Successful Potato production in Nature Farming with effective Microorganisms – A case Study

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Abstract

Field studies evaluated the impact of three common organic materials added with or without Effective Microorganisms (EM)and its derivative EMFPE on yields and disease incidence in organic potatoes (Solanum tuberosum) in major and minor seasons of Sri Lanka. The organic matter was added before planting and EM solutions applied periodically. The three organic materials (cattle manure, green manure and compost) increased yield components and yields and EM increased the benefits to a greater extent. The use of this solution also helped to reduce the incidence of fungal diseases. The benefits of EM in the development of tropical organic or Nature Farming systems for organic potato production are presented.

Introduction

In tropical nations such as Sri Lanka, potato is a luxury vegetable and a high income crop for smallholder farmers, and although the consumption of organic potato is minimal there is a growing demand for exports and for selected markets. However, a major problem in potato production is the heavy infestation of diseases, especially late blight caused by *Phytophthora infestans*, and research (Finckh *et al* 2006) recommends the use of resistant varieties of potato for organic systems. The availability of such resistant varieties is scarce in the developing nations and the technology of Effective Microorganisms (EM) offers potential as its derivatives have reduced the incidence of diseases in organic systems, especially *Phytophthora* (Xu et al, 2001), and the microbial solution is safe and easily available and safe. Thus studies were carried out in a potato growing region to determine the impact of EM and its derivatives for possible production of organic potatoes within a system of Nature Farming in two tropical seasons.

Material and methods

The project was carried out at Hawa Eliya, Sri Lanka, in 2011/12, at an altitude of 1650 m where potato is grown widely. The soil was an Ultisol, with the following soil fertility parameters: - (pH (1:2.5 H_2O)4.6, Organic C $g.kg^{-1}$, 15.4; N $mg.kg^{-1}$20.7,CEC 25.10 . meq/100 g soil. The rainfall received at the site was 2945 mm over the period of study, with 60% received in the major wet season (late August to December). The minor drier season was from February to May. and the mean temperatures were 16 .3°C and 21.3 °C over the major and minor seasons r. The site had not received any agrochemicals for 4 years.

In August 2011 prior to the onset of the major season, land was tilled and plots, with dimensions of 3 x 4 m were prepared to accommodate 8 treatments within 3 replicates. In each replicate, two plots were supplied with 300 g of fresh cattle manure per sq. meter; green manure (1:1 mixture of fresh leaves of *Gliricidia sepium* and *Tithonia diversifolia*) was added at the same rate to another two plots. Compost made of chicken manure, rice husk; green leaves and saw dust was also added at the same rate to another two plots, while the last two plots did not receive any organic matter. Uniform seed potatoes (variety Granola) was planted in all plots as per local recommendations, two weeks after organic matter incorporation, One plot of each organic matter treatment in a replicate received an application of EM at a dilution of 1: 250 at a rate of 100 litres per ha. Furthermore, just prior to planting, EMFPE was prepared as per the APNAN manual (APNAN, 2010) and sprayed to the plots that received the EM, at a dilution of 1:50 to wet the soil. There were 4 organic matter treatments and two EM treatments (1with or without) thus totalling up to 8 treatments within a Randomized Block design with three replicates.

The crop was managed as per local recommendations and at two weekly intervals EM1 and EMFPE were sprayed to the plots that originally received the EM at the same dilutions and rates. The data gathered through destructive sampling were days to tuber initiation, tubers per plant, mean tuber weight and yield per

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sq. meter. In addition, the incidence of diseases was determined by counting the number of infected plants per plot.

In the minor, drier season beginning in February, 2012, the plots were prepared in the same manner and the experiment repeated. The data thus obtained were subjected to statistical analysis using a GLM model and appropriate Statistical packages.

Results and Discussion

Seasonal differences in yield components and yields of potato were clearly evident, due to the warmer and drier climate of the minor season (Table 1).The cooler climate and wet weather in the major season prolonged shoot growth of potato, as seen by the days to tuber initiation irrespective of the organic matter or EM treatments. The lower yields in the drier minor season could be attributed to the warmer climate, as respiration would be higher (Hammes & de Jager, 1990).

Although growth and yields were different in the two seasons, the adopted treatments had a similar impact on all measured parameters (Table 1). The plants in the control treatment took the longest time to initiate tubers and the three organic materials induced tuber development after shorter vegetative periods. The plants in the control plots had the lowest tubers per plant, weights of individual tubers and hence the lowest yields. The three organic materials increased tuber numbers and mean tuber weights, and thus yields to similar extents, and the differences were marginal, which could be attributed to the similar C: N ratios of these three materials (16.6 – 20.4).

The interesting phenomenon was the positive impact of EM in all measured parameters. This microbial solution, approved by most organic systems and made in the respective countries or regions, reduced days to tuber initiation, even in the control. Increments of these traits results in yield increases in all treatments.

The yield increment was lowest in the control plots, and this illustrated the importance of organic matter to realize the benefits of EM. The increments in tuber yields with the other three organic materials and EM ranged from 10 – 16%, highlighting the benefits of this simple technology for organic potato production, and the synergistic effect of organic matter for EM, as recommended for Nature Farming Systems (Amano, 2012).

Table 1. Yield components and yields of potato as affected by organic matter and EM

Organic matter	EM	Yield components and yields							
		Wet season				Dry season			
		Days to tuber initiation	Tubers plant^{-1}	Mean tuber weight g.	Yield g.m^2	Days to tuber initiation	Tubers plant^{-1}	Mean tuber weight g.	Yield g.m^2
CM	Yes	49	6.1	54	1484	41	5.5	48	1265
	No	54	5.3	47	1342	46	5.0	40	1154
Green manure	Yes	48	6.0	56	1447	43	5.4	50	1348
	No	56	5.2	47	1264	50	5.2	43	1160
Compost	Yes	46	6.2	48	1395	43	5.3	45	1386
	No	49	5.1	41	1075	49	4.7	37	1249
Control	Yes	57	3.5	36	1199	45	4.2	34	946
	No	66	3.1	31	1010	51	3.4	29	875
Probability	OM	0.004	0.047	0.037	0.084	0.040	0.684	0.041	0.006
	EM	0.027	0.034	0.005	0.155	0.037	0.021	0.039	0.044
	Interaction	NS	*	NS	*	NS	*	*	NS

The incidence of fungal diseases was higher in the major wet season (Table 2), again due to the moist cooler climatic conditions. The disease incidence was highest in the control plots, especially in this major season, and without EM, almost all plants were infected. This could be due to the lower vigour of the plants, even with EM, as no manures were supplied. The use of EM and especially EM Fermented plant extract reduced the diseased plants in the control plots significantly. Plots that received organic matter had a lower incidence of the disease, due to better growth, which was observed with all three materials. EM and its derivative reduced the disease incidence further, and there were no differences between the three manures. This clearly confirmed the results of Xu *et al* (2001) on the impact of EM and its derivatives on the disease reduction in tomato, another Solanaceous crop species.

Table 2. Impact of organic matter and EM on the incidence of disease incidence in potato

Organic matter	EM	Disease incidence (% of plants)	
		Wet season	Dry season
Cattle manure	With	74	5 4
	Without	92	73
Green manure	With	75	55
	Without	90	71
Compost	With	76	57
	Without	88	74
Control	With	85	61
	Without	98	76
Probability	Organic matter	0.014	0.447
	EM	0.039	0.314
	Interaction	NS	*

Conclusions

This field study illustrated the benefits of organic matter EM and its derivative, EMFPE on increasing yields and reducing the incidence of diseases of organic potatoes under tropical conditions.

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