Advance in Application Techniques Of Fertilizer and Future

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Since 1960, a tremendous change in the socio-economic condition and the international surroundings has made a pronounced influence on the agricultural situation. Labor force has been increasingly drawn out of the agricultural sector and the investigation to increase the agricultural productivity has been continued toward labor-saving and mechanization, and new techniques were developed one after the other.

The role of fertilizer application technique for the confirmation of agricultural productivity is very important and it changes greatly with the progress of the agricultural techniques. The application technique of fertilizer is closely related with the study of soil and plant nutrition, and is greatly influenced by the progress not only in the study of agricultural field, but also the fertilizer industry, especially the development of new fertilizer and the increase of production.

The techniques can contribute to the expansion of agricultural productivity when they are universal, rational and scientific.

In this paper some examples of the fertilizer application techniques studied and developed in Japan are introduced.

Progress and development of fertilizer

Recently, the consumption of fertilizer has increased rapidly together with the acre-yield of cereals and vegetable crops. One must keep in mind that fertilizer application at the in-

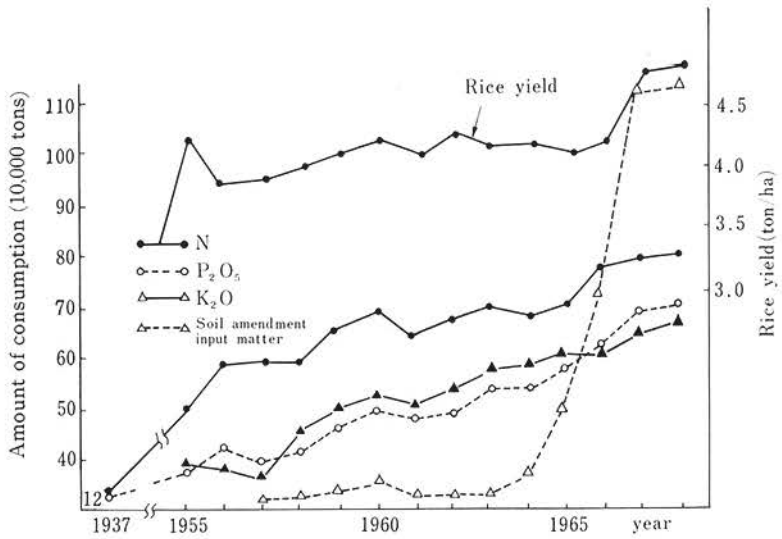

Fig. 1. Transition of the amount of fertilizer consumption and rice yield in Japan.

creased rate has been developed by improving soil as well as the progress of cultivation techniques is connection with the fertilizer application techniques.

When the change is regarded from the standpoint of fertilizer, it was developed appreciably not only in quantity but also in quality in the form of mixing fertilizer, especially highly analyzed of components in place of simple fertilizer providing with the properties for various uses. The representative fertilizers are highly analyzed compound fertilizer, N-K compound one, liquid one, slowly available nitrogen fertilizer and fertilizer to which nitrification inhibitor, micronutrients or pesticide is added.

The effect of these new types is worth noting for they have already been placed on the market and served to the extension of new application method of fertilizer. The standards of fertilizer application for main crops had been set up in nearly every prefecture and they are serving for extension of new application techniques.

Rice plant

It is a well known fact that the deep application of fertilizer devised and practiced in the wartime and post-war periods to cover the shortage of fertilizer, contributed towards increasing rice production throughout Japan. Although the rice yield gradually increased as the result of extensive study and increase in both the supply and demand of fertilizer until about six years ago, producing rice sufficiently for self-support was one of the most important problems and efforts have been continuously made to develop the techniques for maximizing rice yield since 1965.

Recently great achievements in technical advancement have been attained by the energetic researches conducted on a nationwide scale to break off the stagnation of yield increase.

Land improvement, improvement of fertilizer application and cropping practice, introduction of high-yielding rice variety, protection against insect pests and water management are essential prerequisites to maximizing rice yield. Among them, rational application of fertilizer and land improvement have greatly contributed in getting higher yield. Especially a well-balanced supply of each nutriment with an appropriate proportion of nitrogen in its split application, rational fertilizer placement and supply of deficient elements are important.

Considering the technical improvement from the standpoint of fertilization, the direction toward agricultural productivity increase by heavy fertilizer has changed to the direction in which controlling and managing the growth of plants is controlled and managed.

The main methods of fertilizer application are the split application of heavy nitrogen to maintain later stage nutrition represented by the "new Saga Prefecture method", the top application to deeper layer of paddy field in Aomori Prefecture, and Matsushima's V-shaped rice culture theory. The common factor in these methods is to find out how to get the best ripening by fertilization and other countermeasures. All investigations focused on the relation between fertilization and ripening.

The method of deep application plus "Hogoe", top dressing, as mentioned above, may be well accepted now except some points. In this method, top dressing was regarded to be important and has been investigated continuously to maintain the later stage nutrition. The application time of "Hogoe" top-dressing was broadened to 10 to 25 days' period before heading and the quantity was greatly increased incorporating the improved technique of nutritional examination.

The effect of the so-called "Migoe" top dressing, that is, the application of nitrogen fertilizer after the heading stage, has been investigated throughout the country and this method was adopted as the new technique to increase the rice yield in some district such as Saga Prefecture.

This application affects the increasing of straw weight and photosynthetic activity, and

the decreasing of the ratio of brown rice weight to straw weight. But the effects are easily influenced by the variety of rice plant, soil and climatic conditions, nutritional requirement and status of the root system. The method is not yet confirmed as the common technique throughout the country and there are some problems still remaining unsolved.

The method of top application to deeper layer of paddy soil developed at the Aomori Agricultural Experiment Station is widely accepted in the northern area of Aomori Prefecture and results in a higher grain yield. The aim of fertilizer application is differentiated in that the basal fertilizer is to maintain target numbers of tillers and the additional one is to maintain nutrition after the very-young-head-forming period by the application at 35 days before the head-sprouting period. Maximizing rice yield was attained by applying this method at the Kyushu Agricultural Experiment Station (Table 1). But the adaptability for each region and how to save labor is the subject for a future study.

As mentioned above, through these investigations on maximizing rice yield the meaning of the additional fertilization, especially "Hogoe" top dressing, has become clearer and much importance has been attached to this problem. This method was generally accepted and contributed much toward increasing rice production. In connection with the progress of the additional fertilization, the application of nitrate nitrogen to rice plant has been investigated and its effect is being clarified.

The method of direct-sowing rice culture on well drained and flooded paddy fields has greatly progressed in the past ten years. The area under direct sowing covers nearly 30,000 hectares and is on the increase. Many problems in direct-sowing rice culture, such as poor germination, protection against insect and pests, weed-killer etc., were improved through the development of new agricultural chemicals and machineries, improvement of cultivation and fertilizer application and soil management.

Now these techniques were systematized and accepted as the most labor-saving method of rice culture. Especially the characteristics of the direct-sowing rice culture were clarified in relation to soil and plant nutrition and resulted in the establishment of new fertilizer application methods.

There is no large difference in the direct-sowing culture on flooded paddy field from the ordinary planting rice culture, but the direct-sowing rice culture on well drained one shows a great difference. The reasons are;

1) During the upland stage before submerging the field about 20 to 30 days, the applicative nitrogen is lost by leaching and denitrification.

2) Without non puddling the permeability

Table 1. Actual results of top application to deeper layer of paddy soil in Aomori Prefecture

Place	Variety	General application		Top application to deeper layer		
		Basal nitrogen	Brown rice wt.	Basal nitrogen	Additional nitrogen	Brown rice wt.
		N kg/10a	kg/10a	N kg/10a	N kg/10a	kg/10a
Kanina	Shimokita	6.8	510	3.4	3.4	560
Aomori	Towada	9.0	569	4.5	3.4	560
Kashiwa	Fujiminori	9.8	636	4.9	4.9	690
Hiraga	Towada	9.8	558	4.9	4.9	627
Rokunohe	Fujiminori	9.8	557	4.9	4.9	615
Average			566			617
Ratio			100			109

(1965, Aomori Pref. Agri. Expt. Station)

of the soil is kept in good condition and a marked effect of fertilizer is produced. For this reason, when applying quickly available nitrogen fertilizer, it is better to apply it at submerged period as top dressing than basal application at sowing time.

Through many examinations of fertilization to direct-sowing rice culture, the importance of fertilizer placement was revealed and the technique has been developed in connection with mechanization. The most labor saving and promising of direct sowing on well-drained field seems to be the unplowed and broadcast direct-sowing culture. Table 2 shows one example of the results of fertilization experiment in which placement and kinds of fertilizer are taken into consideration. A very significant effect is seen in drill deep fertilization and the hole fertilization method. In these cases development of the root system and the absorption of nutrients greatly differ from others and the methods are very promising for improving the techniques. In connection with them, the effect of the slowly available nitrogen fertilizer, the nitrification inhibitor-added fertilizer and block fertilizer are recognized to have high effect and now they are on the market as commercial products.

Table 2. Effect of fertilization and placement to direct-sowing rice culture

Cultivate method	Fertilizer and placement		Straw wt.	Brown rice wt.	ratio
			kg/are	kg/are	%
Broadcast sowing	Deep application	Ordinary high analysis compound fert	63.9	44.5	100
			75.3	48.5	109
		Nitrification inhibition add	78.0	52.1	117
		Slowly available nitrogen fert	75.9	52.1	117
	Drill application	Nitrification inhibitor add. fert 30 cm*	77.7	52.9	121
		60 cm*	79.0	58.5	100
Unplowed sowing		Cyanamide nitrogen. fert	90.2	59.9	103
	Broadcast application	Nitrification inhibitor add	81.0	59·0	101
		Ordinary high anal. add. fert	60.1	60.1	103
	Hole dressing				

* width of drill placement (depth is 10 cm)

(1967 Hyōgo Pref. Agri. Expt. Station)

Horticulture crops

Since 1960, according to the selective enlargement of the agricultural production, countermeasures were taken for the promotion of horticultural farming and the many results of soil management and fertilization experiments were combined and systematized for practical application. They contributed to the increasing of agricultural production both in quantity and quality. The main countermeasures are the improvement of fertilization, maintenance of soil fertility, and the adequate treatment against growth injury.

The culture of vegetable in green houses and plastic film houses have become popular recently. The conditions of the force culture differ from that of field culture. Especially, due to heavy fertilizer application and also due to the fact that leaching does not take place so much and the air inside tends to be high in temperature and dry, salt is easily accumulated at the surface soil and the yield and the crop quality decline caused by the salt injury, gas injury, successive culture injury and diseases.

The basic countermeasure for them is the rationalization of fertilizer application which is almost confirmed now in combination with countermeasures against salt injury and

diseases. But there are many problems remaining unsolved about the successive culture injury and sick soil which are left for future study.

New fertilizers such as slowly available nitrogen fertilizer and nitrification inhibitor-added fertilizer are used for horticultural crops as in the case of rice culture, and greater efficiency is obtained by using them. For instance, even if a comparatively large amount of the above-mentioned new fertilizer is applied as basal application, salt injury will be avoided. As the result such effect is recognized as effective basal application, which is ideal fertilization, and the decreasing of times of additional fertilizer application.

Recently the maltching culture using plastic film has been spread rapidly. In this culture, there are many effects such as rising of temperature, maintenance of soil water, weed control and protection against soil coagulation and leaching of nutrition.

The application of new type fertilizer is also very effective in this culture. (Fig. 2)

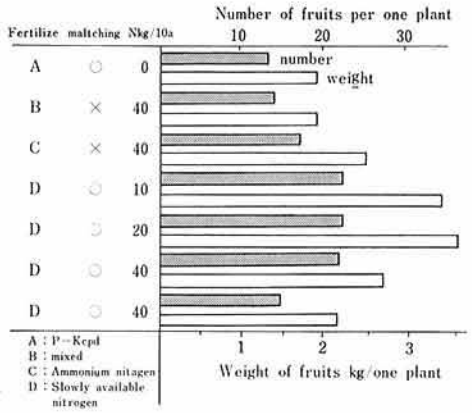

Fig. 2. Effect of maltching and slowly available nitrogen fertilizer to tomato plant. (1968, Hyōgo Pref. Agri. Expt. Station).

Recently soil sterilization has become a useful agricultural technique for the prevention of continuous cropping injury including plant diseases. It is divided into two main methods; One is the steam sterilization and the other is by agricultural chemicals.

Soil sterilization may have a deteriorative effect on the subsequent plant growth caused by nitrogen transformation; for instance, the rice yield increased by applying only one-half nitrogen fertilizer on chloropicrin-treated paddy field or the young shoot died after transplanting on steam sterilization soil.

These phenomena caused by steam sterilization were attributed to the accumulation of NH_4-N and NO_3-N, pH values of soil and excess of manganese. It is clarified that the deteriorative effect may be prevented by decreasing the amount of nitrogen fertilizer, calcium and organic fertilizer before steam sterilization, and the moderate application of nitrate nitrogen fertilizer is recommended after the treatment. Due to the large varieties of crops cultured many points are uncertain, so the ideal technique is not established yet and expected for a future study.

In horticulture, such as vegetable crops, flowers and fruit trees, the application of liquid fertilizer serves both as a fertilizer and water and has a merit that it decreases salt injury and saves fertilizer application labor. The application of liquid fertilizer is gradually being popularized.

The past study on the technique of fertilizer application has been solely focused on increasing crop productivity, but hereafter, further investigation and development of new techniques are necessary by combining it with the progress in quality, and establishment of the improved technique of nutritional diagnosis should be looked for in the future.

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