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Report on Methyl Bromide Phase-out in Horticulture and Commodity Fumigation Sectors In Egypt

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Final Report

(2011)

Contractor's Personnel

Names and Project Function of the Contractor's Key Personnel

Name	**Project Function**
Dr. Ayman F. Abou-Hadid	Subcontract Coordinator and Team Leader
Dr. Nagi Abou-Zeid	Small-Scale Farmers Program and Expert Pathologist
Dr. Usama Ahmed El-Behairy	Strawberry Expert
Dr. Samy Abdel Gawad	Horticulture Expert
Dr. Mossad Kotb	Flower and Herb Expert
Dr. Magdy El Hariri	Grain and Structure Fumigation Specialist

Background

Three previous reports had been submitted to present and indicate what had been done in certain times of this, second, phase of the project. Those previous reports focused on establishing the experiments, training the small farmers and evaluating the efficacy of the used alternatives in controlling, soil-borne fungal and nematode plant pathogens. Similar procedures were carried out on the stored cereals and cereal storage specialists.

Results from the three previous reports were positive and encouraging to go on and continue the experiments as most of the used alternatives were efficient in controlling the soil-borne disease in different vegetable and ornamental crops and the insects of the stored cereals. Some of the used alternatives were as efficient as the out-phasing methyl bromide.

This report is the final report with a comprehensive conclusion of the obtained results through out the season. The report will focus on the yield and the cost of using the MBr-alternatives compared to using methyl bromide.

- **Following up the results of the previous workshops and field days:**
  Wrapping up the results of workshops and field days and concluding recommendations that will help the growers, farmers and cereal storage specialists in the future, especially with the gradual reduction of methyl bromide. any evolved problems.

- **Yield of the cultivated crops and the cost were calculated and reported then analyzed to be compared with those results from the methyl bromide.**
- **The incremental cost was calculated for each treatment to determine the feasibility of using it as an alternative to methyl bromide.**

- **Final results were discussed with farmers, growers, work team and the different participants and different views were considered to excel the process of alternating the phasing-out methyl bromide.**

Results

Results from Tables 1,2,3,4,5,6,7,8,9 and 10 show the strawberry yield from ten different locations in Shben-Elkanater. The strawberry yield from the methyl bromide treatment was similar or slightly higher than the yield of other treatments.

The yield is higher in the Metam Sodium (100 ml/m2) + Soil Solarization followed by Basamid (50 g/m2) + Soil Solarization and Soil Solarization + (Bioarc+Biozeid, 216 kg/ha each) respectively , All the used alternatives varied from little less to little higher costly than MBr. This is a very good and positive result as the used alternatives were as good as the use of MBr.

Table 1: The yield and incremental costs of MBr-alternatives compared to the costs of MBr at the rate of 50g/m2 + plastic malsh in Strawberry grown in the open field at Reffaat Ali Rozkana (2010/2011).

Treatment	Yield (Kg/m^2)	Costs (LE/Kg)	Incremental Costs (LE/Kg
Basamid (50 g/m^2) + Soil Solarization	3.095	0.85	0.08
Metam Sodium (100 ml/m^2) + Soil Solarization	3.571	0.60	-0.17
Soil Solarization + (Bioarc+Biozeid, 216 kg/ha each).	2.619	0.82	0.05
Methyl Bromide	4.048	0.77	

Table 2: The yield and incremental costs of MBr-alternatives compared to the costs of MBr at the rate of 50g/m2 + plastic malsh in Strawberry grown in the open field at Safwan Ghanem Rashed (2010/2011).

Treatment	Yield (Kg/m^2)	Costs (LE/Kg)	Incremental Costs (LE/Kg
Basamid (50 g/m^2) + Soil Solarization	2.857	0.917	0.12
Metam Sodium (100 ml/m^2) + Soil Solarization	3.571	0.60	-0.2
Soil Solarization + (Bioarc+Biozeid, 216 kg/ha each).	1.905	1.12	0.3
Methyl Bromide	3.571	0.80	

List of participant growers (as leaders farmers)

Participant	Location	Crop(s)
Reffaat Ali Rozkana	Shben-Elkanater	Strawberry
Safwan Ghanem Rashed	Shben-Elkanater	Strawberry
Magdy Soliman Eid	Shben-Elkanater	Strawberry
Mohamed Eid Mohamady	Shben-Elkanater	Strawberry
Ashraf Mohamed Yosef	Shben-Elkanater	Strawberry
Esam Ahmed Abd El-Atty	Shben-Elkanater	Strawberry
Saad Ali Rozkana .	Shben-Elkanater	Strawberry
Eid Mohamed Hamad	Shben-Elkanater	Strawberry
Salah Salama Nasr	Shben-Elkanater	Strawberry
Khaled Mansour Menshar	Shben-Elkanater	Strawberry
CLAC	El-Bossely	Pepper- Cucumber

The above mentioned participants (growers) were selected based on:

- **Their previous history of using MBr as all of them have used MBr in their farms and started to suffer from the non-availability of the MBr quantity that they used to use in the previous years.**

- **Their leadership in their areas as most of them are leaders farmers as they will be models for other farmers.**

Table 3: The yield and incremental costs of MBr-alternatives compared to the costs of MBr at the rate of 50g/m2 + plastic malsh in Strawberry grown in the open field at Magdy Soliman Eid (2010/2011).

Treatment	Yield (Kg/m^2)	Costs (LE/Kg)	Incremental Costs (LE/Kg
Basamid (50 g/m^2) + Soil Solarization	2.381	1.0	**-0.11**
Metam Sodium (100 ml/m^2) + Soil Solarization	2.857	0.747	-0.36
Soil Solarization + (Bioarc+Biozeid, 216 kg/ha each).	2.143	1.0	**-0.11**
Methyl Bromide	2.857	1.11	

Table 4: The yield and incremental costs of MBr-alternatives compared to the costs of MBr at the rate of 50g/m2 + plastic malsh in Strawberry grown in the open field at Mohamed Eid Mohamady (2010/2011).

Treatment	Yield (Kg/m2)	Costs (LE/Kg)	Incremental Costs (LE/Kg)
Basamid (50 g/m^2) + Soil Solarization	3.095	0.85	**0.08**
Metam Sodium (100 ml/m^2) + Soil Solarization	3.571	0.60	-0.17
Soil Solarization + (Bioarc+Biozeid, 216 kg/ha each).	2.619	0.82	**0.05**
Methyl Bromide	4.048	0.77	

Table 5 : The yield and incremental costs of MBr-alternatives compared to the costs of MBr at the rate of 50g/m2 + plastic malsh in Strawberry grown in the open field at Ashraf Mohamed Yosef (2010/2011).

Treatment	Yield (Kg/m^2)	Costs (LE/Kg)	Incremental Costs (LE/Kg
Basamid (50 g/m^2) + Soil Solarization	3.81	0.69	**-0.2**
Metam Sodium (100 ml/m^2) + Soil Solarization	3.571	0.60	-0.3
Soil Solarization + (Bioarc+Biozeid, 216 kg/ha each).	2.381	0.90	**0.0**
Methyl Bromide	3.571	0.90	

Table 6: The yield and incremental costs of MBr-alternatives compared to the costs of MBr at the rate of 50g/m2 + plastic malsh in Strawberry grown in the open field at Esam Ahmed Abd El-Atty (2010/2011).

Treatment	Yield (Kg/m^2)	Costs (LE/Kg)	Incremental Costs (LE/Kg
Basamid (50 g/m^2) + Soil Solarization	3.096	0.84	**0.07**
Metam Sodium (100 ml/m^2) + Soil Solarization	3.572	0.59	-0.16
Soil Solarization + (Bioarc+Biozeid, 216 kg/ha each).	2.620	0.81	**0.04**
Methyl Bromide	4.049	0.76	

Table 7: The yield and incremental costs of MBr-alternatives compared to the costs of MBr at the rate of 50g/m2 + plastic malsh in Strawberry grown in the open field at Saad Ali Rozkana (2010/2011).

Treatment	Yield (Kg/m^2)	Costs (LE/Kg)	Incremental Costs (LE/Kg
Basamid (50 g/m^2) + Soil Solarization	3.095	0.85	0.08
Metam Sodium (100 ml/m^2) + Soil Solarization	3.810	0.56	-0.20
Soil Solarization + (Bioarc+Biozeid, 216 kg/ha each).	2.619	0.82	0.05
Methyl Bromide	4.048	0.77	

Table 8: The yield and incremental costs of MBr-alternatives compared to the costs of MBr at the rate of 50g/m2 + plastic malsh in Strawberry grown in greenhouse at Nabil Assy (2010/2011).

Treatment	Yield (Kg/m^2)	Costs (LE/Kg)	Incremental Costs (LE/Kg
Basamid (50 g/m^2) + Soil Solarization	3.333	0.79	-0.21
Metam Sodium (100 ml/m^2) + Soil Solarization	3.571	0.60	-0.4
Soil Solarization + (Bioarc+Biozeid, 216 kg/ha each).	2.381	0.90	-0.10
Methyl Bromide	3.095	1.00	

Table 9: The yield and incremental costs of MBr-alternatives compared to the costs of MBr at the rate of 50g/m2 + plastic malsh in Strawberry grown in the open field at Salah Salama Nasr (2010/2011).

Treatment	Yield (Kg/m^2)	Costs (LE/Kg)	Incremental Costs (LE/Kg
Basamid (50 g/m^2) + Soil Solarization	6.905	0.38	-0.06
Metam Sodium (100 ml/m^2) + Soil Solarization	7.143	3.347	2.9
Soil Solarization + (Bioarc+Biozeid, 216 kg/ha each).	4.286	0.50	-0.3
Methyl Bromide	7.143	0.44	

Table 10: The yield and incremental costs of MBr-alternatives compared to the costs of MBr at the rate of 50g/m2 + plastic malsh in Strawberry grown in the open field at Khaled Mansour Menshar (2010/2011).

Treatment	Yield (Kg/m^2)	Costs (LE/Kg)	Incremental Costs (LE/Kg
Basamid (50 g/m^2) + Soil Solarization	3.12	0.650	-0.48
Metam Sodium (100 ml/m^2) + Soil Solarization	3.94	0.587	-0.49
Soil Solarization + (Bioarc+Biozeid, 216 kg/ha each).	2.69	1.21	+0.13
Methyl Bromide	3.1	1.08	

Results of Tables 11& 12show the Pepper and Cucumber yield from CALC in El-Bossely. The Pepper and Cucumber yield from the methyl bromide treatment was slightly higher than the yield of other treatments.

The yield is higher in the Basamid (50 g/m2) + Soil Solarization followed by Soil Solarization + (Bioarc+Biozeid, 216 kg/ha each) and Metam Sodium (100 ml/m2) + Soil Solarization respectively , All the alternatives were little less costly than MBr. This is a very good and positive results as the used alternatives were as good as the use of MBr.

Table 11: The yield and incremental costs of MBr-alternatives compared to the costs of MBr at the rate of 50g/m2 + plastic malsh in greenhouse of Pepper grown at CLAC (2010/2011).

Treatment	Yield (Kg/m^2)	Costs (LE/Kg)	Incremental Costs (LE/Kg
Basamid (50 g/m^2) + Soil Solarization	5.3	0.50	**-0.04**
Metam Sodium (100 ml/m^2) + Soil Solarization	4.7	0.45	-0.09
Soil Solarization + (Bioarc+Biozeid, 216 kg/ha each).	4.9	0.43	**-0.11**
Methyl Bromide	5.8	0.54	

Table 12: The yield and incremental costs of MBr-alternatives compared to the costs of MBr at the rate of 50g/m2 + plastic malsh in greenhouse of Cucumber grown at CLAC (2010/2011).

Treatment	Yield (Kg/m^2)	Costs (LE/Kg)	Incremental Costs (LE/Kg
Basamid (50 g/m^2) + Soil Solarization	12.5	0.21	**0.01**
Metam Sodium (100 ml/m^2) + Soil Solarization	11.0	0.19	-0.03
Soil Solarization + (Bioarc+Biozeid, 216 kg/ha each).	11.2	0.19	**-0.03**
Methyl Bromide	14.0	0.22	

Conclusion

Regarding to yield and incremental cost:

- **All the used alternatives gave acceptable yield of the under-experimentation vegetables plants showing their feasibility as successful alternatives for the out-phasing methyl bromide.**
- **The used alternatives were successful in giving good yield of strawberry, pepper and cucumber indicating the efficacy of these alternatives on different crops. This an encouraging advantage to use those alternative on a wider variety of other different crops.**
- **Using these alternatives at different geographical locations with a variable weather conditions indicated the stability of those alternatives under different agricultural conditions giving the ability to using them in different areas and different circumstances.**

Regarding reduction of fungal and nematode diseases:
(data was presented in the previous report)

- **All the used alternatives gave reasonable reduction of the occurrence of the pathogenic fungi which are mainly the causal agents of root rots and wilt diseases for several host plants.**

- **Methyl Bromide still to be the superior treatment as in most cases it showed significant increase in reducing the occurrence of the pathogenic fungi compared with the used alternatives. However, the efficacy of some alternatives, in some cases, was close to that of Methyl Bromide.**

- **Among the used alternatives, Soil Solarization + Metam sodium (100 ml/m^2) was the most effective one after the Methyl Bromide.**

- **The efficacy of both Soil Solarization + Basamid (50g/m^2) and Soil Solarization + (Bioarc+Biozeid, 216 kg/ha each) in reducing the occurrence of the pathogenic fungi came after that of the Soil Solarization + Metam sodium (100 ml/m^2).**

- **The efficacy of the used MBr-alternatives in reducing the occurrence of the pathogenic fungi ranged from 56 to 87.6 % while that of Methyl Bromide ranged from 60-94.3%.**

Summary for result of nematode reproduction indicated that the used treatments had a same trend to that on the occurrence of the pathogenic fungi as:

- **All the used alternatives gave reasonable reduction of the root-knot nematodes.**
- **The super efficacy on reducing nematode reproduction was to the Methyl Bromide treatment**
- **The used alternatives shared the superiority in reducing the nematode reproduction.**
- **It is noteworthy that the used biological compounds (Bioarc&BioZeid) were more effective on nematode reproduction than it was on the occurrence of the pathogenic fungi.**

Recommendation

- Science the used MBr-alternatives showed a good effect on reducing the soil disease problems with giving an acceptable yield compared to methyl bromide, they are recommended to replace the out-phasing methyl bromide.
- The successful use of these alternatives encourage people to use them on a large scale with more and more crops and in various geographical locations.
- As the used alternatives cost similar, slightly higher or lower than the cost of using methyl bromide, they are recommended to be used and give the growers the desired profit.
- As the used alternative either the chemical or the biological ones are register for use in Egypt they are recommended to used safely and easily.

II- Evaluation effect of methyl iodide on weeds in vegetable crops.

Conclusion and summary

1- The efficacy of methyl iodide at rate of 14 g/m^2 was similar and was equal to bromide methyl as check, meanwhile, 12 g/m^2 dose was less effective in controlling mentioned annual weeds until 75 days from application.

2- There was some phytotoxicity on cucumber or pepper with iodide methyl in the rate of 14 g/m^2 and greater than 12 g/m^2 whereas no phytotoxicity appeared with bromide methyl . We discussed this phenomenon with the some experts from the importing company who indicated that fertilization with some products containing potassium before treatment or before the complete disposition of methyl iodide from the treated soil could cause such phytotoxicity.

3-No data were recorded at the end of season period of growing as the growers picked up the weeds as they grow using the hand picking-up method. So, no proper data were available.

4-The efficacy of iodide methyl at rate of 14 g/m2 was similar at, almost, the end of the growing season.

It is noteworthy that our results of methyl iodide is only on its effect on some phytopathogens targeted in this work under controlled limited conditions and we have no responsibility on any other properties or traits and registration of the compound as these issues are out of our responsibility.

Storage cereals

Eco_2 fume alternatives of Methyl boromide in storage

Introduction

DESCRIPTION

ECO2FUME fumigant gas is a ready-to-use, non-flammable mixture of phosphine and carbon dioxide that enables highly effective fumigation in a wide variety of sealed-storage applications. It is dispensed external to storage or structures using simple techniques which avoids applicator exposure and enhances worker safety.

ECO2FUME fumigant gas can be transported easily and disperses and penetrates foods and non-foods quickly.

Internal concentration levels of phosphine can be managed by adjusting the amount of fumigant released from the cylinder at any stage of the fumigation process.

Eco2Fume fumigant is quickly and easily aerated.

It produces no waste by-products or dust residues, thus eliminating the hazardous deactivation and disposal issues typically associated with traditional fumigants.

TECHNICAL SPECIFICATIONS

Formulation of ECO2FUME

- Phosphine (PH_3): 2% (by weight)/2.6% by volume
- Carbon Dioxide (CO_2): 98%

PRODUCT BENEFITS

Advantages of ECO2FUME fumigant gas compared to traditional fumigants:

• Non-flammable

– This eliminates spontaneous flammability associated with metal phosphides, which can cause fires within the fumigated space

• Fast-acting

– Required concentration levels are achieved in hours, not days

• Easy application and control

– ECO2FUME fumigant gas is pre-mixed, and operators can easily vary concentration levels and exposure

periods, ensuring elimination of all insect stages

• Enhanced worker safety

- **ECO2FUME fumigant gas comes in ready-to-use cylinders that eliminate worker cont**
- **act**

• No waste generation or disposal

– ECO2FUME fumigant gas yields no waste by-products, and is residue free

• Environmentally friendly

– Unlike alternatives, ECO2FUME fumigant gas will not harm the ozone layer

• Cost-effective

Results

Compared between different ground soils (concrete, plastic sheet, clay soils and sand soils) for fumigation by Eco2 – fume gas against different insect stages and losses of gas through the earth.

Table (43) shows values of Eco2 fume concentration (600 ppm) recorded during grain fumigation on concrete and soil ground with Eco2 fume under new plastic sheet in santa and shoubra-kas shouna. Results indicated that after 3 days exposure period complete mortalities were achieved for the adults and immature stages of tested insects for the concrete ground.

Average total gas concentration during the whole exposure period was 994.8 and 917.9 ppm on concrete and soil ground, respectively. It was evident, that grain fumigation with Eco2 fume on concrete ground caused an increase in the average total concentration during 3 days exposure period by around 8.4% compared with grain fumigation on the soil ground of the shouna.

Table (43): Eco2 fume concentration under new plastic sheet for grain fumigation on concrete and clay soil ground in santa and shoubra kas shouna, Gharbia Governorate.

Treatment	Eco_2 concentration at indicated days				Average	Total increase %	Fumigation result
	Initial time	1st day	2nd day	3rd day			
400 ppm (28 g /m^3) On concrete ground	1210.5	705	621.5	460	749.3	42.5	Incomplete insect mortality
400 ppm (28 g /m^3) On clay soil ground	924	613.5	365.5	201	526	---	Incomplete insect mortality
500 ppm On concrete ground	1382.5	895	801.5	654	933.3	14.8	Incomplete insect mortality
500 ppm On clay soil ground	1412.5	870	599.5	370	813	---	
600 ppm On concrete ground	1384	1015	886.5	693.5	994.8	8.4	Complete insect mortality
600 ppm On clay soil ground	1658.5	912.5	684	416	917.8	---	Incomplete insect mortality

Table (44) shows values of Eco2 fume concentration (600 ppm) recorded grain fumigation on ground sheet in Beni-suef and sand siol in Demo Fayoum shouna.

Average total concentration at 3 days exposure was 1049.3 and 748.3 ppm on ground sheet and sand soil, respectively.

It was evident, that grain fumigation with Eco2 fume on ground sheet caused an increase in average total concentration during 3 days exposure period by around 40.2% compared with grain fumigation on the sand soil of the shouna.

Table (44): Eco2 fume concentration under new plastic sheet for grain fumigation on ground sheet and sand soil in Beni-suef shouna and Demo shouna, fayoum Governorate.

Treatment	Eco_2 concentration at indicated days				Average	Total increase %	Fumigation result
	Initial time	1st day	2nd day	3rd day			
500 ppm (36 g. /m^3) Ground sheet	1354.5	882	640.5	476	719.3	18.1	Incomplete insect mortality
500 ppm (36 g. /m^3) Sand soil	1405.5	640	284.5	104.5	608.6	----	
600 ppm (42 g. /m^3) Ground sheet	1616	1072.5	849	659.5	1049.5	40.2	Complete insect mortality
600 ppm (42 g. /m^3) Sand soil	1422.5	844	496	230.5	748.3	----	Incomplete insect mortality
700 ppm (50 g. /m^3) Ground sheet	2077	1227	939	684	1231.8	36.1	Complete insect mortality
700 ppm (50 g. /m^3) Sand soil	1686	927	601.5	406	905.1	----	Complete insect mortality

Table (45) shows values of Eco2 fume concentration 600 ppm recorded grain fumigation on ground sheet and concrete floor in Damanhour shouna, Beheira Governorate.

Average total concentration at 3 days exposure period was 1006.9 and 821.9 ppm on ground sheet and concrete floor, respectively.

It was evident, that grain fumigation with Eco2 fume on ground sheet caused an increase in average total concentration during three days

exposure period by around 22.5%compared with grain fumigation on the concrete floor of the shouna.

Table (45): Eco2 fume concentration under new plastic sheet for grain fumigation on ground sheet and concrete soil in Damanhour shouna , Beheira governorate.

Treatment	Eco_2 concentration at indicated days				Average	Total increase %	Fumigation result
	Initial time	1st day	2nd day	3rd day			
500 ppm (36 g. /m^3) Ground sheet	1184.5	829.5	711	647.5	843.1	17.7	Incomplete insect mortality
500 ppm (36 g. /m^3) Concrete floor	985.5	730	653.5	522.5	716.1	----	Incomplete insect mortality
600 ppm (42 g. /m^3) Ground sheet	1443.5	964.5	879.5	740	1006.9	22.5	Complete insect mortality
600 ppm (42 g. /m^3) Concrete floor	1161.5	845.5	706	574.5	821.9	----	Complete insect mortality
700 ppm (50 g. /m^3) Ground sheet	1971	1333	1017.5	983.5	1326.3	1.0	Complete insect mortality
700 ppm (50 g. /m^3) Concrete floor	1993.5	1438.5	1010.5	813	1313.8	----	Complete insect mortality

Conclusion

The work in winter season.

-The concentration were used 300,400,500 and600 ppm in Azizia shouma , Elminia and Kafr Diama

shouma not gave100% mortality for pupal stages of S.oryzae and R.dominica and Egg of the same insects

-So,we have to use anther concentration i.e. 700 ppm (50g/m3) in ground soils,clay and sand soils . but in case of ground sheet and concrete floor. The recomended dose is 600 ppm (43g/m3) in winter.

And the recommended dose in the store airtight and the concrete floors is 500ppm(36g/m3) in case of wheat grain seeds.

- The work in summer season

The concentration were used 400,500,600 &700ppm at Beniswef Shouna No.1 demo shouna ,Azizia shouna, shoubra Kas Shouna ,Santa shouna , Damanhour silo shouna , Damanhour shouna , and Kafer – Elshekh crops Shouna.

This work in all shounas at different ground under sheet.

The recommended dose are:

700ppm/m3(50g/m3) at clay and sand soils at 3 days exposure.

600ppm/m3 (43g/m3)at concrete floor and ground sheet.

These doses recommended in winter and summerseason but at different grounds.

500ppm(36g/m3)at the store to seeds on concrete floor.

Over all conclusion

The overall conclusion is that all the used alternatives are reasonable in to replace the out-phasing Methyl Bromide regarding their effects or costs. Some new safer chemical alternatives will be tested this season giving a wider option to the growers. Also, this season will be for more extended awareness for the newly provided alternatives and assuring the stability of the previously used ones.

Results of this report could be considered when taking any decision regarding to reduction of the amount of the used Methyl Bromide in the future.