

Low Production Cost Alternative Systems are the Avenue for Future Sustainability of Vegetable Growers in the U.S

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Abstract

Future sustainability of the vegetable growers in the U.S. will depend on coping with regulations imposed by the global market, and on adoption of production practices that keep production cost low and competitive, conserve natural resources, and protect the environment. Two major policies—The Montreal Protocol and the North American Free Trade Agreement (NAFTA) adversely affected the vegetable growers in the U.S. in general and in Florida in particular. With the banning of methyl bromide (MeBr) and the fragility of the ecosystem, there is a need to develop production practices that maintain or further increase high yields at reduced chemical inputs. We describe an environmentally friendly production system that meets this need.

INTRODUCTION

Vegetables are a major component of U.S. agriculture and an important nutritional source for millions of Americans. Annual production of 34 major vegetables for the year 2000 utilized 1.6 million ha and was valued at \$10.1 billion (Agricultural Statistics, U.S. Department of Agriculture, 2000). California and Florida growers farm 540,000 and 82,000 ha, respectively, with an annual value of \$5.6 billion for California and \$1.1 billion for Florida. These two states farm 38.6% of total vegetable acreage in the U.S.

Climate often dictates what commodities are grown in each state. For example, California produces 93% of all processing tomatoes and 29% of all fresh-market tomatoes grown in the country. In contrast, Florida produces 44% of total fresh-market tomatoes and hardly any processing tomatoes.

For many decades, agricultural production in tropical and subtropical regions such as Florida depended on soil fumigation to control pathogens, nematodes, insects and weeds. Methyl bromide (MeBr) was the main soil fumigant because it was economical and effective over a broad spectrum of soil pests. Agriculture in the U.S. used anywhere from 32 to 40% of world production which in the early 1990s reached a plateau of one hundred thousand tons annually. Florida was a major user of MeBr. The major crops included tomatoes, strawberries, peppers, cucurbits, tobacco and turf. The use of MeBr provided economic sustainability to vegetable growers. Just to illustrate: In the early 1990s before the Montreal Protocol and NAFTA were implemented, annual consumption of the five major vegetables grown in MeBr fumigated soil (tomatoes, bell peppers, cucumbers, eggplants and snap beans) in the U.S. was 104 million tons. About 83% of it was produced in the U.S. and only 17% was imported (VanSickle et al., 2000). Freshly consumed vegetables represented slightly over 50% of total consumption. With the enactment of the two major international policies – the Montreal Protocol and NAFTA, production of vegetables in the U.S. was adversely affected. We present the effects of these two policies on vegetable production in the U.S. in general and on vegetable production in Florida in particular. We further propose a biologically-based MeBr alternative production system that improves soil fertility and yield, and protects the environment.

THE PROBLEM

The Montreal Protocol was initiated to protect the earth from the detrimental effects of ozone depletion through controlling the global production and trade of ozone depleting substances with an ozone depleting potential (ODP) of 0.2 or higher (U.S. EPA Methyl Bromide Phase Out Website 1/28/02). Methyl bromide has an ODP of 0.7. The treaty further stipulated that in developed countries like the U.S., a 25% annual reduction in use begins in 1999 and complete banning is reached in 2005. For developing countries, partial banning begins in 2005, and total banning is reached in 2015. Extending MeBr use by developing countries for ten years over developed countries gave a great advantage to Mexico and other neighboring countries who share the same market window with Florida. During these ten years, Mexico, the strongest competitor to the U.S., will continue to use a highly effective production system using MeBr while the U.S. vegetable growers will still be searching for an economic, alternative production system. The Mexican vegetable growers will have higher yields and lower production costs than the Florida growers partly due to extended use of MeBr and partly because they have lower taxes, lower labor costs and lower insurance.

At the time Florida vegetable growers were desperately searching for an alternative to the MeBr production system to reduce the keen competition, an additional policy, NAFTA, was signed into law in 1993. This policy made the competition keener by a) eliminating over a 30-year transitional period tariffs, quotas and import licenses that complicate U.S. – Mexican trade, and b) liberalizing the transportation sector to allow direct transportation anywhere between the U.S. and Mexico.

The impacts of these two policies on vegetable production in the U.S. in general and on Florida in particular after eight years of implementation (1992 - 2000) are as follows:

1. The share of the U.S. vegetable market met by U.S. growers fell from 80% to 70% and that of Florida growers from 35% to 25%.
2. For tomatoes, U.S. producers and Florida producers supplied 90% and 47% of the U.S. market, respectively. By 1998, the figures declined to 67% and 25%, respectively. During the same period, tomato imports from Mexico alone increased 200%.
3. Whereas, annual consumption of fresh vegetables in the U.S. has, between 1992 and 2000, witnessed a steady yearly increase, U.S. acreage in vegetable production remained unchanged and yields of the five major vegetables per ha increased during the same period by only a modest average of 10% as a result of implementing new research technologies. In contrast, vegetable production in Mexico during the same period increased by about 85% and exports to the U.S. doubled.
4. The near future will even be more competitive unless an economic alternative to the MeBr production system is introduced. Until then, it is predicted that the implementation of NAFTA will further reduce vegetable production in the U.S., stimulate more imports from Mexico, and make the competition keener. Spreen et al. (1995) estimated that the loss of MeBr alone would have a one billion dollar impact annually on the U.S. winter vegetable industry, with Florida accounting for nearly all of this impact. It is further predicted that tomato yields will face an additional 10% decline throughout Florida and a 20% decline in south Florida counties of Miami-Dade and Palm Beach where the use of Telone is not approved because it would leach into the shallow drinking water table.
5. Tomato production in Miami-Dade and Palm Beach (two important vegetable producing counties) is projected to cease completely. Florida is projected to lose \$69 million annually in shipping point revenues for tomatoes, and Mexico to gain \$52 million. Florida will also lose 65% of the pepper market, mostly to Mexico, while production is expected to cease entirely in Miami-Dade county and decline 79% in Palm Beach county.

ALTERNATIVE PRODUCTION SYSTEMS AS A SOLUTION

For any alternative production system to be accepted by growers and approved by law, it has to take into consideration the fragility of the ecosystem in Florida, the low soil

fertility and its heavy infestation with nematodes and other pathogens. The system also has to be practical and produce high yields to reduce the production costs to the level achieved by Mexican growers. Finding alternatives to MeBr is a challenging task because of the high effectiveness of MeBr as a soil fumigant in controlling a broad spectrum of agricultural pests. With only two years left before complete banning of MeBr, and with no equally effective pesticide in the market, many chemical and non-chemical approaches are being evaluated. Chemical alternatives include methyl iodide, Kpam, Telone (1,3 dichloropropene), chloropicrin and metam sodium. Non-chemical alternatives include soil solarization (Sotomayor et al., 1998), manipulation of soil microflora by amendments to enhance suppressive activities of biota, cultural practices including proper management of weeds that host nematodes, crop rotations (Vargas-Ayala and Rodriguez-Kabana, 2001), use of nematode resistant cover crops (McSorley, 2000), and microbial-based control measures such as the use of compost and biological control agents.

We have been developing a biologically-based alternative to the MeBr system for winter fresh-market tomato production. This system utilizes alternating nematode-resistant tomato cultivars and legume cover crops that are not hosts to root-knot nematodes (*Meloidogyne* spp.), in a rotation with reduced tillage and optimum weed management. Nematode-resistant tomato cultivars have been developed for some time and at least one hybrid cultivar (Sanibel) has been specifically developed for Florida. Other nematode-resistant cultivars include 'Sunjay', 'Clemente', 'Cisco', and 'Shady Lady', and many more are being bred by the seed companies. They all have the M i gene that is expressed as long as the temperature remains below 31.5° C (Abdul-Baki et al., 1996). At temperatures above 31.5° C, the tomato plant loses its resistance to the root-knot nematode. Similarly, some bell pepper cultivars have resistance to nematodes and include 'Charleston Bell' and 'Carolina Wonder'.

A large number of grassy and leguminous cover crop cultivars have shown resistance to one of more species of pathogenic nematodes (Aguilar et al., 1998; Araya and Caswell-Chen, 1994; Defour et al., 1998; McSorley, 2000; McSorley et al., 1994; Rodreguiz-Kabana et al., 1992; Vargas-Ayala and Rodriguez-Kabana, 2001). No one cover crop can serve as non-host to all nematode species. Therefore, in soils where many species are found, selection of the cover crop has focused on the species most damaging to the vegetable crop. In the tomato growing area of southern Florida, the root-knot nematode (*Meloidogyne incognita*) is the most serious pest and inflicts the highest damage. Consequently, in our experiments, we used three non-host leguminous species, velvetbean (*Mucuna prurens* var. *Utilis*), cowpea (*Vigna unguiculata* cv. 'Iron Clay') and sunn hemp (*Crotalaria juncea* var. *Tropic Sun*).

We conducted our experiments in Krome, very gravelly loam soil. The experiments included a MeBr/chloropicrin (67-33%) control at MeBr rate of 625 kg·ha⁻¹, and biological alternative treatments to MeBr based on the three cover crops—velvetbean, cowpea and sunn hemp. The cover crops were seeded on raised beds in June, mowed in early August and left to regrow leaving the residue on the soil surface. They were mowed again in October and the residue was incorporated into the soil before the raised beds were reformed and covered with polyethylene mulch. The MeBr treatment received 225 kg N·ha⁻¹ whereas, the cover crop treatments received 192 kg N·ha⁻¹. The assumption is that the rest of the N will be provided by the cover crops. All other subsequent cultural operations for all treatments were identical to growers' practices. Average marketable yields and extra-large fruit yields for 2001 and 2002 are summarized in Table 1.

The results from two years suggested that a) marketable yields from the cowpea and velvetbean treatments were comparable to that from the MeBr treatment; whereas, marketable yield from the sunn hemp treatment was lower than the rest; b) marketable yields of all the treatments (including MeBr) were higher than the marketable yield average (39.3 t·ha⁻¹) for Miami-Dade County; c) yields of extra large fruits were similar in all treatments; and d) elimination of soil fumigation with MeBr reduced production cost by \$1,544 per ha. An additional \$130 per ha was saved from reducing fertilizer N. Other

benefits from using the cover crops included fixing nitrogen, recycling of nutrients, improving soil tilth by adding organic matter and reducing soil erosion.

In summary, the proposed alternative production system of using nematode resistant cultivars of tomatoes and cover crops in a crop rotation is a viable system for fresh-market winter production of tomatoes in South Florida. Marketable yields in two of the three cover cropping systems are equivalent to that in MeBr. Production cost in the alternative system is lower than that in the MeBr system due to elimination of MeBr and reduction in fertilizer application. Finally, the alternative systems improve soil fertility and provide safe working conditions to farm workers as well as a great protection to the environment.

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Tables

Table 1. Average yields of extra large fruits and marketable yields of fresh-market tomatoes for 2001 and 2002 produced in methyl bromide and cover crop mulches.

Treatment	Extra large fruit t·ha⁻¹	Average marketable yield t·ha⁻¹
MeBr	30.5a*	60.9a
Cowpea	31.6a	57.0a
Velvetbean	28.9a	57.0a
Sunn hemp	31.1a	47.1b

*Means in the column with the same letter are not significantly different at 5% level by Duncans multiple range test.