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SPECIAL REPORT:
VALIDATING THE YIELD PERFORMANCE OF ALTERNATIVES TO METHYL BROMIDE FOR PRE-PLANT FUMIGATION

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Foreword

On behalf of the Montreal Protocol Technology and Economic Assessment Panel (TEAP) we are pleased to release the ***TEAP/MBTOC Special Report, 'Validating the Yield Performance of Alternatives to Methyl Bromide for Pre-Plant Fumigation'***.

The study was undertaken by Methyl Bromide Technical Options Committee (MBTOC) Co-Chair Dr. Ian Porter, Leanne Trinder, and Debra Partington with the assistance of Dr. Jonathan Banks, Stefan Smith, Murray Hannah, and Natalie Karavarsamis. MBTOC members and members of their global expert network contributed to the report and TEAP members peer reviewed and edited the final version. MBTOC members and members of their global expert network contributed to the report.

The policy-relevant technical findings are that crops produced with certain alternatives to methyl bromide have statistically equivalent yields to crops produced with methyl bromide.

These findings give extraordinary confidence to global efforts to minimize and eliminate exemptions for Critical Use of methyl bromide allowed under the Montreal Protocol for developed countries.

The results will be welcome by farmers, farm workers and their families who are particularly vulnerable to skin cancer and cataracts from the long hours working under conditions of high ultraviolet-B (UV-B) solar radiation that is increased by stratospheric ozone depletion.

This report is one of the most comprehensive meta-analyses studies ever conducted for the agricultural sector. It considered the available global library of peer reviewed reports of field studies. These studies were collected by MBTOC members and by the authors from global internet agricultural data bases. It used sophisticated analytical techniques and computer modelling to compare yields of crops grown with methyl bromide and methyl bromide alternatives and displays its results in tabular and graphical formats that are suitable for interpretation by agricultural specialists, agribusiness managers, and policy makers.

The report was reviewed and endorsed by the MBTOC and TEAP.

Parties to the Montreal Protocol and their agricultural advisors will want to carefully study this report in order to consider the alternatives to methyl bromide that best accomplish their goal of a rapid phaseout of methyl bromide. The Multilateral Fund and its implementing agencies can use the analysis to identify the alternatives that maintain crop yields for favourable cost-effectiveness. Pest control advisors and their suppliers will want to use the analysis to guide agricultural sectors to the best alternatives. And chemical suppliers will want to use the results to focus future research on those uses that have less satisfactory options.

Action by national and regional environmental and agricultural authorities is particularly necessary in cases where the most suitable alternatives are not yet registered or where use restrictions inhibit protection of the ozone layer.

TEAP congratulates the authors and collaborators for this important analysis that supports global efforts to protect the earth for our and future generations.

Stephen O. Andersen, Lambert Kuijpers, and Jose Pons
TEAP Co-Chairs

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GLOSSARY OF KEY ACRONYMS

CUN	Critical Use Nomination
CUE	Critical Use Exemption
EC	Emulsifiable Concentrate
HDPE	High Density Polyethylene
LDPE	Low Density Polyethylene
LSI	Least Significant Interval
SE	Standard Error
VIF	Virtually Impermeable Films

EXECUTIVE SUMMARY

The report presents a formal meta-analysis that validates the yield performance of alternatives to methyl bromide for some major pre-plant treatments that are currently subject to the Critical Use Exemptions under the Montreal Protocol. The policy-relevant technical finding is that crops produced with certain alternatives to methyl bromide have statistically equivalent yields to crops produced with methyl bromide.

Evaluation of Critical Use Nominations for Methyl Bromide is a very difficult and complex task. Analysis of international research studies is key part of this process. MBTOC and TEAP are required by the Parties to provide well-considered and authoritative advice on whether particular nominations meet the criteria for a Critical Use Exemption, and particularly whether there are technically and economically feasible alternatives to the nominated use available within the context of Decision IX/6.

Decision XVI/5 provided financial support to the Methyl Bromide Technical Options Committee's (MBTOC) co-chairs *inter alia* for expert to provide more detailed assessment of the nominations' claims against the criteria of Decision IX/6 and also expert assistance with the preparation of the Methyl Bromide Technical Options Committee's reports on its assessment of the critical-use nominations, so as to ensure that such reports provide sufficient levels of transparency and detail to meet the requirements of the Parties.

This report is endorsed by TEAP and MBTOC and its development was supervised by MBTOC, with funding provided under Decision XVI/5.

The report presents the methodology and outcomes of a formal meta-analysis into methyl bromide alternatives for some major pre-plant treatments that are currently subject to the CUNs. This quantative statistical analysis allows a comparison of effectiveness of alternatives in a transparent and rigorous way for some crops for which complex CUNs have been made. It provides the statistical best estimate of the relative effectiveness of the major alternatives to methyl bromide as determined by analysis of information across a large number of studies in different regions and under different pathogen pressures. Effectiveness was assessed by comparing relative yield of the alternative to the respective methyl bromide/chloropicrin (MB/Pic) treatment. The study takes account of both registered and unregistered products.

The key steps to achieve this outcome were:

a) a literature review of refereed and non refereed publications and develop a bibliography database of trials conducted in studies reported since 1997 evaluating alternatives to methyl bromide for pre-plant fumigation. A limitation on resources prevented reviewing previous studies. Also more recent studies are considered more appropriate as improvements in performance of new alternatives often occur with repeated trialing, new formulations and new application technologies.

b) development of a PC based (Microsoft Access) multifactor database of parameters contained in the major studies so that the data can be used for comparative analyses of the information.

c) development of a PC based (Excel) multifactor database of trial details in numeric format which enabled biometrical analyses.

d) a meta-analyses using statistical comparisons of yields, paying particular attention to variations in inoculum density of the pests (fungal pathogens and nematodes), nutsedge, soil type, barrier films, method and rate of application of alternatives from major studies relevant to major crops applying for Critical Use Nominations (CUNs).

This report concentrates on two major crops, strawberry fruit and tomatoes. Comparisons are made to peppers, melons, eggplants and cucurbits data where possible. Too few articles have

been published to allow meta-analysis of the latter crops on an individual basis. However, much of the information for tomatoes (i.e. effect on target pathogens and weeds) is relevant to the outcomes for these other crops. The meta-analysis also includes a detailed assessment of the effect of alternatives for nutsedge under different pressures and the influence of low permeability barrier films across a range of regions and crops.

Sufficient published articles for the two main crops (tomatoes and strawberry fruit) have been captured during this study to provide accurate trends with most alternatives. It is recognised that there may be additional relevant studies that have been completed, but were not incorporated in this present study because full details of results were not provided or were unavailable. Incorporation of further data from these other studies may improve the precision of the meta-analysis. Conclusions about some of the newer alternatives are limited by the lack of reported studies.

The report outlines the power of the meta-analysis for decision making, and some of the challenges encountered during the data collection phase of the project and the procedures used to resolve these issues. The meta-analysis deals only with technical efficacy of alternatives measured by relative yield outcome. It considered relative yield for the crop following treatment only and made no attempt to analyse the effect on the subsequent crop(s). To this extent it closely mirrored the comparison of alternatives for many of the Critical Use Nominations. The study considered only alternatives which may directly replace MB for fumigation of soils – it did not consider methods which avoid the need for fumigation, i.e. soilless media and other substrates, potted plants and hydroponic systems which are considered as potential methods to replace production in fumigated soils.

This study has been conducted independently of restrictions to use of alternatives due to regulations, registration and market forces and recognises that economic feasibility also needs to be taken into account before a treatment can be considered a suitable alternative to MB under Decision IX/6. Full assessment of Critical Use Nominations by MBTOC takes into account both technical and economic feasibility.

OVERVIEW OF FINDINGS

The relative efficacy and variability in yield of a wide range of alternatives were compared to a standard MB/Pic treatment. The alternatives most often reported were chemicals, although a number of non-chemical alternatives were also included in the studies (eg. solarization, biofumigation, composts and biological control agents). Data from a large number of trials from regions which have applied for critical use exemptions, i.e. Europe, North America and Australasia, 101 for strawberries and 61 for tomatoes, have been included in this study.

Analyses from strawberry fruit trials showed that a large number of alternatives used alone or in various combinations had mean estimated yields which were within 5% of the estimated yield of the standard methyl bromide treatment (MB/Pic 67:33). Of these a number of