An Approach to Apple Cultivation in Nature Farming

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Abstract

The cultivation of apples in Japan is a significant enterprise. A few farmers in Nagano also cultivate apples under organic systems. A programme was therefore initiated to use Effective Microorganisms for apple cultivation under organic systems. The productivity of the orchard increased with EM, and the incidence of pests and diseases was minimal. The success of using EM in organic apple farming is presented.

Introduction

The production of apple, which is a typical deciduous fruit tree in Japan, is decreasing with the ageing of apple growers. People living in cities like Tokyo, where they can hardly see orchards, may think that apples are cultivated in a natural environments abundant with greenery. In reality, however, apples are cultivated using many types of pesticides.

Those who are interested in apple cultivation without pesticide may remember the lawsuit in Hokkaido in 1988 which originated from apple scab disease (Venturia inaequalis) in an orchard using no pesticide. Although the case was settled in reconciliation, many people might have felt, "Why should agriculture become a cause of dispute between neighbors ?"

When I visited an apple grower in Aomori Prefecture who had been cultivating apples without pesticide, he told me that he had only a few good years during his 20 years of cultivation. He also told me that if the situation did not change, his son, his successor, would not be able to continue to grow apples. Although he said that the infestation of pests in his orchard had not caused any problems to the neighbors, unlike the case in Hokkaido, trees defoliated early in the season and the orchard were showing difficulty in adapting to non-pesticide cultivation.

In 1993, I visited an experimental orchard of the Fruit Tree Experimental Station Nagano. They compared conventional cultivation (12 pesticide applications), low-pesticide cultivation (6 applications), and non-pesticide cultivation (however, lime sulfur and machine oil were applied once). Fruits grown by the latter two methods were infested with caterpillars. Some fruits were not edible at all. This experience clearly showed the difficulty of non-pesticide and low-pesticide cultivation of apples.

Last year, on the other hand, apples were imported from New Zealand and the USA for the first time as a step for opening the Japanese agricultural market. At the same time, the safety of imported apples, such as the problem of post harvest and residual pesticides, came into question. In domestic agriculture, the necessity for specific products and of reducing production cost was widely talked about. Efforts have been made by our local agricultural cooperative association to select fruits not by appearance but by quality. To reduce the labor of fruit selection: they introduced fruit selectors using optical sensors. Individual farmers, however, have been slow to change their way of thinking, and are still using conventional selecting methods for apples.

In contrast, there are a few apple growers in Nagano Prefecture who have been practicing low-pesticide cultivation for many years. To start the cultivation of apples, which is the principal agricultural commodity product in the region of our experimental station, we investigated the current situation of the conventional as well as the low pesticide cultivation of apples. The possibility of apple cultivation by Nature Farming was also studied. An apple orchard of about 10 ares was rented in 1993, and they have been practicing the low-pesticide or partially non-pesticide, cultivation of apples. Furthermore, some apple growers in Nagano and Aomori Prefectures started the low-pesticide cultivation of apples using EM.

Apple Cultivation at The Experimental Orchard

Soil Conditioning

To improve the biota of the soil and supply nutrients to the trees, EM Bokashi was applied to the soil three times a year, namely in March, September, and November. EM Bokashi was made by fermenting the mixture of rice bran, fish meal, and rape seed meal with effective microorganisms (Kyusei EM-1). It was either sprinkled over the soil surface or buried in holes. The amount of application was 240 to 400 kg (12 to 20 kg in terms of nitrogen) per 10 ares for adult trees. We also used green manures as an additional source of nutrients. Furthermore, we cultivated soil to secure enough organic matter and to stabilize the biota.

Herbicides were not used because these kill grass on the soil surface and deprive habitats and food for organisms living near the surface, which consequently simplifies the biota. This creates an environments for frequent disease and insect infestation.

Pest Control

Table 1 shows the record or pest control at the experimental orchard in 1994. EM-5 was made by fermenting the mixture of molasses, vinegar and distilled liquor (alcohol-Shochu) with Kyusei EM-1. The sprayed EM did not show any direct effect on disease and insects. Therefore it is believed that microorganisms and sugar in EM-5 work to diversify the biota of the soil.

Pesticide	Date		Amount of spraying per 10a
	Apr. 11 (Germination period)	Water	400 ℓ
		EM-5	2 ℓ
	Apr. 19	Water	500 ℓ
		EM-5	1 ℓ
	Apr. 27	Water	500 ℓ
		EM-5	1 ℓ
◎	May 6	Water	400 ℓ
	(Beginning of the blooming period)	Trifumin wettable powder (fungicide)	0.1 ℓ
		Wood vinegar	0.8 ℓ
◎	May 12	Water	400 ℓ
	(Blossom drop period)	Diebolt wettable powder (fungicide)	0.2 ℓ
		Wood vinegar	0.8 ℓ
	May 20	Water	500 ℓ
		EM-5	1 ℓ
	May 30	Water	500 ℓ
		EM-5	1 ℓ
◎	June 7	Water	500 ℓ
		Jimandaisen wettable powder (fungicide)	0.5 ℓ
		Dasuban wettable powder (insecticide)	0.25 ℓ
		Wood vinegar	1 ℓ
	June 8	Water	500 ℓ
		EM-5	1 ℓ
◎	July 2	Water	500 ℓ
		Spreader	
		Bordeaux mixture (fungicide) Quick lime	6kg
		Copper sulfate	2kg
		Nicotinic sulfate (insecticide)	0.5 ℓ
		Zinc sulfate (fungicide)	1kg
	Aug. 19	Water	500 ℓ
		EM-5	1 ℓ
		EM-3	0.25 ℓ
	Sept. 13	Water	500 ℓ
		EM-5	1 ℓ
		EM-3	0.25 ℓ
	Nov. 10	Water	500 ℓ
		EM-5	1 ℓ
		Kyusei EM-1	1 ℓ

Table 1. Record of Pest control at the apple orchard in 1994.

For controlling apple scab, diluted fungicides were applied, to the trees on two occasions. The chemical (Trifumin) was half the original concentration by mixing it with wood vinegar (diluted at 1:1,000), at the beginning of the blooming period; and Diebolt wettable powder in middle May (in the period of blossom drop). The disease apparled on leaves but hardly on fruits. Although Alternaria blotch appeared in July, it could be controlled by spraying Bordeaux mixture in early July. In 1995, we had a lot of rain in July, which provided an environment for easy disease infestation. Since we did not spray fungicides in July as had been done in 1994, Alternaria blotch appeared on fruits on some trees of the Tsugaru variety, which is more vulnerable to disease than the Fuji variety.

Since insecticides were not used in spring of 1994 and 1995, some young fruits were eaten by larvae of moths from late May to early June. Although we at one time suspected that no fruit would be left undamaged by larvae, all the fruits of each cluster of flower were hardly eaten. In fact we had more undamaged fruits at thinning.

While spider mites (Terancychidae) were not onserved in spring, they were observed in August, of 1993 and 1994. When pesticides were sprayed in July, they were observed most on dwarf-cultured trees of the Fuji variety, and then on those of normal cultivation of the same variety. They were hardly observed on trees of the Tsugaru variety for both types of cultivation types.

We also observed ladybird beetles, which are known as the natural enemy of aphids; and predatory spiders; larvae of syrphid flies; and perdatory mites (Phytoseiidae). This fact shows, that while insect pests appear in low-pesticide cultivation using EM, many natural enemies of also appear. It indicated the diversification of insects.

It was also found that the hardness of leaves varied with different methods of cultivation (Table 2). The apple leaves in our orchard had lighter colours, a lower total nitrogen content, and a higher ratio of carbon to nitrogen, compared with those grown by conventional method. This means that our apple leaves were harder and more resistant to insects.

Table 2. Comparison of the composition of apple leaves between two cultivation methods

	Total carbon (%)	Total nitrogen (%)	Carbon / Nitrogen
Our orchard	49.90	2.10	23.8
Conventional method	48.80	2.80	17.4

The number and the cost of pesticide applications are compared between the two cultivation methods in Table 3. According to the conventional pest control schedule in the area, the frequency of pesticide spraying was 15 times a year, including two special applications. The cost of pesticides per 10 area was Y 81,478 in 1993 and Y 79,742 in 1994.

The frequency of pesticide spraying at the experimental orchard was 6 times a year in 1993, and its cost per 10 ares was Yen 24,343. In 1994, there were 4 applications and the cost was Yen 12,903 (16.2% of the cost in conventional method), respectively. In 1995, the frequency of spraying was twice a year, and we expect that the cost would be reduced to less than 10% of that of conventional method.

These costs were reduced by lowering the number of pesticide applications through using EM, and by reducing the concentration of pesticides through mixing with wood vinegar.

Table 3. Comparison of the cost of pest control

	1993	1994
Recommended pest control for the area:		
Number of pesticide applications	15 (100%)	15 (100%)
Cost of pesticides for 10 ares	Y 81,478 (100%)	Y 79,742 (100%)
Our orchard:		
Number of pesticide applications	6 (40.0%)	4 (26.7%)
Cost of pesticides for 10 ares	Y 24,343 (29.9%)	Y 12,903 (16.2%)

Sales and Distribution

Although some trees of the Tsugaru variety developed Alternaria blotch in 1995, fruits were sold to consumers after explanting that their flesh was not different from that of ordinary apples. It seems to be necessary to consider the use of pesticides according to the weather as well as to try to inform consumers how apples are cultivated. Before shipping to our local agricultural cooperative association, apples were sorted into three groups by each grower: two groups to be sold fresh and one group for making apple juice. Apples to be sold fresh were further classified into 4 classes by colour and shape and eight classes by size, 32 classes in all. Since growers spend considerable time for harvesting and sorting, and since a lot of man power is required for further sorting at the agricultural cooperative association, a grower receives about 70 % of the market price.

Summary

Pest control

Since we had low rainfall and high temperatures during the growing period in 1994, the appearance of diseases was very low, and the trees grown without pesticide hardly developed apple scab. This allowed us to sell apples of sufficiently high quality for direct consumption.

At present, it is impossible to control apple scab with only EM. We need to develop a method to control apple scab without pesticides in the young fruit period, and a method to control Alternaria blotch in a year having high rainfall in July.

As in the case of the infestation of larvae, the method of controlling insect pests greatly differ depending on how much the grower can allow the infestation to develop. In conventional cultivation, it is necessary to reduce the cost of pesticides by controlling application according to the condition of the trees and the degree of infestation. If we can allow damage caused by insect pests to a certain degree while reducing the amount of pesticides, the resulting increase of organisms, including natural enemies of the insects, would compensate the increase of insect pests caused by reduction of pesticides.

Support from consumers for low-pesticide cultivation

Apples are now imported to Japan from the U.S.A. and New Zealand. It becomes more important to urge consumers to change their way of thinking on the quality of apples and to select apples based on the method of cultivation rather than a mere appearance. Initially apples from New Zealand were thought to have been exposed to minimal pesticide application since they are grown in a good cultivation environment. The amount of pesticide used on them, however, is not necessarily low because they are cultivated according to the circumstances in the importing country.

The Japanese apple market will be opened more and more in the future. It may not be long before apples grown by organic farming are imported from abroad. Until then, we hope to achieve the cultivation of apples without pesticide in cooperation with those growers who are practicing the low-chemical cultivation of apples using EM.

In our orchard, apples were cultivated using EM with a smaller pesticide and without chemical fertilizer.