# Application of Rice Straw to Paddy Fields

By YOSHIMITSU DEI

Chief, Laboratory of Soil and Fertilizer Application
Environment Division, Central Agricultual
Experiment Station

## Background of the application of rice straw

The need of increased labor productivity has become the center of public interest in rice culture in Japan recently and a large-scale mechanization of the working system is being developed by the use of planting machines in combination with combines in rice culture.

But as a result of the use of combines, a large amount of rice straw is abandoned in the field, and how to dispose of it to prevent the next year's crop from its injurious effect is now an urgent question.

On the other hand, the popularization of small-sized cultivators after the war swept away draft animals from farms, and a recent labor shortage on farms caused a further decrease in production of compost and stable manure, resulting in a grave situation for maintainance of soil fertility.

For all these situations, application of rice straw to paddy fields has not been recommended for the reasons that the application increased damages of rice plants by diseases and insect pests (for instance, rice blast and rice stem borer) and deteriorates growth of rice plants.

However, since one of these problems, damages by diseases and insect pests, was solved by recent developments of agricultural chemicals, studies have been continued on the other problem, deterioration of the growth of rice plants.

And the results obtained until now prove that the application of rice straw to paddy fields has no bad effect on the growth of rice plants but it increases the soil fertility, though the suitable method of application differs with the weather or the soil. And the application of rice straw is gradually increasing in amount recently.

## Yield and chemical composition of rice straw

The yield of rice straw is influenced by such factors as growth of rice plants, variety, district and cultural condition. The yield of straw has a high correlation with that of brown rice when the latter is below 55 kg/a. The grain/straw ratio in rice is higher in the northern part of Japan than in the southern part, being 1.06 and 0.84, respectively.

Accordingly, the straw yield per unit area is 65 kg/a in the northern part and 73 kg/a in the southern part, showing clear difference between the two. Long-stemmed rice varieties yield much more straw than short-stemmed ones.

When the yield of brown rice was so much as 80 kg/a, the straw increased in yield to 110 kg/a. From these data it is estimated that the amount of rice straw which can be applied to the field is 70 kg/a in average and 100 kg/a at the maximum.

The deteriorated growth of rice plants after the application of rice straw is mainly due to unsuitable chemical composition of straw. The composition is markedly different between rice straw and compost. Namely, the nitrogen con-

tent of compost is about 2%/dry matter, while that of rice straw is lower than 1%. But the latter contains more soluble carbohydrate than the former. The nitrogen content of rice straw ranges from 0.5 to 1.2% and increases with the amount of nitrogen applied as fertilizers. The rice straw in cold districts tends to contain more nitrogen than the one in warm districts.

## Decomposition process of rice straw

Compost is decomposed during the piling and decreases in C/N ratio, becoming suitable to be applied to paddy fields. On the contrary, straw is applied in undecomposed condition and directly plowed into fields. So active decomposition takes place in the soil after application, having an important influence on the growth of rice plants.

The decomposition of straw is mainly influenced by the temperature and moisture in the soil. When rice straw is plowed into the soil, soluble carbohydrate in it is decomposed first. This decomposition is mostly finished within 40 days after application if it is warm. Cellulose and lignin are then decomposed gradually.

The decomposition of rice straw applied is comparatively rapid in summer, and half the amount in dry weight of it is decomposed 50 days after the plowing in. The progress of its decomposition is shown in Fig. 1.

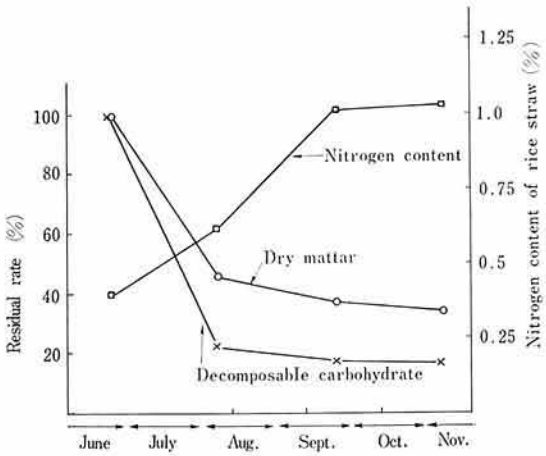


Fig. 1. Decomposition of rice straw and change in nitrogen content.

The decomposing rice straw takes nitrogen from the soil at the beginning and releases it into the soil later. Such fixation of nitrogen and the time of its release have important effects on the growth of rice plants.

In general, rice straw applied to paddy field fixes the nitrogen in the soil at the beginning, especially during the period of decomposition of soluble carbohydrate, inhibiting nitrogen supply to rice plants, though the fixed nitrogen is gradually released thereafter. Accordingly such a move of nitrogen has a good influence on rice culture in a district, while it exerts a bad effect in another.

## Effect of the application of rice straw

The application of rice straw to paddy fields has such good effects on rice culture as the supply of nutrients contained in straw, the regulation in fertilizing effect of nitrogen and the improvement of soil structure. However, it causes an increase in reducing power which is due to the presence of too much soluble organic matters in the soil and the damage by the nitrogen deficiency caused by the fixation just after the application. Therefore, to decrease these injurious effects and to increase the fertilizing effect, a technique suitable to each district and soil type must be devised for the application of rice straw to paddy field.

As the decomposition of rice straw is influenced by the temperature, its application technique is different between the cold and warm districts. In a cold district (where the air temperature is about 16°C at the time of planting), as a rule, rice straw must be spread over the surface of fields in autumn immediately followed by plowing in, or plowed in soon after the thawing of snow in early spring. The colder the temperature is, the smaller the amount of rice straw to be applied must be. In a district the amount is said to be 50 kg/a at the maximum.

In a warm district (where the air temper-

ature is about 21°C at the time of planting) even the rice straw plowed in spring is expected to be effective (Table 1). And in a

**Table 1. Relation between the kind of soil and the effect of rice straw applied**

| Exp. plot | No rice straw | Rice Straw (kg/a) | | Compost (kg/a) | |
|---|---|---|---|---|---|
| | | 30 | 60 | 100 | 200 |
| Yield of brown rice (kg/a) | 54.8 | 58.0 | 57.9 | 55.8 | 58.9 |
| Well-draind field | | | | | |
| Index | 100 | 106 | 106 | 102 | 107 |
| Yield of brown rice (kg/a) | 50.1 | 52.9 | 51.5 | 53.2 | 55.3 |
| Ill-drained field | | | | | |
| Index | 100 | 105 | 103 | 106 | 110 |

district where rice seedlings are planted near to summer a fairly good result is obtained even by plowing in of rice straw just before planting.

Among the soil conditions, drainage is a factor which has an important relation to the technique of rice straw application. In ill-drained field of high moisture the decomposition of applied rice straw is slow in progress, and the rice straw is generally inferior in fertilizing effect to compost.

Therefore, rice straw must be applied as early as possible, for intance, in autumn, and the amount should be reduced as compared with that in well-drained fields (Table 1).

In the ill-drained field one of the causes of growth inhibition by the application of rice straw is high reduction of soil coming from the decomposition of the rice straw. So lowering of reduction by intermittent drainage or other methods is effective to decrease the inhibitory effect. And application of rice straw is generally not desirable in paddy fields of peat soil and of polder soil, because the decomposition of rice straw proceeds slowly in such fields doing damage to rice plants.

The most injurious effect of the application of rice straw is that the nitrogen in the soil is fixed by the decomposition of rice straw, and rice plants temporarily suffer from want of available nitrogen. And the shortage of nitrogen causes great damage to rice plants especially in a cold district where the growth of rice plants at an early stage sharply reflects on their yield.

The first measure to be taken to prevent the nitrogen shortage is the application of nitrogenous fertilizer as decomposition promoter of rice straw at the time of plowing in. A common fertilizer used for this purpose is calcium cyanamide which is applied at a rate of 0.5~1.0 kg/a as nitrogen. The next measure often taken to supply the deficiency of nitrogen is increased application of nitrogenous fertilizers as basal dressing. A suitable amount of nitrogen fertilizers applied for this purpose is 0.2~0.4 kg/a as nitrogen (Table 2).

As mentioned above, the application of rice

**Table 2. Relation between the time and effect of rice straw application**

| Amount of rice straw applied (kg/a) | | Exp. plot | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Standard fertilization | | | | | Increased nitrogen | |
| | | No straw | Compost | Days from application of straw to planting | | | No straw | 50 days before application of straw |
| | | | | 130 | 90 | 50 | | |
| 40 | Yield of brown rice (kg/a) | 36.1 | 38.7 | 39.1 | 37.2 | 38.5 | 38.1 | 39.3 |
| | Index | 100 | 107 | 108 | 103 | 107 | 106 | 109 |
| 60 | Yield of brown rice (kg/a) | 38.8 | 42.3 | 41.1 | 40.3 | 40.5 | 40.9 | 46.1 |
| | Index | 100 | 109 | 106 | 104 | 104 | 105 | 119 |

straw inhibits growth of rice plants at an early stage through nitrogen shortage, though the nitrogen which was thus taken into the rice straw begins to be returned to the soil after the decomposition has passed the peak of its process. Accordingly, the application of rice straw tends to prolong the effective period of nitrogen applied as basal dressing. So when rice straw was applied, top dressing must be applied with attention to the leaf color to avoid over-fertilization which often damages rice plants.

If rice straw is applied to a dry field for direct sowing special precaution must be taken against the arrest of germination. Rice straw applied to fields is sometimes distributed densely in the upper layer and blocks the rise of water by capillarity in the soil, causing reduced germination. In such a case the application of rice straw gives a good result if it is done in autumn to rot the straw sufficiently before the sowing or if straw is plowed into the lower layer of the soil.

## References

1) Agriculture, Forestry and Fisheries Research Council: Application of Rice Straw to Paddy Fields and Its Standard (1968).
2) Promotion Bureau, Ministry of Agriculture and Forestry, and Shizuoka Agricultural Experiment Station: Experimental Data on the Application of Raw Rice Straw to Paddy Field (1959).
3) Agriculture, Forestry and Fisheries Research Council and Shizuoka Agricultural Experiment Station: Experimental Data on the Application of Raw Rice Straw to Paddy Fields (1965).
4) Kawamoto, Y. and Sakai, H.: On the simple method for testing the decomposition process of raw rice straw in the soil. *Chugoku Nogyo-kenkyu* No. 34 (1966).