Iran Agricultural Research, Volume 3, No. 1, 1984

NOTE

PRELIMINARY ASSESSMENT OF MICROBIAL-BASED SOIL ADDITIVES[1]

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ABSTRACT

This study evaluated the influence of three commercially available, microbial-based soil additives on dry matter yield of greenhouse tomatoes (*Lycopersicon esculentum* Mill.), and on relevant soil physical and chemical properties. No beneficial effects were observed for any of these materials, applied either alone or in combination with either organic or inorganic fertilizers. This study, therefore, questions the use of such materials in agriculture and the legislation pertaining to them.

تحقیقات کشاورزی ایران

جلدسوم شماره دوم ۱۳۶۳

ارزشیابی مقدماتی مواد میکروبی اضافه شده به خاک

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بترتیب استاد خاکشناسی ، کمک محقق ومربی دانشکده کشاورزی وعلوم غذائی دانشگاه آمریکائی بیروت

خلاصه

دراین آزمایش اثرسه نوع مواد میکربی تجارتی اضافه شده به خاک ، برروی میزان ماده خشک گوجه فرنگی گلخانه ای وهمچنین خصوصیات فیزیکی وشیمیائی خاک ،ارزیابی گردید . استعمال این مواد به تنهائی یا همراه با کودهای آلی وغیرآلی هیچ اثرمثبتی نداشت بنابراین دراین بررسی کاربرداین مواددرکشاورزی وقوانین ومقررات مربوط به آن ، موردسئوال قرارمیگیرد .

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INTRODUCTION

Though the indispensable role of commercial fertilizers has long been established in the agriculture of developed, particularly western countries, the awarness of the need for, and the benefits of fertilization in developing countries is more recent. However, despite the obvious benefits which accrue from fertilizer use, circumstances have developed which promote competitive materials which purportedly reduce or eliminate the need for commercial fertilizers.

In the West this includes a public, principally urban skepticism of "chemicals" in agriculture, and a consequent trend toward "organically grown" foods. Implicit in this concern is the notion that chemicals, including fertilizers, are harmful and result in poorer quality produce. In developing countries, alternatives to fertilizers are fostered by higher prices and, in many cases, the unavailability of commercial fertilizers due to hard currency restrictions on importation. Other compounding factors include a poor administrative and physical infrastructure, less than adequate legislative control, and weak research-extension systems.

Lebanon is representative of a developing region, the Middle East, where the latter conditions obtain, and are even exacerbated by the years of on-going civil strife. Though fertilizer use in Lebanon is comparatively intensive (2), its agricultural sector has recently been characterized by the encroachment of non-traditional materials whose postulated effects are based on microbial action. This preliminary study sought to examine the commercial claims for three such materials by growing tomatoes (*Lycopersicon esculentum* Mill) on a number of soils treated with the additives alone and in combination with organic and inorganic fertilizers. Changes in soil properties were also monitored in an incubation experiment.

MATERIALS AND METHODS

The materials evaluated in this study were: 1) Biotrone-microbial enzymatic metabolizer; buff-colored, condensed liquid fermentation product; pH 3-4; aerobic (*Bacillus subtilis, Enterobacter agglomeranas, Penicillium sp.*) and anaerobic (*Clostridium beijerinckii* and *Clostridium butyricum*) bacteria, as well as lesser amounts of yeasts, molds and actinomycetes; enzymes of the hydrolase and desmolase groups; and traces of vitamins, organic acids and nutrient elements 2) Regebac-whitish powder purporting to contain unspecified bacteria which transform organic matter, fix atmospheric N, suppress pathogenic bacteria, and produce growth-promoting substances; and 3) Humobacter-a solid organic material purporting to be rich in agriculturally beneficial organisms. Other materials used in the growth experiment were a compound fertilizer (N, P_2O_5, K_2O, 17: 17: 17), commercial peatmoss, and a locally produced organic material-Dubaline (mixture of animal manures and grape and sugarbeet residues).

The main soil (no. 1) used in the study was from the primarily agricultural area the Bekaa valley (clayey, mixed, mesic, Vertic Xerochrept). The soil had a CEC of 31 meq/100 g and contained 17% $CaCO_3$. Three other calcareous soils of differing textures were also used, i.e. clay (no. 2), clay loam (no. 3) and a sandy soil (no. 4). No soil series have been identified since available maps are based on reconnaissance surveys. Moreover, only one of the four soils was formally classified. Values of pH and EC for the four soils were approximately 8.0 and less than 0.25 mmhos/cm, respectively. Surface samples were air-dried and passed through a 6.35 mm sieve prior to potting.

In the first greenhouse trial, all three materials were evaluated by growing tomato plants from seed on Soil 1 (5 kg/pot) for 8 weeks. The materials were applied according to recommended rates as follows: Biotrone-2.5 mL in 50 mL H_2O poured on soil surface; Regebac-2.5 g mixed with soil; and Humobacter- 10 g mixed with soil. Standard rates were applied for the compound fertilizer (7.5 g), while the 100-g rate for peatmoss was arbitrary, but nevertheless a valid basis for considering the possible influence of bacterial additives on this organic amendment. In the second growth experiment lasting 7 weeks, Biotrone alone at similar rates was evaluated using three soils (2 kg/pot). In this case Dubaline was used at a rate of 1% (wt/wt). Untreated control pots were included in both trials. All pots were watered daily or as required from the basins upwards. Each treatment was in triplicate in a randomized design. After each growth period, dry matter yield data were recorded and in the first trial, tissue N was determined by the standard Kjeldahl procedure. Where appropriate, data were evaluated statistically using analysis of variance followed by Duncan's Multiple Range Test.

In a laboratory experiment, batches of polypropylene tubes were incubated with 15-g samples (2 mm) of the three additive-treated soils (no. 2, 3, and 4) at field capacity and room temperature for 2, 6, and 12 weeks. After these times duplicate sampels were removed and extracted by $NaHCO_3$ followed by N determination by the Kjeldahl procedure and P by colorimetry (5). Organic C was determined in separate samples by the standard Walkley-Black procedure. For an assessment of aggregation, 50-g samples were used in aluminum cans with subsequent measurement of the suspended soil particles by the Buoyoucos hydrometer method (3).

In addition to these trials, the materials were analyzed for pH using a ratio of 1: 2.5 for the solid materials, Regebac and Humobacter, and the undiluted solution for the liquid Biotrone. Also an attempt was made to characterize them with respect to microbial population using procedures outlined in Buchaman and Gibbons (1).

RESULTS AND DISCUSSION

The data indicated that none of the three additives-Biotrone Regebac or Humobacter-had any significant effect in increasing dry matter yield of tomatoes (Table 1). The N concentration of the tissue was similarly unaffected, and therefore N uptake was not affected. When Biotrone was evaluated along with a commercial compound fertilizer (N, P_2O_5, K_2O, 17: 17: 17) and Dubaline on soil No. 2, there was no additional effect of Biotrone. The material also had no effect by comparison with either control soils (Table 1).

The incubation trial further revealed no consistent or positive effect of any of the three materials. However, organic C tended to decrease with increasing incubation time only in the sandy soil: values decreased from 1.7% after 2 weeks to 0.31% after 12 weeks, while samples treated with Biotrone, Regebac and Humobacter declined to 0.32, 0.51, and 0.40%, respectively after 12 weeks incubation. The index of aggregation, i.e., amount of soil in suspension as measured by the hydrometer, did not reflect any difference due to incubation time or the addition of the three materials.

Though P and N in the $NaHCO_3$ extracts fluctuated with incubation time, there was no obvious influence of the additives. For example, after 2, 6, and 12 weeks, P values for the clay soil (no. 2) were 66, 71, and 104 ppm respectively, and for the sandy soil (no. 4) 21, 16, and 22 ppm, respectivley. The corresponding values where Biotrone was added were 74, 74 and 112 ppm (no. 2) and 24, 19, and 21 ppm (no. 4), respectively. The pattern of $NaHCO_3$-extractable N was even more erratic than for P, i.e., for the clay soil values after 2, 6 and 12 weeks were 204, 48, and 215 ppm N, respectivley, while with addition of Biotrone, the corresponding values were 150, 181, and 174 ppm, respectively. Such differences obviously reflected variable rates of mineralization and immobilization.

Laboratory analysis of the materials revealed the

Table 1. Dry matter yield and N concentration of greenhouse tomato plants in response to microbial-based soil additives.

		Treatment (Soil 1)					
		Alone		+NPK		+Peatmoss	
Trial	Material	Dry matter (g)	N(%)	Dry matter (g)	N(%)	Dry matter (g)	N(%)
I	Control	10.2a*	0.91	25.9a	1.83	12.6a	1.04
	Biotrone	8.9a	0.98	26.6a	2.30	12.6a	0.92
	Regebac	11.3a	0.85	26.1a	2.30	13.5a	0.90
	Humobacter	9.4a	1.06	25.4a	2.20	10.7a	0.98
		Soil 2		Soil 3		Soil 4	
II	Control	3.4a		3.4a		3.3a	
	Biotrone	3.6a		3.9a		2.3a	
	NPK	12.3b		9.2c		9.5a	
	NPK+Biotrone	12.9b		10.8c		9.6c	
	Dubaline	10.8b		7.0b		5.1b	
	Dubaline+ Biotrone	11.1b		6.5b		5.4b	

†N concentration was based on a composite sample of the three replicates.

*Individual columns within each trial with data having different letters denote significant differences at the 5% level with Duncan's Multiple Range Test.

respective pH values of Biotrone, Regebec, and Humobacter to be 3.5, 5.9, and 6.2, while the EC values were 24, 18, and 0.9 mmhos/cm, respectivley. Microbiological assays following standard procedures (1) indicated no growth of organisms in the Biotrone sample, the presence of *B. subtilis* and some N fixers in Regebac, and *B. pumilis* and some N fixers in Humobacter.

Thus, not only did the study fail to identify any positive effect of these additives on plant growth, but it also indicated some possible explanations for such failure. For example, the absence of any microbial growth in Biotrone could be attributed to both the acidity of the medium as well as the high salt content, which was also high for Regebac. Discrepancies also existed between the organisms detected compared to what was indicated in the literature related to these materials.

Based on the results of these preliminary studies, there is no basis for recommending such microbial-based materials for crop production on normal soils either as complete or partial substitues for conventional organic or inorganic fertilizing materials. While these materials may contain organisms capable of fixing atmospheric N, their addition to soils which normally contain high population of these organisms from specific soils is most likely attributable to adverse soil or environmental conditions. Inoculation under such conditions would most likely be ineffective.

The absence of any field trial data which might validate the commercial claims for microbial-based materials further underscores the caution that should be exercised before they are accepted for routine use. In a recent paper dealing with commercial claims of such non-traditional soil additives, Halvorson (4) stressed that such products should identify the active ingredients and the mode of action of each component. However, the materials under consideration in this study do not fully meet these criteria. Thus, the legislative and administrative control of microbial additives as soil amendments to enhance crop growth should be questioned. A similar conclusion was arrived at by Ryan *et al.* (7) regarding another category of non-traditional additives "growth regulators". The use of ineffective products can have serious implications for agriculture, especially that of developing countries where legislative and administrative control generally is absent, and where local research-extension systems are inadequate.

ACKNOWLEDGEMENT

The authors wish to thank Dr. Randa Melhem, Assistant Professor of Microbiology, for bacteriological analysis.

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