 kg /ha | 0.7 | 1.7 | 1.1 | 3.5 | NS |

**weeds largest count occurred in the witness trial. NO STATISTICAL DIFFERENCE WAS SHOWN**

TABLE 4. PERCENTAGE OF PLANTS WITH FUNGI EARLY STEM DISEASE.

| TREATMENT | 55 DAT | DUNCAN 0.1 |
|---|---|---|
| 1. absolute witness | 22.5 | A |
| 2. Me Br 250 kg/Ha. | 6.7 | AB |
| 3. Me.Br. 125 kg/Ha. | 10.0 | ABC |
| 4. Metham Sodium 350 l/ha | 15.8 | BC |
| 5. Solarization + MS 350 L/Ha. | 17.5 | BC |
| 6.chicken manure 4546 kg7ha | 10.8 | BC |
| 7. basamid 267 kg /ha | 5.8 | C |

**Gomosis is a prevalent disease as reported by agronomist in site. Signifficative differences were observed with the different treatments.**

TABLE 5 YIELD FOR EXPORT. BOXES PER HECTARES.

| | Grade "A" | | | | | Total | | | |
|---|---|---|---|---|---|---|---|---|---|
| Treatments | 9 | 12 | 15 | 18 | 23 | Grade A | Grade B | Grand total | Duncan 0.05 |
| 1. absolute witness | 0 | 35 | 93 | 131 | 181 | 440 | 542 | 982 | NS |
| 2. Me Br 250 kg/Ha. | 0 | 23 | 157 | 239 | 187 | 607 | 674 | 1282 | NS |
| 3. Me.Br. 125 kg/Ha. | 0 | 35 | 130 | 177 | 320 | 662 | 783 | 1445 | NS |
| 4. Metham Sodium 350 l/ha | 0 | 35 | 56 | 100 | 193 | 384 | 629 | 1013 | NS |
| 5. Solarization + MS 350 L/Ha. | 0 | 0 | 93 | 77 | 139 | 309 | 533 | 842 | NS |
| 6.chicken manure 4546 kg7ha | 0 | 12 | 46 | 69 | 121 | 248 | 575 | 824 | NS |
| 7. basamid 267 kg /ha | 0 | 46 | 56 | 77 | 85 | 264 | 563 | 827 | NS |

**Production at the second stage, Grade A and Total production (grade a + b ) reflects the best results for methyl bromide. Metham sodium rated second at 3500 lts per hectare.**

TABLE 6 TOTAL COST FOR THE TWO MELON CROPS IN THE SAME EXPERIMENTAL AREA. By yield and treatment (US $ / Ha)

| | treatments | | | | | |
|---|---|---|---|---|---|---|
| Variable | 1 | 2 | 3 | 4 | 5 | 6 |
| OUTPUT * BOXES/Ha | 2,564 | 2,826 | 3,152 | 2,689 | 2,383 | 2,328 |
| GROSS INCOME / BOX | 10,256 | 11,304 | 12,608 | 10,756 | 9,532 | 9,312 |
| Me Br | 0 | 551 | 276 | 0 | 0 | 0 |
| Metham sodium | 0 | 0 | 0 | 595 | 595 | 0 |
| Plastic film | 465 | 465 | 465 | 465 | 490 | 465 |
| Chicken manure | 0 | 0 | 0 | 0 | 0 | 0 |
| Basamid | 0 | 0 | 0 | 0 | 0 | 1,869 |
| Treatment application | 20 | 25 | 25 | 25 | 30 | 30 |
| Additives | 0 | 0 | 25 | 0 | 200 | 0 |
| Variable cost total | 485 | 1,041 | 766 | 1,085 | 1,315 | 2,364 |
| Net benefit | 9771 | 10,263 | 11,842 | 9,671 | 8,217 | 6,948 |

**Partial costs continue to be the same as in the first trial, some change depend on the net benefits for each treatment.**

Table 7 DOMINCE ANALYSIS for each treatment US $

| Variable | Variable cost / Ha | Net benefit Us$ | Dominance |
|---|---|---|---|
| 1. absolute witness | 766 | 11,842 | D |
| 2. Me Br 250 kg/Ha. | 1,41 | 10,263 | D |
| 3. Me.Br. 125 kg/Ha. | 485 | 9,771 | D |
| 4. Metham Sodium 350 l/ha | 1,85 | 9,671 | D |
| 5. Solarization + MS 350 L/Ha. | 1,180 | 8,440 | D |
| 6.chicken manure 4546 kg7ha | 1,315 | 8,217 | D |
| 7. basamid 267 kg /ha | 2,364 | 6,948 | D |

Methyl Bromide at half a dose obtained the highest rate of capital return us $ 15.98 and Me Br at 250 lt / Ha the marginal rate of return diminishes to us $ O.41 . se table 7 and 8.

TABLE 8 MARGINAL RATE OF RETURN. IN US $

| TREATMENTS | VC | VC | NI | NI | NI/VC |
|---|---|---|---|---|---|
| WITNESS | 485 | -- | 9,771 | | |
| METHYL BROMIDE 125 K/Ha | 766 | 281 | 11,842 | 2,071 | 737 |

**Dominance analysis and marginal rate of return were applied to methyl bromide and the witness and showed a 737.1 % MRT with respect to the witness. THE OTHER**

TREATMENTS WERE NOT SELECTED DUE TO THE LOCAL HIEGHER COSTS FOR THE ALTERNATIVE PRODUCTS.

13. FINDINGS:

1. Nematodes counts. 30 DAT. Treatments with the best control over nematodes are: Me Br (125 Kg/Ha), Me Br (250 Kg /Ha), the absolute witness shows the second lowest count. Other treatments are consistently higher.
2. Gomosis affected plants range from 22.5 % in witness to 5.8 % basamid treatment. No relation ship is shown between soil treatments an gomosis.
3. No statistical difference was apparent for stem length for each treatments.
4. The average fruit out put, boxes per Ha is 1,030. There is no statistical difference between treatments.
5. Net income (benefits) is higher with Methyl Bromide treatments(125 Kg/Ha) . Us $ 5,396, Me Br (250 Kg/Ha) us $ 4,604. Absolute witness = us $ 3,682.
6. And metham sodium with us$ 3,509.
7. MRT for MeBr treatment as compared to absolute witnes is 1,219.9 %
8. Some of local prices for the alternative products have a low demand.
9. Metham sodium seems to be the most feasible alternative.
10. Me Br is effective at low volume dose (125 Kg / Ha)

RECOMMENDATIONS:
To validate in the open fields Me Br at 125 Kg / Ha as a reduction alternative, Metham sodium has to be validated as an alternative with a 250 lt / Ha.}

To evaluate Metham sodium at 350 lt / Ha at tne begging of the cycle in heavily exploited fields

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## ALTERNATIVES TO THE USE OF METHYL BROMIDE TOBACCO EXPERIMENT. LA FRAGUA "EL GOLFITO" ZACAPA

**Experimental Sites Description and results**: This experiment replaces "Cabañas" experiment site. Purpose to evaluate alternatives to the use of methyl bromide in soil desinfection to prepare, tobacco seedlings and then transplant to treated fields. New area site is located in La Fragua Golfito, at DIMON company.
**Crop cycle : September 1998 – february 1999**

### Specific Objectives:

- To evaluate the impact of different alternatives in pathogen populations
- To determine effects on tobacco commercial
- To establish production costs and cost-benefit for each treatment

**Experimental Design:** Experimental design has been defined as random blocks and four replications. 8 random blocks, 8 treatments and 4 . Total plot 10 sq. mt (net 6 sq.mt) table length 1 x 1 meter wide. Experimental unit 10 square meters. 680 square meters treatments with and with out solarization were applied 5-6 October 1998, Methyl Bromide treatments were applied in October 27. Due to severe weather conditions (Mitch Hurricane ) seed beds was established on November 17$^{th}$. 41 and 19 days after soil treatments were applied.

### Alternative treatments:

1. Absolute witness
2. Me.Br. 45 gr. / square meter.
3. Me.Br. 22.5 gr. / square meter.
4. Metham Sodium 350 Lt./Ha
5. Metham sodium 350 lt. / Ha + solarization 4 weeks.
6. Chicken manure 4545.45Kg. / Ha + solarization 4 weeks
7. Basamid 40 gr. / sq. mt.
8. Basamid 40 gr. / sq. mt. + solarization 4 weeks

### Soil sampling:

1. **before applying treatments**
2. **after soil was treated**
3. **after 60 days in seedling site**

### Microbiological Analysis:

1. **nematodes counts in for the three samplings**
2. **field direct observation to assess fungi and bacterial diseases.**
3. **Cultural works recording**
4. **Phytosanitary seedling treatment**
5. **Watering and weeds control.**
6. **climatic variables, temperature, rain precipitation.**

**Variables to be Evaluated:**

a) weeds population
b) nematodes and pathogens
c) plantules developments
d) plantules final quality evaluation.

**Agricultural Activities:**

- Soil preparation September 28
- Experiment layout September 28
- Sampling October 10
- treatments application October 10
- Planting/seedlings December 30
- Transplant 2nd week January 99

Statistical analysis. statistical analysis was performed using logarithmic transformations (base 10) with cero and angular transformation or seno arch when data is in percentage units. when an statistical difference is find Duncans means test is applied. economic analysis relates to total costs in us $.

**RESULTS PRESENTATION.**

TABLE 1 NEMATODES COUNT. TOBACCO SEEDLINGS

| TREATMENTS | MELOIDOGYNE | | | PRATILENCHUS | | | ROTILENCHUS | | |
|---|---|---|---|---|---|---|---|---|---|
| | Before | | final | Before | | final | Before | | final |
| | befor e | Trea t | See dl | befo re | treat | see dl | befor e | Treat | Seed l |
| 1. absolute witness | 0 | 0 | 0 | 40 | 20 | 0 | 0 | 0 | 0 |
| 2. meBr 45 grms / m2 | 0 | 0 | 0 | 40 | 0 | 0 | 0 | 0 | 0 |
| 3. meBr 22.5 grms / m2 | 0 | 0 | 0 | 40 | 0 | 0 | 0 | 0 | 0 |
| 4. Metham Sodium 350 lt /Ha | 0 | 20 | 0 | 40 | 20 | 0 | 0 | 20 | 0 |
| 5. Metham Sodium 350 lt /Ha + Solarization | 0 | 0 | 0 | 40 | 0 | 0 | 0 | 60 | 0 |
| 6. Chicken manure 4545 Kg / Ha + Solarization | 0 | 0 | 0 | 40 | 80 | 0 | 0 | 0 | 0 |
| 7 Basamid 40 gr. / square meter | 0 | 0 | 0 | 40 | 0 | 0 | 0 | 0 | 0 |
| 8 Basamid 40 gr. /s.m + solariz | 0 | 0 | 0 | 40 | 0 | 0 | 0 | 0 | 0 |

Menatodes count per 100 ml of diluted soil
First sampling was done in the experimental site before treatments. Only a slight count of pratilenchulus was visible before treatments. Later this count was considerably diminished. Metham sodium . Chicken manure shows the highest count even more than the absolute witness.

TABLE 2 WEEDS COUNTS 23 DAYS AFTER PLANTING BY SQUARE METER

| TREATMENTS | graminea e | Dunca n 0.1 | Wide leaf | Dunca n 0.1 | ciperac ea | Dunca n 0.05 |
|---|---|---|---|---|---|---|
| 1. absolute witness | 32 | A | 9 | ABC | 7 | A |
| 2. meBr 45 grms / m2 | 2 | C | 0 | C | 0 | B |
| 3. meBr 22.5 grms / m2 | 5 | BC | 2 | BC | 0 | B |
| 4. Metham Sodium 350 lt | 9 | BC | 10 | AB | 0 | B |
| 5. Metham Sodium 350 lt /Ha + Solarization | 5 | BC | 3 | BC | 5 | AB |
| Chicken manure 45 Kg / Ha + solarization | 17 | B | 12 | A | 0 | B |
| 7 Basamid 40 grs / square meter | 10 | BC | 6 | ABC | 1 | B |
| 8 Basamid 40 grs /s.m + solariz | 1 | C | 0 | C | 1 | B |

AFTER 23 DAYS Me Br and Metham sodium + solarization and Basamid showed the lowest weeds counts.

TABLE 3 leaf length. 23 32 and 42 DAYS AFTER PLANTING / SQ MTR.

| TREATMENTS | 23 DAS | Duncan 0.01 | 32 DAS | Duncan 0.01 | 42 DAS | Duncan 0.01 |
|---|---|---|---|---|---|---|
| 1. absolute witness | 1.3 | D | 7.6 | B | 12 | B |
| 2. meBr 45 grms / m2 | 2.4 | A | 12.0 | A | 17.25 | A |
| 3. meBr 22.5 grms / m2 | 1.9 | ABCD | 1.1 | A | 16.13 | A |
| 4. Metham Sodium 350 lt /Ha | 1.5 | BCD | 10.4 | AB | 14.50 | AB |
| 5. Metham Sodium 350 lt /Ha + Solarization | 1.4 | CD | 11.0 | A | 15.25 | AB |
| Chicken manure 45 Kg / Ha +Solarization | 2.1 | ABC | 11.4 | A | 16.13 | A |
| 7 Basamid 40 grs / square meter | 2.1 | ABC | 11.5 | A | 15.25 | AB |
| 8 Basamid 40 grs /s.m + solariz | 2.2 | AB | 12.5 | A | 16.88 | A |

**after 42 days all treatments are statistically the same regarding leafs length.**

**TABLE 4** NUMBER OF PLANTULES INFECTED / sq. mt. 23 AND 42 DAYS AFTER SEED PLANTING. TOBACCO SEEDLINGS

| TREATMENTS | 23 DAYS AFTER SEED | 42 DAYS AFTER SEED |
|---|---|---|
| 1. absolute witness | 148 | 72 |
| 2. meBr 45 grms / m2 | 150 | 79 |
| 3. meBr 22.5 grms / m2 | 167 | 73 |
| 4. Metham Sodium 350 lt /Ha | 147 | 71 |
| 5. Metham Sodium 350 lt /Ha + Solarization | 142 | 73 |
| 6 chicken manure 45 Kg / Ha + solarization | 127 | 65 |
| 7 Basamid 40 grs / square meter | 137 | 84 |
| 8 Basamid 40 grs /s.m + solariz | 124 | 81 |

**Treatments with less plants reduction are MeBr at 42 days after seed planting and the two basamid treatments. chicken manure + solarizations presents the lowest count. Plantules reduction is affected mainly by the blue mold (peronospora tabacina).**

**TABLE 5 incidence percentage** BLUE MOLD (peronospora tabacina) 35 days after seeds planting TOBACCO SEEDLINGS.

| TREATMENTS | 35 DAT | DUNCAN O.01 | 42 DAP | N.S. |
|---|---|---|---|---|
| 1. absolute witness | 42.25 | A | 27.25 | |
| 2. meBr 45 grms / m2 | 31.00 | ABC | 25.75 | |
| 3. meBr 22.5 grms / m2 | 41.75 | ABC | 24.25 | |
| 4. Metham Sodium 350 lt /Ha | 17.50 | C | 17.75 | |
| 5. Metham Sodium 350 lt /Ha + Solarizat. | 33.75 | ABC | 22.75 | |
| chicken manure 45 Kg / Ha +solarization | 22.75 | BC | 21.50 | |
| 7 Basamid 40 grs / square meter | 50.17 | A | 29.00 | |
| 8 Basamid 40 grs /s.m + solariz | 20.00 | BC | 20.75 | |

Blue mold is present in various levels (17 –50 %) 35 days after seeds planting. Treatments with the highest incidence are absolute witness and Basamid Metham sodium showed the lowest count. To control the mold dimetomorf + mancoseb (acrobat) were applied, at 42 DAT no statistical difference was found

**TABLE 6** PLANTULES QUALITY 42 DAT measured by blue mold, plant vigor, plantules uniformity.

| TREATMENTS | BLUE MOLD | PLANT VIGOR | UNIFORMITY | TOTAL |
|---|---|---|---|---|
| 1. absolute witness | 4 | 3 | 2 | 9 |
| 2. meBr 45 grms / m2 | 3 | 2 | 1 | 6 |
| 3. meBr 22.5 grms / m2 | 3 | 2 | 2 | 7 |
| 4. Metham Sodium 350 lt /Ha | 3 | 3 | 2 | 8 |
| 5. Metham Sodium 350 lt /Ha + solar. | 3 | 2 | 1 | 6 |
| chicken manure 45 Kg / Ha + solr. | 3 | 2 | 1 | 6 |
| 7 Basamid 40 grs / square meter | 4 | 2 | 1 | 7 |
| 8 Basamid 40 grs /s.m + solariz | 3 | 2 | 1 | 6 |

**Best treatments are Me Br ( 45 gr. / sq. m), Metham sodium (350 lt / Ha + solarization, chicken manure (4545 Kg / Ha + solarization and Basamid 40 gr. / sq. m. + solarization. All three favor plant vigor, plant uniformity and less blue mold incidence.**

**Table 7** PARTIAL SEED BED COST FOR ONE HECTARE IN US $ . TOBACCO SEEDLING

| VARIABLES | TREATMENTS | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| out put/plantules/seed. | 8,064 | 8,848 | 8,176 | 7,952 | 8,176 | 9,408 | 9,072 | 7,280 |
| gross income | 48.4 | 53.1 | 49.1 | 47.7 | 49.1 | 56.4 | 54.4 | 43.7 |
| methyl bromide | -- | 27.1 | 13.5 | -- | -- | -- | -- | -- |
| metham sodium | -- | -- | -- | -- | 7 | -- | -- | -- |
| Basamid | -- | -- | -- | -- | -- | 31 | 31 | -- |
| chicken manura | -- | -- | -- | -- | -- | -- | -- | 14 |
| plastic film | -- | 16 | 16 | -- | 14 | -- | 14 | 14 |
| seed beds preparation treatments application, cleaning | 33.5 | 30 | 30 | 33.5 | 30 | 48.5 | 30 | 30 |
| variable cost | 33.5 | 73 | 59.5 | 40.5 | 58 | 79.5 | 75 | 58 |
| net income | 14.9 | 19.9 | 10.4 | 7.2 | 14.3 | 23.1 | 20-6 | 14.3 |

**table 7 summarizes cost for applied treatments. all of the cost are similar to the agribusiness costs. Labor cost are higher with solarization treatments since soils are compressed due daily irrigation (one week) Metham sodium treatments show good economic performance compared to the commercial witness. Radicular nodules were prevalent affecting all plants this affection might be caused by a hormonal treatment applied to the tobacco seeds. The company decided not to transplant to open field. Samples were taken for phytopatology analysis.**

TABLE 8 RADICULAR NODULES PRESENCE % AFFECTED PLANTULES 64 DAT. TOBACCO

| TREATMENTS | 64 DAT | DUNCAN 0.05 |
|---|---|---|
| 1. absolute witnes | 79.50 | AN |
| 2. meBr 45 grms / m2 | 51-75 | B |
| 3. meBr 22.5 grms / m2 | 55.75 | B |
| 4. Metham Sodium 350 lt /Ha | 94.75 | A |
| 5. Metham Sodium 350 lt /Ha + solar | 75 | B |
| Chicken manure 45 Kg / Ha +solar | 77.75 | AB |
| 7 Basamid 40 grs / square meter | 75 | AB |
| 8 Basamid 40 grs /s.m + solariz | 58.75 | B |

Due to the presence of root nodules it was decided to perform microscopic analysis and fine culture to identify such pathological findings. Dra. Concepcion Jorda and Dr. A. Bello were able to isolate a bacteria RODOCOCUS that might be causing this alteration in association with a growing hormone. Further studies have to be pursued to determine the main cause of this pathology.

## FINDINGS

Weeds count ( gramineacea)Taking the absolute witness as a parameter for weeds count (100 %) the other treatments would account for the following percentages: 11 % for methyl bromide, 9 % for chemical treatments + solarization; 53 % for biofumigation; and 30 % for chemical treatments without solarization.
For wide leaf weeds Me Br is 11 %, solarization + chemical is 17 %. The highest count is for biofumigation 133 % and 89 % for other chemical treatments with out solarization. For ciperaceas weeds count Me Br shows 0 % the same as biofumigation and 7 % for chemicals with or with out solarization.

23 days after seeds planting treatments that present the best plat development are me br. chicken manure + solarization, basamid. Statistically are the same.

Reduction in the number of plantules was due to the presence of peronospora tabacina 20 days after seed planting, causing severe damage and dying of many plantules. Dimetomorf + mancoseb was applied twice to control this fungii .After 35 days there was statistical difference between tretments specially for absolute witness and basamid with out solarization. The remaining are statistically the same.

According to the scales used to determine seedling quality the best treatments are: Me Br. 45 grs /sm; Metham Sodium 350 lts /Ha + solarization, biofumigation and Basamid 40 gr. / s.m + solarization.

According to variable costs, treatments with Metham sodium, biofumigation and basamid + solarization are competitive to the traditional used treatment.

RECOMENDATIONS:

- TO EVALUATE HIGHER DOSIS FOR METHAM SODIUM 350 lt / Ha since it competitive to Me Br.
- TO EVALUATE JOINTLY FOR METHAM SODIUM OTHER VALTERNATIVAS SUCH AS FLOTING BEDS AND PEAT MOSS SEEDLING.
- TO TIMELY EVALUATE PLANTING PERIODS ACCORDING TO WEATHER CONDITIONS
- SEEDLING WERE AFECTED BY FUNGII DISEASES AND BACTERIAL DISEASES

**TOMATO EXPERIMENT.**
**ICTA . EL OASIS ESTANZUELA, ZACAPA**

This experiment replaces Santa Rosalia tomato seedlings experiment which was lost because of extreme weather conditions. The new experiment was located at ICTA finca el OASIS, ZACAPA. It was initiated on October 20th and was finalized in march 1999. The vegetative growth cycle was 25 days. Harvest occurred in March 1999. The experiment was performed under plastic coverage and dripping irrigation.

**Site Description .** La Fragua, Zacapa is a high temperature (18- 40° C) low precipitation (660 mm) valley which offers good conditions for export crops. There are over 100 farmers in the area cultivating tomato in 750 Ha. Me Br is used for bed seedling preparation, recently this practice is being replaced by commercial seedlings. The research site is located in EL OASIS – ICTAs experimental station under the field management of PROTISA. This land has not been used for intensive agriculture crops. The contribution of this project is fundamental to strengthening the sustainability of the agricultural production in hot dry weather area to preserve the production of this crop and to comply with international regulations stated in the Montreal Protocol.

**General Objective:** To evaluate alternatives to the use of MeBr in soil desinfection and its effect on out put for tomato and melon crops.

**Specific Objectives:**

1. To determine the effect of the alternatives upon pathogen counts
2. To assess total crops out put
3. To determine production costs and cost for each applied alternative
4. To comply with Montreal Protocol regulations

**Methodology:** Experimental design has been defined with randomized blocks and four replications. Each experimental plot is 5.4 meters wide and 10 meters long. For a total area of 32.4 square meters. Statistical analysis: variance analysis utilizing university of Michigan statistics analysis: MSTAT. If significance is found at 5%, median analysis will be applied Duncan's Test.

**Experimental Design** A randomized blocks design was utilized with 4 replications. Each plot measured 32.4 sq. meters. Experimental area 907 sq. meters.

**Alternatives Treatments:**

1. **Absolute Witness**
2. **MeBr (250Kg/ha)**
3. **MeBr (125Kg/ha)**
4. **Metham Sodium 350 lts/ha**
5. **Solarization + Metham Sodium 350 lts/ha 4 weeks**
6. **chicken manure 4,545 kg/ha + solarization 4 weeks.**
7. **Basamid 267 Kg / Ha**

**Soil analysis :** Soil samples were collected previously to the treatments applications (nematodes counts). Every four days physical inspections will be performed to assess plant disease. By the end of the crop 10 plants will be sampled from each one of the replications to evaluate the presence of meloydogine. Economic analysis will be performed to assess benefits and variability of the experiments.

**FINDING AND RESULTS PHASE I :** After performing preparatory activities and applying treatments and completing the vegetative cycle 75 days yield was collected. Trial results are presented in table 1 to 10

**Table 1 NEMATODES COUNTS./100ML/SOIL/TOMATO . El " Oasis" ICTA October 1998.**

| Treatments | Soil sampling | | | Root |
|---|---|---|---|---|
| | Pre treatmt | Post treatm | Harvest | Harvest |
| 1. witness | 20 | 40 | 1060 | 250 |
| 2. Me.Br. 250 kg/Ha | 20 | 20 | 40 | 0 |
| 3. Me.Br. 125 kg/Ha | 20 | 30 | 60 | 0 |
| 4. MS 350Lts/Ha | 20 | 20 | 1620 | 200 |
| 5. MS 350Lts/Ha + Solarization | 20 | 0 | 1500 | 275 |
| 6. Chicken manure 4545.45Kg/Ha + solarizat | 20 | 0 | 1450 | 225 |
| 7. Basamid 400 kg/Ha | 20 | 0 | 1900 | 150 |

Table 1 Comments: INICITIAL COUNT WAS 20 mematodes per 100 ml .Both nematodes Rotylenchulus and Aphelenchus were present at the pre treatment sample. Counts were drastically reduced MS, Chickenmanure + solarizationand and basamid. (1DAT) Metham sodium shows the same effect as Me Br. The

absolute witness shows a two folds increase for N. Rotylenchus and N. Aphilenchus. Rotylenchulus roots counts 85 days after transplant shows the lowest counts for Me Br..

**Table 2 PLANT HEIGTH IN CMS TOMATO. El "Oasis" ICTA Oct - Dec 1998**

| Treatments | days | Replications | | | | Median |
|---|---|---|---|---|---|---|
| | | I | II | III | IV | |
| 1. Witness | 15DDT | 18.5 | 18.3 | 18.4 | 18.4 | 18.35 |
| 2. MeBr 250 kg/ha | 15DDT | 19.1 | 18.9 | 19.3 | 19.3 | 19.13 |
| 3. MeBr. 125 kg/ha | 15DDT | 19.2 | 18.2 | 18.3 | 18.3 | 18.73 |
| 4. Methan Sodium 350lts/ha | 15DDT | 18.8 | 19.2 | 19.3 | 19.3 | 19.05 |
| Methan S 350 Lts/Ha + solarizat | 15DDT | 17.3 | 17.2 | 17.8 | 17.8 | 17.60 |
| 6. Chicken 4545.45 Kg/ha + solarization | 15DDT | 20.1 | 19.4 | 19.2 | 19.2 | 19.60 |
| 7. Basamid 400 kg/Ha | 15DDT | 18.7 | 18.6 | 18.3 | 18.3 | 18.45 |

**Table 2 Comments: Absolute witness AV 18.35 15 days after treatment the highest average was observed for treatment 6,4 and 2. The effect of residual heat and water loss could affect responce for treatment # 5.**

**Table 2 A PLANT HEIGTH IN CMS 30 days after transpalnt TOMATO. El "Oasis" ICTA**

| Treatments | Days | Replications | | | | Median |
|---|---|---|---|---|---|---|
| | | I | II | III | IV | |
| 1. Witness | 30DDT | | | | | 57 |
| 2. MeBr 250 kg/ha | 30DDT | | | | | 57 |
| 3. MeBr. 125 kg/ha | 30DDT | | | | | 60 |
| 4. Methan S 350lts/ha | 30DDT | | | | | 61 |
| 5. Methan S 350 Lts/Ha + Solarization | 30DDT | | | | | 58 |
| 7. Chicken 4545.45 Kg/ha + solarization | 30DDT | | | | | 62 |
| 7. Basamid 400 kg/Ha | 30DDT | | | | | 57 |

**Plants high 30 DAT shows no statistical difference between treatments.**

Table 3 WEEDS POPULATION 30 DAYS AFTER TREATMENT CROP: TOMATO
CROP phase I El "Oasis" ICTA Oct - Dec 1998

| Treatments | Counts 30 DAT | | | | Duncan |
|---|---|---|---|---|---|
| | Wide leaf | Grammeade | Cyperacea | Total | |
| 1. Witness | 8.5 | 3.75 | 0.25 | 12.5 | A |
| 2. MeBr 250 kg/Ha | 0.0 | 0 | 0 | 0 | B |
| 3. MeBr. 125 kg/Ha | 0.0 | 0 | 0 | 0.5 | B |
| 4. MeBr. 350Lts/Ha | 0.25 | 0 | 50 | 0.25 | B |
| 5. MS 350 Lts/Ha + solarization | 0.0 | 0 | 0 | 0 | B |
| 6. Chicken Compost 4545.45 kg/Ha + Solarization | 0.75 | 1.25 | 0 | 2.0 | B |
| 7. Basamid 400 kg/Ha | 0.25 | 0 | 0 | 0.25 | B |

Findings. Absolute witness 15.3 weeds 20 DAT MeBr. and Metham sodium + 5 = 0 Basamid = 0.25.
**Weeds count 35 days after transplant showed no statistical difference except for the absolute witness**

Table 4 PHITOTOXICITY ASSOCIATED TO TREATMENTS 3 DAT
TOMATO El "Oasis" ICTA Oct - Dec 1998

| Treatments | 3 DDT |
|---|---|
| 1. Witness | 0 |
| 2. MeBr 250 kg/Ha | 0 |
| 3. MeBr. 125 kg/Ha | 0 |
| 4. MeBr. 350Lts/Ha | 0 |
| 5. MS 350 Lts/Ha + solarization | 0 |
| 6. Chicken Compost 4545.45 kg/Ha + Solarization | 0 |
| 7. Basamid 400 kg/Ha | 0 |

Table 5 Comments: no Phitotoxicity was found, products have been used according to prescribed dose.

**Table 6** ACTIVE INGREDIENT COSTS (PRODUCTS) FOR SOIL DESINFECTION TOMATO El "Oasis" ICTA Oct - Dec 1998

| Product | Cost /Ha US$ |
|---|---|
| Methyl Bromide 250Lts/Ha | 550 |
| Methyl Bromide 125Lts/Ha | 275 |
| Metham Sodium 350 Lts/Ha | 525 |
| Chicken Com post 4545.45 kg/ha | 415 |
| Basamid 400 kg/Ha | 2,800 |

Table 6 Comments: MeBr. has the lowest cost by product, indirect cost have to be considered, and cost benefit analysis performed.

8 CROP YIELD. TOMATO PHASE I BOXES PER HECTARE. ICTA EL OASIS

| TREATMENTS | PLOTS | | | | AVERAGE | DUNCAN |
|---|---|---|---|---|---|---|
| | I | II | III | IV | | |
| 1. Witness | 2745 | 3570 | 3075 | 3103 | 3123 | B |
| 2. MeBr 250 kg/Ha | 3066 | 3703 | 3561 | 3708 | 3510 | A |
| 3. MeBr. 125 kg/Ha | 3314 | 3533 | 3231 | 3414 | 3373 | AB |
| 4. MeBr. 350Lts/Ha | 3149 | 3250 | 3116 | 3217 | 3183 | AB |
| 5. MS 350 Lts/Ha + solarization | 2897 | 3667 | 3236 | 3511 | 3327 | AB |
| 6. Chicken Compost 4545.45 kg/Ha + Solarization | 3158 | 3309 | 3281 | 3108 | 3214 | AB |
| 7. Basamid 400 kg/Ha | 3066 | 3506 | 3194 | 3259 | 3256 | AB |

**TABLE 8 COMMENTS**: THE MEAN YIELD WAS 3284 boxes per hectare this production is double than the average yield per hectare in the region. The witness performance 3,123 boxes per hectare can be attributed to i) dripping and plastic film coverage.

**Table 9 ACTIVE INGREDIENT COSTS (PRODUCTS) FOR SOIL DESINFECTION TOMATO El "Oasis" ICTA Oct - Dec 1998**

| Product | Cost /Ha US$ |
|---|---|
| Methyl Bromide 250Lts/Ha | 550 |
| Methyl Bromide 125Lts/Ha | 275 |
| Metham Sodium 350 Lts/Ha | 525 |
| Chicken Com post 4545.45 kg/ha | 415 |
| Basamid 400 kg/Ha | 2,800 |

Table 9 Comments: MeBr. has the lowest cost by product, indirect cost have to be considered, and cost benefit analysis performed.

Table 10 cost analysis. out put. Gross income, variable cost and net income. TOMATO ICTA OASIS ZACAPA.

| Treatment | Out put boxes/ per Hectare | Gross Income | Variable cost | Net Income |
|---|---|---|---|---|
| 1. testigo | 2874 | 12932 | 485 | 12447 |
| 2. BrMe 250 K/ha | 3510 | 15795 | 1041 | 14754 |
| 3. BrMe 125 K/ha | 3374 | 15181 | 766 | 14415 |
| 4. Metam Sodio 350Lt/ha | 3183 | 14325 | 1085 | 13240 |
| 5. Metam Sodio 350 Lt/ha + solarization | 3328 | 14976 | 1315 | 13661 |
| 6. gallinaza 4,545.45 K/ha + solarization | 3215 | 14465 | 1180 | 13285 |
| 7. Basamid 267 K/ha | 3257 | 14655 | 2364 | 12291 |

Table 10 comments : Methyl Bromide (250 Kg/Ha) shows the highest benefit ($. 14,754), and Methyl Bromide (125 Kg/Ha) with us$ 14,415 followed by Metham sodium (350 Lt./Ha + solarization) accounts for us$ 13,661. Chicken manure (4545 Kg/Ha +solarization : us$ 13,285 metham sodium (350 Lt./Ha) : us $ 13,240. It is assumed that the absolute witness would not be used commercially.

Table 11 . partial costs in us $ (dollars)

| | TREATMENTS | | | | | | |
|---|---|---|---|---|---|---|---|
| Concept | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| YIELD BOXES/HA | 3,123 | 3,510 | 3,373 | 3,183 | 3,328 | 3,215 | 3,256 |
| MARKET PRICE | 14,057 | 15,795 | 15,178 | 14,324 | 14,976 | 14,460 | 14,652 |
| Me Br | 0 | 551 | 276 | 0 | 0 | 0 | 0 |
| Metham Sodium | 0 | 0 | 0 | 595 | 595 | 0 | 0 |
| Chicken manure | 0 | 0 | 0 | 0 | 0 | 454 | 0 |
| Basamid | 0 | 0 | 0 | 0 | 0 | 0 | 1,869 |
| Plastic film | 465 | 465 | 465 | 465 | 490 | 490 | 465 |
| Treatment labor | 20 | 25 | 25 | 25 | 30 | 35 | 30 |
| Additives | 0 | 0 | 0 | 0 | 200 | 200 | 0 |
| Variable cost | 485 | 1,041 | 766 | 1,085 | 1,315 | 1,180 | 2,364 |
| Net benefit | 13,572 | 14,754 | 14,4115 | 13,240 | 13,660 | 13,285 | 12,291 |

- US$ 4.50 per Box =55Kg
- Comments: Basamid cost are the highest it double than me Br. Witness cost is the cost of plastic film and labor to please the cover. Me Br and solarization constitute the best options.

**Table 12. cost analysis DOMINANCE ANALYSIS by treatment TOMATO crop.**

| Treatments | Variable cost | Net income | Dominance |
|---|---|---|---|
| 1. testigo | 485 | 13572 | -- |
| 2. BrMe 250 K/ha | 1041 | 14754 | -- |
| 3. BrMe 125 K/ha | 766 | 14415 | --- |
| 4. Metam Sodio 350Lt/ha | 1085 | 13240 | D |
| 6. Metam Sodio 350 Lt/ha + solarization | 1180 | 13285 | D |
| 5. gallinaza 4,545.45 K/ha + solarization | 1315 | 13660 | D |
| 7. Basamid 267 K/ha | 2364 | 12291 | D |

Comments: existing local prices for alternative products are affecting the possibilities for the alternative treatments. Me Br (250 Kg / Ha and 125 Kg / Ha) and the witness show the best economic benefits.

**Table 10 Marginal rate of return by treatment. In us $ dollars TOMATO crop.**

| Treatment | Variable cost | Net income | Incremetal net income | Incremental Variable cost | MR of return |
|---|---|---|---|---|---|
| 1. testigo | 485 | 13570 | -- | -- | -- |
| 2. BrMe 250 K/ha | 1041 | 14754 | 339 | 275 | 123.39 |
| 3. BrMe 125 K/ha | 766 | 14415 | 843 | 281 | 299.9 |
| 4. Metam Sodio 350Lt/ha | | | | | |
| 5. Metam Sodio 350 Lt/ha + solarizat | | | | | |
| 6. gallinaza 4,545.45 K/ha + solarizat | | | | | |
| 7. Basamid 267 K/ha | | | | | |

Comments : Methyl Bromide (250 Kg/Ha) as compared to Me Br (125 Kg /Ha) shows a 123.39 MRT. Methyl Bromide 125 Kg / Ha shows a 299.9 % MRT compared to the absolute witness.

**11 FINDINGS**

Evaluated treatments have similar effect for weed control. The absolute witness shows statistical difference. Weeds did not affects plants growth.

Nematodes control effectiveness :Basamid demonstrated the best results at 267 Kg / Ha. Chicken manure * solarization (4545 Kg 7 Ha + solarization), Metham sodium (350 lt/Ha). Rotylenchulus count were insignificant and do not affect plant development and yield.

Rotylenchulus count after harvest ranges between 40 to 60 nematodes per 100 soil grs. In Methyl Bromide soil treatments (250 Kg /Ha). Nematodes count for other treatments range from 1,060 to 1,900 nematodes. Nematodes count is nil per 25 grams roots-soil for Me Br. Nematodes count for other treatments ranges from 150 to 150.

Average crop yield was 3,284 boxes / Ha. It is two fold increase in regard to the average tomato yield in the area. (La Fragua Zacapa). Statistical difference was found between treatments.

Cost Benefit Analysis .Methyl Bromide (250 Kg/Ha) as compared to Me Br (125 Kg /Ha) shows a 123.39 MRT. Methyl Bromide 125 Kg / Ha shows a 700.36 % MRT compared to the absolute witness. Metham sodium shows the third best MRT.

RECOMMENDATIONS:

It is advisable to promote dripping irrigation with plastic coverage, soil treatment with Metham Sodium since it will increase yield as compared to the usual output prevailing in the area

To validate in the farmer fields metham sodium (350 lt /Ha) as an alternative to the use of Methyl Bromide.

BIBLIOGRPHY

See annotated bibliography in melon crop.

**TOMATO CROP SECOND PHASE:**

This experiment is to validate findings in the first tomato experimental site (ICTA OASIS TOMATO PHASE I). Same site and methodology are being applied residual effects are expected to occur . The crop cycle started in April to August 1999. Plantules were transplanted in May , an homogeneous growth was observed in all the treatments. 77 days after transplant harvest was initiated. Elio hybrid tomato was selected for market demand.

**TRIAL RESULTS :**

**TABLE 1. MEMATODES COUNTS. 50 Days after Transplant/ 100 ml soil. Tomato phase II**

| TREATMENTS | PRE TRANSPLANT | 50 DAT |
|---|---|---|
| 1. testigo | 1060 | 2710 |
| 2. BrMe 250 K/ha | 40 | 1120 |
| 3. BrMe 125 K/ha | 60 | 250 |
| 4. Metam Sodio 350Lt/ha | 1620 | 4980 |
| 5. Metam Sodio 350 Lt/ha + solarization | 1500 | 1220 |
| 6. gallinaza 4,545.45 K/ha + solarization | 1450 | 3120 |
| 7. Basamid 267 K/ha | 1900 | 2710 |

**COMMENTS. The highest incidence occurred with Basamid second highest were Metham sodium treatments and chicken manure. Me BR showed lower counts. 50 DAT nematodes counts considerably increased in 4,5,6 and 7 treatments.**

**Table 2 PLANT HEIGTH IN CMS TOMATO phase II. El "Oasis" ICTA April August 99**

| Treatments | DAYS AFTER TRANSPLANT | | |
|---|---|---|---|
| | 0 | 35 | DUNACAN |
| 1. Witness | 12.5 | 46.8 | AB |
| 2. MeBr 250 kg/ha | 12.5 | 45.8 | AB |
| 3. MeBr. 125 kg/ha | 12.5 | 45.6 | AB |
| 4. Methan S 350lts/ha | 12.5 | 50.1 | A |
| Methan S 350 Lts/Ha + Solarization | 12.5 | 43,9 | AB |
| Chicken 4545.45 Kg/ha + solarization | 12.5 | 39.7 | B |
| 7. Basamid 400 kg/Ha | 12.5 | 41.7 | B |

**Table 2 Comments: Absolute witness significant differences were found Metham sodium has the greatest development, followed by the witness trial (46.8 cm). Me Br 45.80 and 45.60 cm.**

**Table 3 WEEDS POPULATION 30 DAYS AFTER TREATMENT CROP: TOMATO phase I El "Oasis" ICTA Oct - Dec 1998 counts 30 days after transplant**

| Treatments | Wide leaf | Gramina e | Cyperace a | Total | Duncan |
|---|---|---|---|---|---|
| 1. Witness | 39 | 2 | 25 | 66 | A |
| 2. MeBr 250 kg/Ha | 10 | 0 | 2 | 12 | C |
| 3. MeBr. 125 kg/Ha | 12 | 13 | 2 | 26 | BC |
| 4. MeBr. 350Lts/Ha | 16 | 0 | 1 | 17 | C |
| 5. MS 350 Lts/Ha + solarization | 12 | 1 | 15 | 28 | BC |
| 6. Chicken manure 4545.45 kg/Ha + Solarizat | 35 | 5 | 13 | 53 | AB |
| 7. Basamid 400 kg/Ha | 12 | 6 | 1 | 19 | C |

Findings. Weeds count 30 days after transplant showed no statistical difference except for the absolute witness and chicken manure in gramineae. Wide leaf was high because of high precipitation.

Table 4 percentage plants affected with bacteria and fungi. TOMATO phase II ICTA el OASIS

| TREATMENTS | 77 days after transplant | | No significance |
|---|---|---|---|
| | infected plants | Percentage % | |
| 1. Witness | 6.25 | 10.4 | |
| 2. MeBr 250 kg/Ha | 7.7 | 12.9 | |
| 3. MeBr. 125 kg/Ha | 8.2 | 13.7 | |
| 4. MeBr. 350Lts/Ha | 8.0 | 13.3 | |
| 5. MS 350 Lts/Ha + solarization | 9.7 | 16.3 | |
| 6. Chicken manure 4545.45 kg/Ha + Solarizat | 10.2 | 17.0 | |
| 7. Basamid 400 kg/Ha | 6.55 | 10.5 | |

Comments: fungi and bacteria incidence. Chicken manure, solarization and metham sodium show 16 % plants damage. Basamid and witness had the lowest conut.

## 5. CROP YIELD. TOMATO PHASE II BOXES PER HECTARE. ICTA EL OASIS 1999

| TREATMENTS | PLOTS | | | | | DUNCAN |
|---|---|---|---|---|---|---|
| | I | II | III | IV | AVERAGE | |
| 1. Witness | 1368 | 1483 | 1256 | 732 | 1212 | |
| 2. MeBr 250 kg/Ha | 1485 | 1872 | 1177 | 745 | 1620 | |
| 3. MeBr. 125 kg/Ha | 1448 | 1518 | 604 | 1479 | 1262 | |
| 4. MeBr. 350Lts/Ha | 1762 | 1907 | 598 | 1149 | 1354 | |
| 5. MS 350 Lts/Ha + solarization | 948 | 1776 | 943 | 958 | 1156 | |
| 6. Chicken Compost 4545.45 kg/Ha + solariz | 1638 | 903 | 818 | 496 | 966 | |
| 7. Basamid 400 kg/Ha | 1547 | 988 | 370 | 986 | 973 | |

Comments: Yield is recorded by plots in boxes per Ha. High yields were obtained with Methyl Bromide and metham Sodium 1,354 and 1,320 boxes respectively. Basamid and chicken manure obtained the least yield. No significant difference was demonstrated. Compared with phase I the over all yield diminished in half. *

## 6. ECONOMIC ANALYIS.

Table 6 . yield in boxes /hectare and partial costs in us $ (dollars) tomato PHASE II EL OASIS ICTA 1999

| | TREATMENTS | | | | | | |
|---|---|---|---|---|---|---|---|
| Concept | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| YIELD PHASE I | 3,123 | 3,510 | 3,373 | 3,183 | 3,328 | 3,215 | 3,256 |
| YIELD PHASE II | 1,210 | 1,320 | 1,263 | 1,354 | 1,157 | 967 | 973 |
| TOTAL YIELD | 4,334 | 4,830 | 4,637 | 4,537 | 4,485 | 4,182 | 4,230 |
| TOTAL INCOME * | 22,527 | 25,035 | 24,022 | 23,803 | 23,075 | 21,234 | 21,466 |
| Me Br | 0 | 551 | 276 | 0 | 0 | 0 | 0 |
| Metham Sodium | 0 | 0 | 0 | 595 | 595 | 0 | 0 |
| Chicken manure | 0 | 0 | 0 | 0 | 0 | 454 | 0 |
| Basamid | 0 | 0 | 0 | 0 | 0 | 0 | 1,869 |
| Plastic film | 465 | 465 | 465 | 465 | 490 | 490 | 465 |
| Treatment labor | 20 | 25 | 25 | 25 | 30 | 35 | 30 |
| Additives | 0 | 0 | 0 | 0 | 200 | 200 | 0 |
| Variable cost | 485 | 1,041 | 766 | 1,085 | 1,315 | 1,180 | 2,364 |
| Net benefit | 22,042 | 23,994 | 23.256 | 22,718 | 21,760 | 20,054 | 19,102 |

- US$ 4.50 per Box =55Kg
- COMMENTS table 12: yield in the second phase diminished by half. And variable costs remained the same. An average income figure for phase I and II shows the best income for Me Br and metham sodium
  EXTREME WEATHER CONDITIONS AFFECTED OVER ALL PRODUCTION IN THE WHOLE AREA OF RIO HONDO.

**Table 7. Cost analysis DOMINANCE ANALYSIS by treatment TOMATO PHASE II .**

| Treatments | Variable cost | Net income | Dominance |
|---|---|---|---|
| 1. testigo | 485 | 22,042 | -- |
| 2. BrMe 250 K/ha | 1041 | 23,994 | -- |
| 3. BrMe 125 K/ha | 766 | 23,256 | --- |
| 4. Metam Sodio 350Lt/ha | 1085 | 22,718 | D |
| 6. Metam Sodio 350 Lt/ha + solarization | 1180 | 21,760 | D |
| 5. gallinaza 4,545.45 K/ha + solarization | 1315 | 20,054 | D |
| 7. Basamid 267 K/ha | 2364 | 19,102 | D |

Comments: existing local prices for alternative products are affecting the possibilities for the alternative treatments. Me Br (250 Kg / Ha and 125 Kg / Ha) and the witness show the best economic beneffits.

**Table 8 Marginal rate of return by treatment. In us $ dollars TOMATO PHASE II ICTA el OASIS.**

| Treatment | Variable cost | Net income | Incremetal net income | Incremental Variable cost | MR of return |
|---|---|---|---|---|---|
| 1. testigo | 485 | 22,042 | -- | -- | -- |
| 2. BrMe 250 K/ha | 1041 | 23,994 | 738 | 275 | 268.36 |
| 3. BrMe 125 K/ha | 766 | 23,256 | 1,214 | 281 | 432.03 |
| 4. Metam Sodio 350Lt/ha | | | | | |
| 5. Metam Sodio 350 Lt/ha + solarization | | | | | |
| 6. gallinaza 4,545.45 K/ha + solarization | | | | | |
| 7. Basamid 267 K/ha | | | | | |

Comments : Methyl Bromide (250 Kg/Ha) as compared to Me Br (125 Kg /Ha) shows a 268.36 % MRT. When Methyl Bromide is compared to the absolute witness the MRT is 432.03 % MRT. If Me Br could be disregarded then Metham sodium would rate the best.

**Findings and Recommendations.**

- Treatments in the two stages, showed similar effects for weeds control. The absolute witness showed statistical difference ($P<0.05$) The mean number of weeds was 3.5 specimens per square meter. Weeds constitute no real threat in all trials including the witness:

- Nematodes control (Rotylenchulus sp.) assessed at pre and post treatments time showed the best results with Basamid 267 Kg/ha, Chicken manure 4545 Kg/ha + solarization, Metham sodium 350 l/ha + solarization. Nematodes count in general are very low, and it can be considered that no significant damage is caused to plats output ($P<0.05$).

- Rotylenchulus counts were diminished at the end of the second stage and did not caused any damage to the crop in any of the treatments. Residual effects of some of the treatments was observed such as Metham sodium and methyl Bromide.

- Partial cost analysis taking into consideration the two stages showed the best net benefits for Methyl Bromide and Metham sodium with out solarization. Methyl Bromide and the absolute witness showed the best rates of return.

The two trials were performed in a land that was intensively used for the first time (dripping and plastic coverage) Net benefits are affected by the additional costs originated with the application of additives and the higher market prices for Metham sodium in Guatemala .

**PROJECT: ALTERNATIVES TO THE USE OF METHYL BROMIDE**
**TRIAL PROTOCOL GUA 97/128**

**GRAFTING IN MELONS: AGRONOMIC EVALUATION OF *Cucurbita maximaXmoschata* AND *Cucumis melo* ROOTSTOCKS.**

**RESEARCHERS:** DR. JULIO CÉSAR TELLO MARQUINA.
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UNIVERSITY OF ALMERÍA.
Eng. Héctor Ramazzini and Eng. Francisco Girón
Eng. Eladio Trabanino and Eng. Roberto Dubon

**SITES:**

1. Pegón Piloncito (seedlings) El Jocotillo Villa Canales and COMAGUA, (field transplant) Estanzuela, Zacapa

2. PROTISA (seedlings and field transplant) La Fragua, Zacapa

DATE: NOVEMBER 1999-JANUARY/FEBRUARY 2000.

SEED MATERIALS: *AS ROOTSTOCKS:*

Two different groups are proposed:

**group A:** interspeciphic hybrids of *Cucurbita maximaXmoschata:*

| *cultivar* | *company* |
|---|---|
| RS841 | (Royal Sluis), |
| PATRÓN | (Tezier ibérica), |
| BRAVA | (Petoseed ibérica), |
| HÉRCULES | (Ramiro Arnedo) |
| TITÁN | (Ramiro Arnedo) |

**group B:** cultivars of *Cucumis melo* with MNSV genetic resistance.

| *cultivar* | *company* |
|---|---|
| EROS | (Petoseed ibérica), |
| PRIMAL | (S&G NOVARTIS), |

as CULTIVATED VARIETIES (SCIONS):

All the rootstocks will be tested with one of the two melon cultivars traditionally used on the zone: HONEY DEW and CANTALOUP types. The Cantaloupe variety was chosen in both sites.

## GRAFTING METHODOLOGY:

Seeds of *Cucumis melo* rootstocks will be sown simultaneously with Honey dew and Cantaloup cultivars, while *Cucurbita maximaXmoschata* seeds will be manually sown 5/7 days after in order to have simmilar developmental stages when grafting. The plant nursery in this area should be shaded with a 50%-60% shading net. The nursery trays where the melon and the rootstocks will be initially sown are the traditionally used.

The technique will be approach grafting, being needed: cutters, plant trays with 200 cc/plant aproximately (that will be occupied only after the grafting takes place), Sn trips, small tunnel 1,7 $m^3/m^2$ covered by PE low density.
Cultivar roots will be cut 5 days before planting.

Grafting success rate before plantation, and plant quality will be controlled.

## EXPERIMENTAL DESIGN :

An split plot with 4 replicates design is proposed in the following table, being needed 15 plants per plot, which spatial distribution (row and plant distance) will be decided upon the traditional cropping system at Guatemala (C=Cantaloup type, H=

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| H/RS 841 | H/ Patrón | H/ Brava | H/ Hércules | H/ Titán | H/ Eros | H/ Primal | C/ RS 841 | C/ Patrón | C/ Brava | C/ Hércules | C/ Titán | C/ Eros | C/ Primal |
| C/ Patrón | C/ Primal | C/ Titán | C/ Hércules | C/ RS 841 | C/ Brava | C/ Eros | H/ Eros | H/ Hércules | H/ Patrón | H/ Primal | H/RS 841 | H/ Brava | H/ Titán |
| H/ Titán | H/ Eros | H/ Hércules | H/ Patrón | H/RS 841 | H/ Brava | H/ Primal | C/ Eros | C/ Primal | C/ Hércules | C/ Titán | C/ RS 841 | C/ Patrón | C/ Brava |
| C/ Brava | C/ Hércules | C/ RS 841 | C/ Eros | C/ Primal | C/ Titán | C/ Patrón | H/ Titán | H/ Brava | H/RS 841 | H/ Primal | H/ Eros | H/ Patrón | H/ Hércules |

## STUDY VARIABLES:

**Compatibility will be checked under field conditions. Total yield, marketable yield, fruit size distribution, number of fruits per plant, and quality parameters such us fruit flesh pH, soluble solids content, fruit firmness and taste will be analyzed.**

**Rational:** Me Br. Has been applied trying to control fusariosis as the cause of melon sudden death. The presence of MNSP was determined by laboratory analysis ( root samples and vegetative material). The virus vector is a fungi olpidium radicale which cannot be controlled by the treatment of water source. Seeds have been proved to be a potential vector. The incidence of the fungi cannot be controled by applying Me Br.

**MAIN OBJECTIVE:**

_ To train local personal in grafting methodology (stem approximation) in the local sites in a seedling station and COMAGUA and PROTISA agribusiness.

_ To evaluate this alternative to the use of methil bromide, biological control, and a resistant variety to MNSV Melon Necrotic Spot Virus.

Specific Objectives:

_ To evaluate the bonding percentage under controlled conditions utilizing 8 recipients of cucurbita maxima with the cantalupe variety, durango hibrid

_ To evaluate transplant results of the inter specific hybrids related to production, quality, quantity, export fruit from cucumis melo with MNSV genetic resistance.

METHOLOGY:

SITES:

GREEN HOUSE : Pegón Piloncito, el Jocotillo Villa Canales
Field transplant :COMAGUA, Zacapa

GREEN HOUSE INVERSA Estanzuela Zacapa
Field transplant: PROTISA ESTANZUELA zacapa

Time frame :

Greenhouse : November /99 to December 99
Field transplant: December /99 March 2000

Treatments:

Inter specific hybrids Cucurbita Maxima :
Hercules
Brava
Titan
RS 841
Patrón

Melon recipients (MNSV genetic resistant):
Primal
Quito
Eros

Grafting Cultivar:
Type cantaloupe, hybrid Durango

Variables:

In green house :
Grafting date
Transplant date to open field.
Recipients diameter/ grafting diameter : 5 and 18 DAG
Bonding percentage of grafted plantules 5 and 18 (DDG).

Field transplant:
Transplant date
Starting population, net count at 10 DAT.
Final Population at harvest time first fruit cut.
Recipients diameter/ grafting diameter :15, 30, 45 DAT

Cultivar Vigor at 15, 30, 45 DAT

Vigor scale :
1= Vigor excellent plants vigorously growing
2= Vigor very good
3= Vigor good
4= Vigor bad, dying plants
5= Vigor Very bad, dead plants

flowering dates DDT, 50% of plants have flourished

Net formation. 50% of the fruit show network design formation.

Days to fruit cut DDT for second commercial cut.

Total yield boxes per hectare

Mean weight per fruit in kilograms 5 fruit of each size

Network design appreciation
1= Excellent (high or low dense and thin )
2= Good (high or low, dense and thick )
3= Regular (high or low , rare and thin)
4= Bad (high or low, rare or thick)

Brix Grade, sample three fruits/parcel during the 5th or 6th cut.

Fruit internal quality

| | |
|---|---|
| 1= close | = Excellent |
| 2= partially open | = Good |
| 3= open | = Regular |
| 4= very wide | = Poor |

Cultivar uniformity fruit distribution (even) color and size .

| | |
|---|---|
| 1= Even | = Estable |
| 2= Intermediate | |
| 3= Variable | = Inestable |

sturdiness, fruit consistency
1= Hard
2= medium
3= soft

Susceptibility to virus disease 15, 30 y 45 DAT
1= very resistant
2= resistante
3= susceptible
4= very susceptible

Nemátodos Meloidogyne nodules
1= NO
2= YES

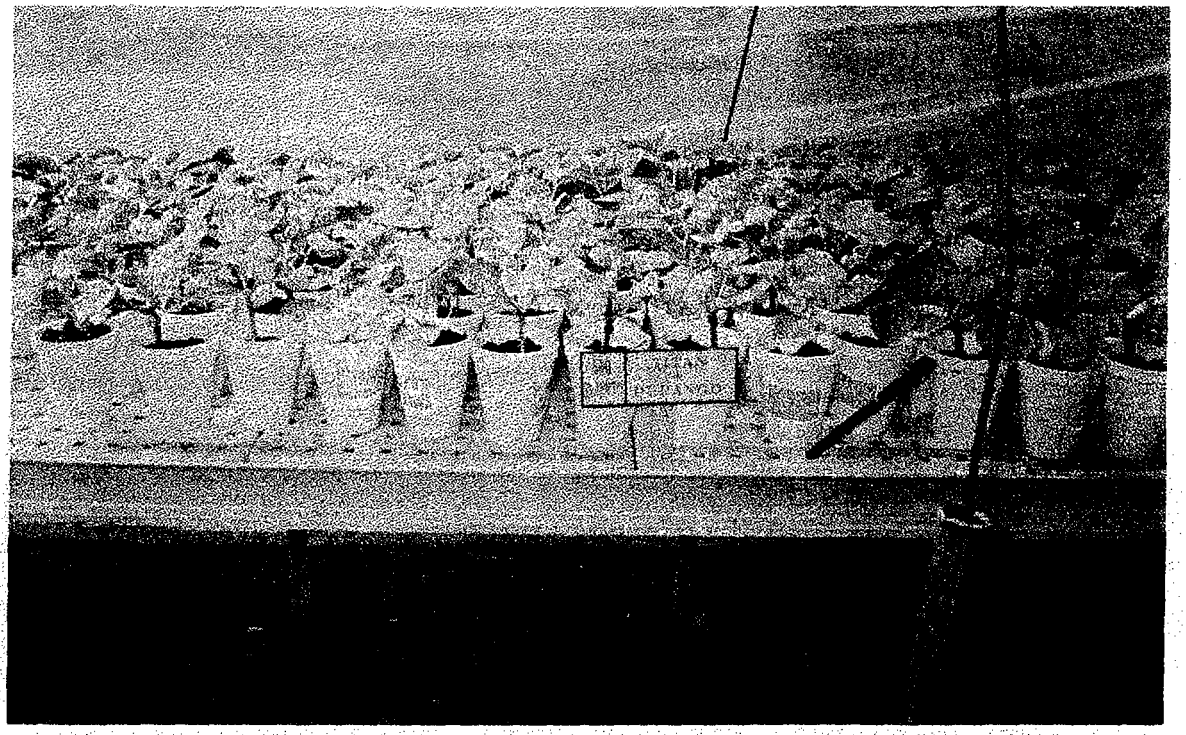
FINDINGS:

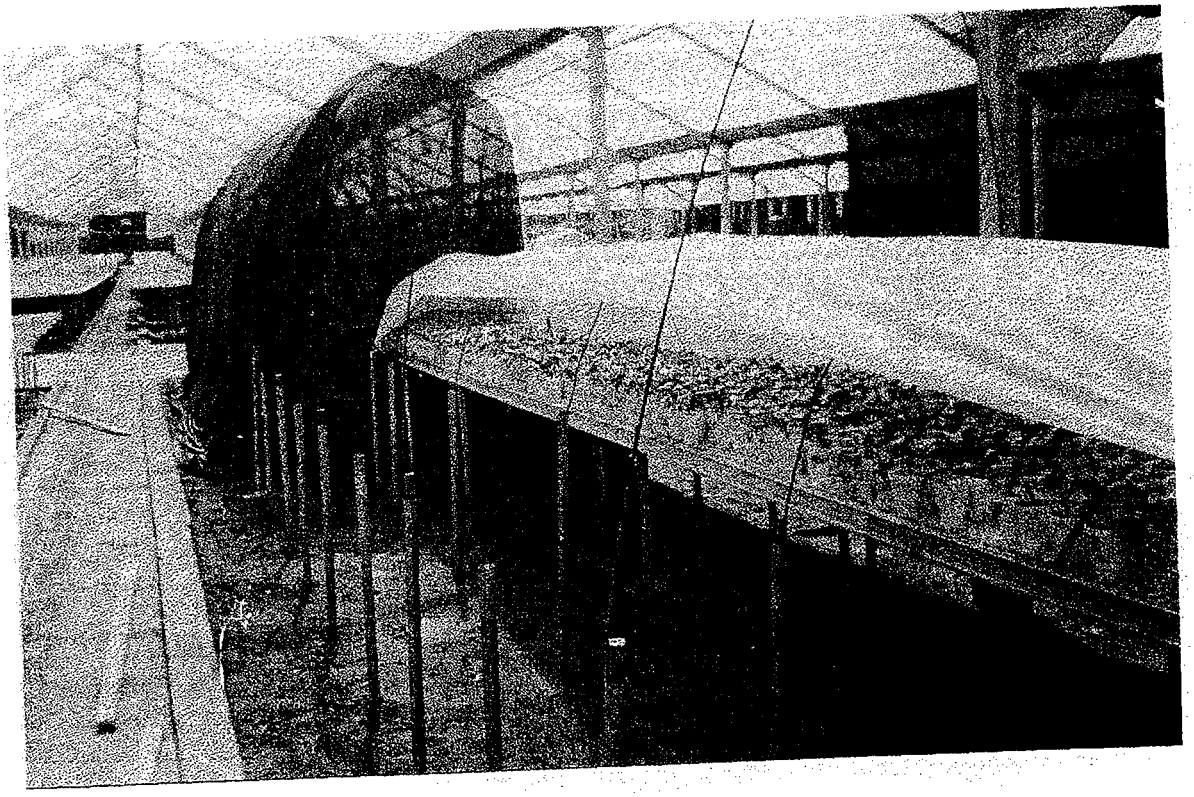
□ STATISTICALL ANALYSIS from data registered according to statistical design. Plants in green house transplanted to definitive field.

**PARTIAL FINDINGS**

**Inter specific hybrids and resistant cultivars (Seeds) were planted during the second and third weeks in November. Cucurbita and melon resistant plantules were grafted by approximation after 14 and 18 days respectively. Dr. Eduardo fernadez trainned in this procedure local personnel at both sites (Pegón Pegoncito and COMAGUA). Percentage bonding 5DAG for each of the different materials: Hecules 98 %, Brava 99 %, Titan 98 %, RS841 100%, patron 100 % PRIMAL 98 % QUITO 99 % EROS 98 %.**

**FIELD EVALUATION WILL BE PERFORMED AT THE END OF FEBRUARY.**





## INTERNATIONAL WORKSHOP ON ALTERNATIVES TO THE USE OF METHYL BROMIDE GUATEMALA OCTOBER 25-27 1,999

In order to present and validate trial results a three day workshop was organized and conducted in Guatemala under the Coordination of National Environmental Commission (CONAMA), the Agricultural Research Institute (ICTA) and the professional services from UNIDO.

International speakers were invited to present scientific aspects related to the ozone layer depletion, the use of alternative treatments, fitopatology aspects and Montreal Protocol Policy related issues.

Local speakers include the Vice Minister of Agricultural, the Non Traditional Experts Sector Coordinator, CONAMA, officials, authorities and researchers from ICTA and Agribusiness operation managers from 11 companies.

Methyl Bromide demonstration projects (alternative trials)officers and researchers from: Argentina, Uruguay, Jordan, Venezuela, Dominican Republic, El Salvador, Honduras and Nicaragua, presented progress situation. Among the participants were present the agrochemical distributors and media reporters

### WORKSHOP SUMMARY

On day one the inaugural session was presented by the Vice Minister of Agriculture, engineer Luis Alberto Castañeda. He recognized the efforts and high standards utilized to carry on the trials and the cooperation between growers, the research specialists and the international support from the Montreal Protocol. Also he mentioned the complexity for alternative technologies to substitute the use of methyl bromide but also to obtain the sustainability of agriculture and the productivity of non traditional exports.He expressed his willingness to support results utilization to comply with Montreal Protocol policies.

Dr. Antonio Sabater de Sabates from the Montreal Protocol at UNIDO, expressed how satisfactory was to assess the progress and the results obtained from the on going demonstration project. He mentioned that 10 years ago 140 countries signed the Montreal Protocol to express their commitment to ban and substitute the use of Ozone depleting substances including methyl bromide.

He insisted that several alternatives have been proved and apply in many countries and for different crops. Finally he expressed that the Guatemalan research project was a promising one with sound application to the validated alternatives. Engineer Víctor Hugo García form the non traditional exports association referred to the outstanding role of non traditional exports to the national economy. Its influence regarding income generation, labor, food supply, and balance of payment. From 1986 to1998 the exports structure was substantiality changed. Non traditional export were only 29,5% in 1986; but in 1998 they were increased to 55.9%. Out of 3,052 exports companies 2,764 are in the non

traditional market. Traditional products have a participation in exporting such products as Coffee(70%), sugar (19%), bananas (9%) and cardamom (2%).In order to increase NTE trend it is necessary to access to new technologies to improve productivity and to obtain a sustainable development situation. For the coming years Non Traditional Exports have been projected to increase 14% each year.

Dr. Bill Thomas form the US Environmental Agency addressed the participants in the methyl bromide policy issues. In his presentation he established the relation ship between methyl bromide use, the ozone depletion science U.S. laws and regulations. Finally he stated that in the 9 last months U.S. EPA officials and researchers from the U.S. from department of agriculture have met to define additional work to ensure good alternatives for the phase out stage.

Dr. Rodrigo Rodriguez Kábana from the University of Auburn in Alabama made a substantial presentation with deep reference to the history of methyl bromide and other products that were in use in the mid 20´s. He made remarks related to the dangerous use of this products and also to their questionable efficiency. Experience has shown that many substitutes are available and that they have agricultural and economic advantages. In most cases, what is needed is a sound agricultural monitoring and understanding of soil and plant behaviors

Dr. Michael Rassmussen from the Danish protection agency presented the factors, conditions and mechanism needed to accomplish the phase out stage. Surveys should be performed to assess field applications, then establish a dialogue with stake holders and to agree with phase out date. Then to prepare the measures and alternative methods to phase out. Research should be encouraged to define some of the specific requirements and other related issues.

"As alternatives to the current use of methyl bromide as pesticide already exists and are in practical use, the authors recommend that political decisions about phasing-out should not be delayed by demands for further research into alternatives to methyl bromide as a control agent and a soil disinfection agent. However, some initiatives may be needed to facilitate the implementation of alternatives for those who have been dependent upon the use of methyl bromide as a fumigant."

The organizers and participants to the work shop deeply regret the absence of Dr, Antonio Bello who is suffering serious health impairments. We hope he will soon recover. Dr. Javier Tello senior research specialist to the project from the plant pathologist department at the University of Almería, Spain. presented how methyl bromide was substituted is Spain. On Thursday 26, results from the demonstration project were presented. The panelists referred to the following issues: methyl bromide alternatives are ready to use, soil biofumigation is and effective treatment, chemical alternatives are more expensive due to actual market prices, grafting is a good alternative to prevent the use of methyl bromide. Conditions vary for different crops, climate and agricultural practices.

A final conclusion stated that alternatives had demonstrated their agronomic and economic feasibility. Agribusiness have been conducting research for alternatives to more effectively replace in the near future the use of MeBr.

In the afternoon session, a presentation by the participants from Argentina, Uruguay, Venezuela, El Salvador, Dominican Republic, Honduras, Nicaragua and Jordan explained how their on research were doing . Engineer Carlos Heer Deputy Director from ICTA conducted the panel integrated by the researchers, company delegates and experts.

During the afternoon (from 3 to 4:30) Mr. Thomas, Mr. Rodriguez Kábana and Mr. Rassmussen visited PAMPUTIK an NORCAFE cut flowers exporters, where biofumigation and biofumigation and steam boiler treatment were in place. As stated from companies managers trials were promising and cost effective.

Mr. Heikki Wilstedt from UNEP presented the clear house operation of UNEP Ozone Action Programme located in Paris, and invited a participants to request information and technical assistance.

During the third day a field visit was organized for the 42 visitants to Río Hondo, Zacapa research sites. Tobacco and floating trays were observed. two sites where tomato trials had been performed were visited. The melon field was inspected with the guidance from PROTISA field engineers. They expressed how the company had fully participated in the trials and how findings were encouraging. They recognized the assistance given by Dr. Javier Tello and his research collages from the University of Almería, the Politecnical Research Institute in Valencia and the Science and Technology research center in Madrid. After lunch a round table was organized with a presentation from Dr. Rodriguez Kábana and Dr.Tello, the audience composed by field engineers and agrochemical suppliers placed questions an queries to the presented issues.

After return to Guatemala city the workshop was adjourned, recognizing the quality of the performed trials, the sound results obtained, and the support given by the Multilateral Found of the Montreal Protocol. Especial mention was expressed to Dr. Antonio Sabater de Sabates and to the UNIDO administrative unit in Vienna for there unconditional support.

The climate and understanding after the workshop had to be capitalized to gain momentum for methyl bromide phase out actions. The Agricultural Vice Minister was requested and appointment to discuss policy issues. A meeting with Eng. Daniel Cardona melon growers technical committee coordinator, was promising in stating the wiliness from this sector to use the alternatives in a commercial scale. He suggested another reunion with the nine members of technical committee to agree for the phase out activities. A letter from Vice Minister of Agricultural expressing the willingness from the government was obtained. It is expected to led to the preparation of an investment project in first quarter of the year 2,000.

**SEMINARIO INTERNACIONAL SOBRE ALTERNATIVAS AL USO DEL BROMURO DE METILO UNIDO . ICTA – CONAMA , GUATEMALA, 25 al 26 DE OCTUBRE DE 1999. HOTEL MARRIOT**

| | FECHA Y SESIONES |
|---|---|
| DÍA 1 | LUNES 25 DE OCTUBRE 1999 |
| 08:00 - 09:00 a.m. | Inscripción Participantes |
| 09:00 – 09:30 a.m. | Inauguración Ingeniero Luis Castañeda Vice Ministro Agricultura, Ganadería y Alimentación. |
| 09:30 10:00 a m. | Dr. Antonio Sabater Programa ONUDI |
| 10:00 - 10:30 a.m. | CAFÉ y presentación de video |
| 10:30 – 11:00 a.m. | Ing Victor Hugo Garcia Importancia económica cultivos No tradicionales en Guatemala |
| 11:00 – 11:45 am. | Dr. Bill Thomas Politica sobre BM en los USA |
| 11:45 – 12:30 am. | Dr. Rodríguez Cabana Alternativas al uso del MeBr |
| 12:30 – 13:15 Pm. | Dr. Rassmussen Experiencia en Dinamarca. Tecnologías de sustitución |
| 13:15 – 14:30 Pm. | ALMUERZO |
| 14:30 – 15:15 pm | Dr. Antonio Bello Uso y sustitución del Br Me en España |
| 15:15 – 16:15 pm | Panel preguntas a los expositores<br>Coordinación Dr. Javier Tello y Dr.Hugo Figueroa |
| 16:15 –16:30 pm | Café y presentación del video |
| 16:30 – pm | Fin de la jornada |
| DÍA 2 | MARTES 26 DE OCTUBRE 1999 |
| 8:00 – 8:30 | Ing. Luis Calderón Coordinador<br>Metodología de la investigación en el proyecto alternativo |
| 08:30 –09:15 | Ing Fernando Solis Presentación resultados de los experimentos en el área de Chimaltenango |
| 9:15 – 10:15 | Ing. Elmer Barillas, Ing Eladio Trabanino Ing Edgar Zeceña<br>Presentación resultados area Zacapa |
| 10:15 – 10:45 | CAFÉ |
| 10:45 – 11:45 | Ing. Carlos Heer<br>Panel de las Empresas participantes PROTISA, DIMON, KERN´S, AGRIPLAN, PAMPUTIK, NORCAFE, COMENTARIOS A LOS RESULTADOS Y RECOMENDACIONES |
| 11:45 – 13:30 | MESA REDONDA : preguntas a los expositores<br>Coordinación Dr. Javier Tello y Dr. Hugo Figueroa |
| 13:30 – 14:45 | ALMUERZO |
| 13:30– 15:45 | Presentación de los delegados de los piases<br>Br.Me. Situación del BM en sus respectivos países<br>Coordinación Dr. Antonio Sabater |
| Día 3 | MIERCOLES 27 OCTUBRE 1999 |
| 8:00- 17:00 | Visita de campo Zacapa |