The 6th ESAFS International Conference Soil Management Technology on Low-productivity and Degraded Soils

November 24-29, 2003, National Taiwan University, Taipei, TAIWAN

Extended Abstracts

Organizers

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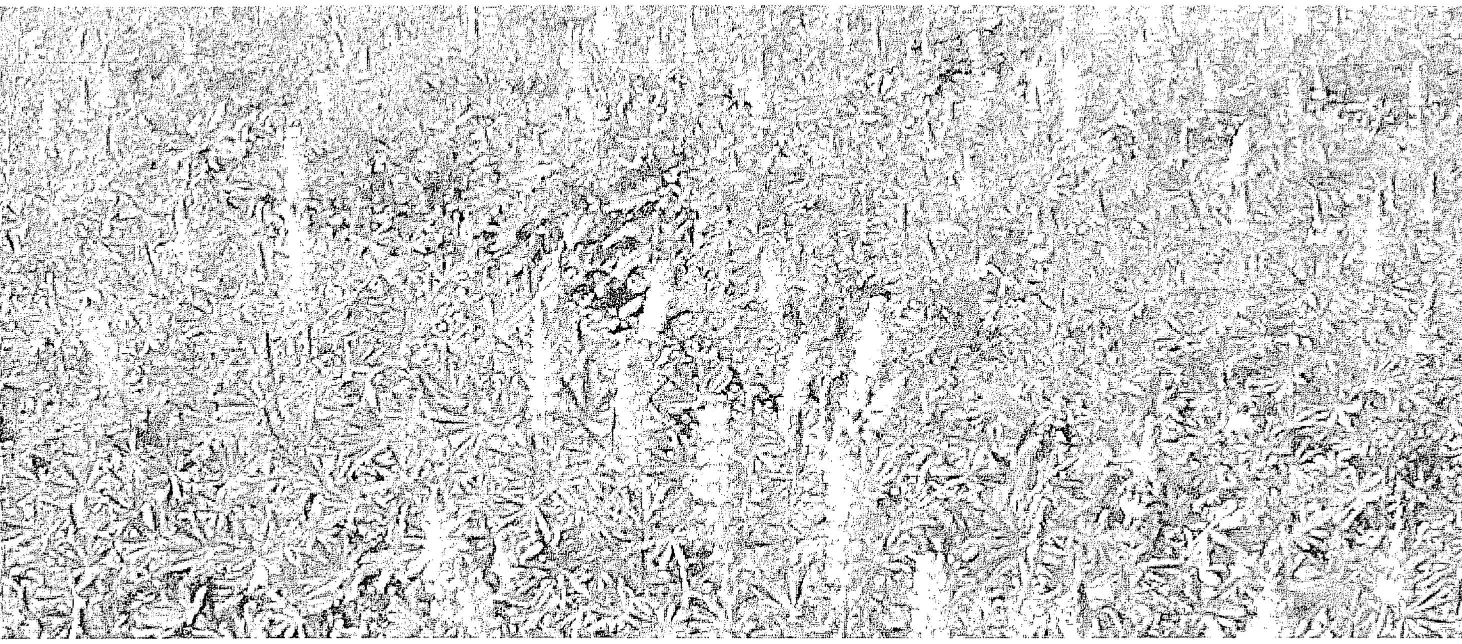

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Approaches of improving fertilizer management for low productivity soils

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INTRODUCTION

Inadequate fertilizer use, improper fertilizer management and depletion of soil nutrients have been identified as critical constraints to crop production on the low-productivity soils in Asian and Pacific region. They are also serious causes of soil degradation. Approaches and technological options for improving soil fertility on low-productivity soils have been intensively discussed. Promotion of the balanced and efficient use of plant nutrients from both organic and inorganic sources has been proposed as the major task to overcome such constraints and to intensify agriculture toward a sustainable manner (Pinstrup-Andersen and Rajul, 1998).

Fertilizer adds to cost of production, which a poor farmer in the developing countries may not be able to afford. In order to increase profits, reduce cost of production and to produce environmentally safe vegetables, development of technologies for improving vegetable production and minimizing environmental risks through promotion of judicious fertilizers use has become a burning issue.

Vegetable crops grown using organic fertilizer on an N equivalent basis to inorganic fertilizer, however, has generally been known to result in reduced plant growth and yields. Slow mineralization rate of nutrients and particularly the available N from the organic composts, has been attributed to be the cause. Previous studies at AVRDC have shown that a small amount of inorganic fertilizer solution as a starter, as basal, and/or well-timed sidedressing may help plants to overcome the shortage of nutrients released by organic fertilizers and to meet the immediate nutrient needs during active growing periods which resulted in higher yields (AVRDC, 1998-2002). These benefits are attributed to the enhancement of nutrient release from organic composts by the starter solution application. This report aims to summarize the integrated approach of "Starter Solution Technology" on initial growth and yield of selected vegetables.

An incubation study was also set out to clarify the enhanced effects of starter solution on nutrient availability of organic composts.

METHODS

Organic fertilizers are banded in beds as basal fertilizer before transplanting or sowing. Small amounts of inorganic fertilizer with various compositions are prepared as a concentrated liquid fertilizer solution and applied near root vicinity right after transplanting or at critical periods during crop growth, which provides plants with readily available nutrients. The liquid solution applies in volume less than 1% of soil maximum water holding capacity and is adsorbed on the soil surface, with minimal leaching. The selected crops included heading cabbage, cherry tomato and sweet pepper. The experiments used randomized complete block design with four replications. Initial growth responses were measured as dry weights of tops (leaf and stem) at 2-3 weeks after transplanting. Head or fruit weights were measured at harvest. Additional details for each trial are listed in Table 1.

RESULTS AND DISCUSSION

Figure 1 illustrates the available N release patterns of chicken manure (CM) composts during the incubation period. Application of starter solution at a rate equivalent to 14-12-12 N-P-K kg/ha enhanced N release from CM by 3-4% of total application. The starter solution brought inorganic N level of the tested soil from 9.3 to 25 ppm, which might become critical for a plant's initial establishment. This study provides the evidence for the enhanced effect on nutrient releases from the manure composts by starter application. Although the increment of NPK occupies 3-4% of total amounts released, it is critical to improve the plant establishment at first week after transplanting. These results also indicate that the improvement of N management during the initial 30 days after application of CM is the key to promote plant responses grown using organic fertilizers.

Regardless of crop tested, the initial growth of common cabbage, cherry tomato and sweet pepper were significantly enhanced by one starter solution application as compared to standard inorganic check (CK) or organic fertilizer alone (Table 1). Organic fertilizer supplemented with starter solution at transplant and one later application resulted in higher head yields of cabbage. While cherry tomato grown with CM composts supplemented with one starter and two later applications attained the higher yield than the CK treatment. For sweet pepper, the yield was highest in the CK treatment added with one starter application.

Vegetables required high amounts of nutrients, particularly N in a relatively short time period. The initial N availability in soil may influence much of the early growth, which subsequently affects the later yield production. This research has indicated the importance of keeping nutrient concentration high in soil solution to booster the early growth of plants. Based on results obtained from field trials, the balanced organic/inorganic fertilization practices have been established.

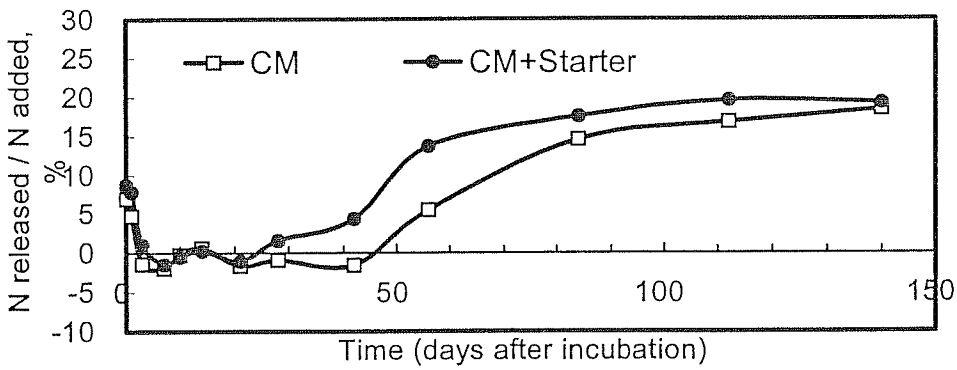

Fig.1. Available N released from chicken manure compost amended soil as affected by starter application (as percentage of total application)

CONCLUSIONS

Traditional fertilizer management for low productivity soils is often based on a high input, synthetic fertilizer-based approach. These series of trials are based on a high efficient, limited input and natural resource-based approach, which can be applicable to many developing countries where the price of inorganic fertilizer is high or the source of inorganic and organic fertilizer is limited. The booster effects of starter solution application on initial plant's growth are very evident. It can substitute 30-50% of inorganic fertilizer and half of the organic fertilizers. The later effects of starter solution on yield may vary with type of vegetables, crop season and other supplemental fertilizers. By applying liquid or solid sidedressing at different timing, the balanced organic/inorganic fertilization practices can be established.

Table 1. The effect of starter solution combined with organic or conventional fertilization on the initial growth and yield of selected vegetables.

		Top dry weight at 12 , 21, 16 DAT[1]		Head or Fruit Yield	
Fertilizer treatment	Crops	g/plant	Index[2]	t/ha	Index
CM*2[3]	Cabbage	2.4 c[4]	77	30.1 ab	115
CM*1	Cabbage	--	--	21.8 c	83
CM + $St4_0$[5] +St4 12DAT	Cabbage	3.9 a	123	32.0 a	121
Standard inorganic[7] (CK)	Cabbage	3.2 b	100	26.3 bc	100
CM[3]	Cherry tomato	11.1 b	103	38.6 b	96
CM + $St5_0$[6] + Side[8] 63 DAT	Cherry tomato	17.1 a	159	48.1 a	120
CM + $St5_0$ + St5 21,63 DAT	Cherry tomato	15.6 a	146	47.7 a	119
Standard inorganic (CK)[7]	Cherry tomato	10.7 b	100	40.1 b	100
CM[3]	Sweet pepper	1.6 b	97	20.7 b	92
CM + $St4_0$[5] + St4 12,24,36,88 DAT	Sweet pepper	3.2 a	192	22.9 b	101
CK + $St4_0$	Sweet pepper	3.5 a	209	28.1 a	124
Standard inorganic (CK)[7]	Sweet pepper	1.7 b	100	22.6 b	100

[1]DAT = days after transplanting, 12 DAT for cabbage, 21 DAT for tomato and 16 DAT for sweet pepper

[2]Percentage of standard inorganic treatment in each trial

[3]Amounts of chicken manure (CM) applied equivalent to 1x and 2x times of N applied as inorganic solid fertilizer (11.2 and 22.3 t/ha of CM and CM*2 for cabbage, 14 t/ha CM for cherry tomato and sweet pepper, respectively

[4]Mean separation within columns by Duncan's multiple range test, $P \leqq 0.05$

[5]Starter solution was inorganic liquid compound fertilizer # 4(6N-5.2P-5K), diluted and applied at a rate of 240N-206P-199K mg in 50 ml water per plant (equivalent to 7.2N-6.2P-6K kg/ha) after transplanting and at 12 DAT ($St4_0$, St4-12DAT) for cabbage; and after transplanting and at 12,24,26,88 DAT for sweet pepper ($St4_0$, St4-12, 24,36, 88 DAT), respectively

[6]Starter solution was inorganic liquid compound fertilizer #5 (4.5N-4P-7.5K), diluted and applied at a rate of 160N-140P-33K mg in 50 ml water per plant (equivalent to 4.7N-4.2P-7.9K kg/ha) after transplanting and at 21, 63 DAT ($St5_0$, St5 21, 63 DAT)

[7]Standard inorganic fertilizer (CK) comprised a basal application of 60N-39P-50K kg/ha and side-dressings of 60N-0P-33K kg/ha at 12, 25 and 36 DAT for cabbage; basal application of 90N-39P-75K kg/ha and 1st, 3rd side-dressings of 60N-26P-50K kg/ha at 21 and 63 DAT; and 60N kg/ha as 2nd and 4th side-dressings at 42 and 84 DAT for cherry tomato; basal application of 80N-41P-75K kg/ha and 40N-4P-17K kg/ha at 12,24 and36 DAT; 30N-3P-13K kg/ha at 88 and 96 DAT for sweet pepper, respectively

[8]Side = sidedressing; applied at 60N-26P-50K kg/ha, at either 21 or 63 days after transplanting

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