and such crop as vegetables, Chinese yam, or peanut is afterwards planted between the ridges. For planting with wide spacing like watermelon, pumpkin, seedling of fruit tree, and garden tree, the chemical is applied to only the planting site 1 to 2.5m in diameter according to the plant species, at the rate of 4 to 5 ml per injection, 20cm deep, at 30cm intervals. After a certain period from injection, plowing should always be made to remove the vapor out of the soil. The length of time between application and plowing is determined mainly depending on the soil temperature, and this is normally a week in summer and 2 to 3 weeks in spring and autumn. In summer, the soil should be watered immediately after the application in order to keep the vapor in the soil as long as possible.

A 1 : 1,000 or 2,000 aqueous solution of DBCP emulsifiable concentrate is evenly applied to trenches or concentric circles set up at the base of tree, up to 10—15cm deep, at the rate of 3 to 7ml of the chemical per square meter. Soil is immediately put back after application. For plants that are grown on ridges, like fig, tea, and mulberry trees, the chemical is applied to trenches 10-15cm deep positioned on both sides of a row of trees. DBCP granules are also available and usually applied in the same way as the emulsifiable concentrate. Another application method is an even broadcasting of the chemical onto the surface, being followed by plowing. When orchards have a cover crop, an injection or drench with DBCP emulsifiable concentrate is preferable. The best trial result is secured with the high dilution of emulsifiable concentrate. This may be due to the better dispersion of the chemical in the soil and the limited concentrations around the roots, although ample water supply is needed. Dosage rates of DBCP will vary with plant specsel· It seldom exceeds 10 g active ingredients per square meter. The recommended dosage in. Japan is, 4g for mulberry, 7-8g for fig, tea, grapevine and citrus, and 10g for peach and apple. For ideal dispersion of DBCP, soil temperature must not be below 15 °C and the period from May to September is favored. Specifically for fig, May to early June ; for peach, April to May ; for apple, May or October ; for pear, May to June or from September to October ; for citrus, July to September ; for tea, May to October ; and for mulberry, middle to late April or from middle to late June.

A field once treated can hardly remain safe from nematodes for several years, and accordingly, a rotation of crops should be taken up as much as possible to minimize nematode damage and to prolong the duration of effectiveness.

Photosynthetic Characters and Fertilizer Response of Rice Varieties

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It is said that the varietal difference in fertilizer response, especially in nitrogen response, of rice plant is concerned with not only resistance to disease or lodging, but also physiological and morphological characteristics.[1] Meanwhile, factors contributing to dry matter production as well as the rate of photosynthesis per unit leaf area are easily influenced by nitrogen. Therefore, experiments were carried out to investigate the relationship between the photosynthetic characters and the nitrogen response of rice varieties.

Efficiency in dry matter production

Dry matter production is, in principle,

approximately equal to the balance between the total assimilation and the total respiration of population. When the population is unluxuriant, individual leaves being exposed fully to the light, the amount of total photosynthesis is relatively larger than that of respiration. However, when the leaf area is expanded luxuriantly, the photosynthesis will not come to increase proportionately with the amount of leaf area, as the inner leaves of population can not receive enough light. On the contrary, respiration increases proportionately with the amount of leaves. Subsequently, the ratio of the total photosynthesis to the total respiration of rice population decreases, the efficiency of dry matter production becoming lower. From such a viewpoint, following experiments were undertaken, since nitrogen response of varieties is the characteristic which comes to the problem under luxuriant conditions due to high nitrogen supply. Six varieties which are different in their nitrogen response were grown in the paddy field under normal and double nitrogen supply. Photosynthesis and respiration of population and other factors concerning the dry matter production in the field were determined, and the ratio of photosynthesis to respiration

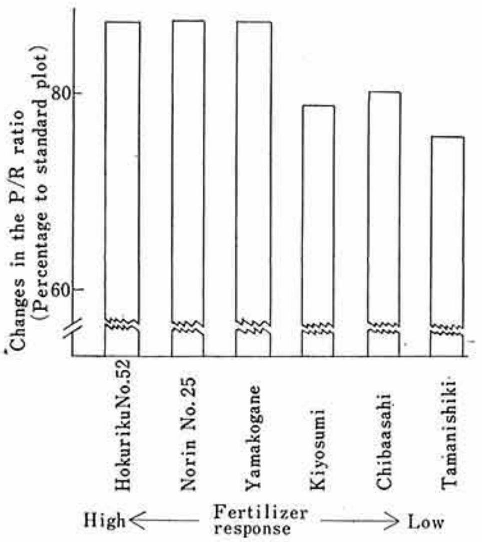

Fig. 1 Changes in the ratio of photosynthesis to respiration of population (P/R) by increasing nitrogen supply[4].

(P/R) which may be regarded as an index of efficiency in dry matter production were calculated. Though this ratio was decreased with increasing supply of nitrogen in all varieties tested, it was recognized that the rate of decrease in this ratio was smaller in varieties of high nitrogen response than in those of low response (Fig. 1). In other words, varieties suitable for heavy manuring have ability to produce dry matter efficiently, even when nitrogen was abundantly supplied.

Factors consisting of the efficiency in dry matter production

According to Murata et al.[2], total photosynthesis of population (P) can be represented approximately as the product of rate of photosynthesis per unit leaf area (p_0), total leaf area per unit field area (A) and "light-receiving coefficient" (f) ($P=p_0Af$). "Light-receiving coefficient" is the mean lowering rate of the light intensity, since the light intensity in the inner part of a population will be lowered owing to the luxuriance of the population. The population respiration (R) can be taken approximately equal to the product of total plant weight (W) and respiratory rate per unit weight (r)($R=rW$).

Therefore, P/R can be transformed as follows:

$$\frac{P}{R}=\frac{p_0Af}{rW}=\frac{p_0f}{r}\cdot\frac{A}{W}$$

where A/W is equal to that which is called as "leaf area ratio".

Consequently, it can be considered that the P/R ratio consists of four factors, rate of photosynthesis per unit leaf area, respiratory activity per unit weight, light-receiving coefficient and leaf area ratio.

Changes in these factors by increasing supply of nitrogen were then investigated. Increase in respiration rate per unit dry matter by increasing supply of nitrogen was higher in varieties of low nitrogen response than in those of high response. The rate of increase in leaf area and leaf area ratio also tended to be larger in the former.

It has been reported that varieties suitable for heavy manuring often have a high light-receiving coefficient, because their leaves are, in general, erect and short, the form of the population being favorable to receive light. In this experiment, however, direct relation between light-receiving coefficient and nitrogen response was not obtained.

On the other hand, there existed a close relationship between the response of photosynthetic rate per unit leaf area to applied nitrogen and the varietal nitrogen response. This was observed from solution culture experiments, using varieties differing in their nitrogen response (Fig. 2). These varieties were treated with different concentrations of nitrogen, low, medium and high, at the active vegetative growth stage and the photosynthetic rate was determined 9 to 10 days after the treatment. Increasing rate of photosynthetic activity by increasing supply of nitrogen was higher in varieties of high response than in those of low response.

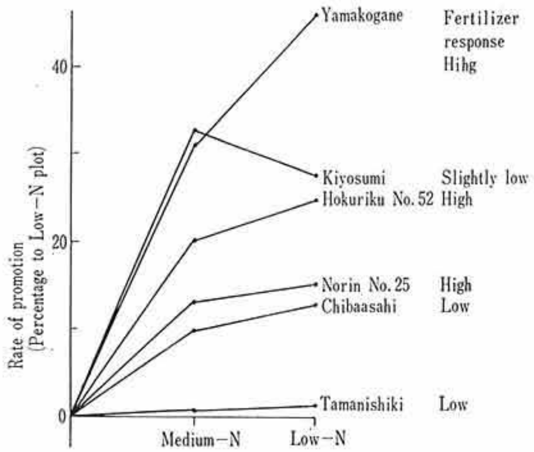

Fig. 2 Rate of promotion in photosynthetic activity per unit leaf area by increasing supply of nitrogen (japonica varieties)[4].

In addition to this trait in photosynthetic rate, increase in the respiratory rate and leaf area of varieties suitable for heavy manuring is, as mentioned above, less than those of ones unsuitable. As a result, the varieties of high nitrogen response keep their P/R ratios relatively high and can produce dry matter more efficiently, compared with the varieties of low response, when nitrogen is supplied abundantly.

Nitrogen response of indica varieties

From the experiments with indica varieties conducted by author[3] in Ceylon, it was recognized that those traits as to the nitrogen response are common to the indica varieties. In the case of indica, the relationship between rate of photosynthesis per unit leaf area and nitrogen supply is also quite similar to that in japonicas (Fig. 3).

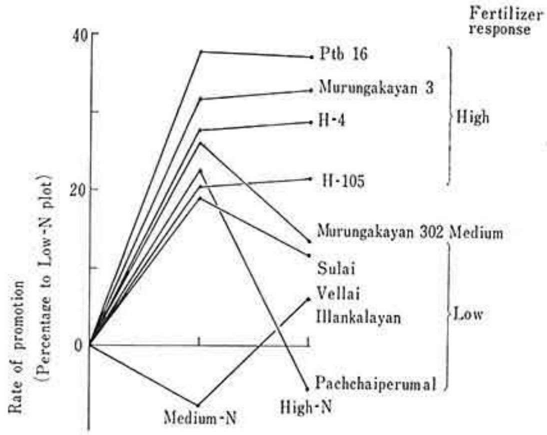

Fig. 3 Rate of promotion in photosynthetic activity per unit leaf area by increasing supply of nitrogen (indica varieties)[4].

It was also observed that the increasing rate of respiratory activity by increasing supply of nitrogen is higher in varieties of low nitrogen response.

It is said that japonicas have, as a rule, higher response to nitrogen than indicas. In the solution culture experiment comparing with the difference in the nitrogen response of the rate of photosynthesis per unit leaf area between japonica and indica variety, an indica variety, H-4 showed a lower optimum concentration of nitrogen for photosynthetic rate than a japonica variety, Norin No. 1;

Table 1. Comparison between japonica and indica variety in the relationship of nitrogen supply to photosynthetic activity (solution culture experiment)[3].

Variety	Nitrogen concentration in solution, ppm.			
	5	10	20	40
japonica (Norin No. 1)	11.12*	13.24	13.47	14.03
indica (H-4)	9.15	10.20	11.75	11.73

* Rate of photosynthesis per unit leaf area, CO_2 mg/100cm² LA, hr.

the rate of the former reaching maximum value at 20 ppm of nitrogen, that of the latter continuing to increase up to 40 ppm (Table 1.). This difference is also recognized in another indica and japonica varieties as shown in Fig. 2 and 3. Tanaka et al.[5] found similar difference as to the response of dry matter production to nitrogen concentration in solution.

Another experiment in which the influence of nitrogen top-dressing upon photosynthetic characters was investigated showed that the increase in leaf area of indica by top-dressing was fairly larger than that of japonica, suggesting that indica becomes luxuriant easily under high nitrogen conditions.

Accordingly, it may be possible to conclude from the standpoint of photosynthesis that the difference in the nitrogen response among indica varieties or between indica and japonica are governed by the same factors as in the case of japonica varieties.

Percentage of fully ripened grains and the nitrogen response

Though dry matter production is a fundamental process for grain production of rice, the amount of the former is not necessary proportionate to that of the latter. In the case of grain yield, the amount of the photosynthate which would be translocated to the panicles is an important factor. In this aspect, there are still many unknown points. However, a close correlation between the percentage of fully ripened grains and nitrogen response was observed.

Grain yield of rice under the high nitrogen conditions is often determined by this percentage. The percentage is affected by the total photosynthate and the total number of spikelets. Experiments which were done from such a viewpoint with varieties differing in their nitrogen response showed that the percentage of fully ripened grains is mainly governed by the ratio of the rate of photosynthesis (p_0) to the product of leaf area (A) and the total number of spikelets (n), (p_0/An).

Leaf area or number of spikelets is a factor to obtain a high yield in itself. However, if it exists excessively, the percentage of fully ripened grains will be decreased owing to lowering the light-receiving coefficient or increasing grains ripened unfully. On the other hand, if the rate of photosynthesis per unit leaf area is active, the ratio of p_0/An will also be high, resulting in the high percentage of fully ripened grains.

The trait that the rate of increase in photosynthetic activity of high nitrogen response varieties is higher than that of low response ones is still kept at the ripening period. Moreover, in high response varieties, decrease of the p_0/An ratio which is usually lowered by increasing the supply of nitrogen is less than in low response varieties.

It may be, therefore, possible to deem that the above-mentioned fact is one of the processes which govern the differences in grain yield of varieties differing in nitrogen response under the high nitrogen conditions, though there might exist many unknown processes.

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Characteristics of Microorganisms in Paddyfield Soils

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Distribution of Microorganisms in Various Horizons of Paddyfield Soils.

The oxidation-reduction reaction of soils goes on in paddyfields not in the same way as in upland fields, because soils are, being covered by irrigation water, not aerated during summer in the former, while they are aerated year-round in the latter. It is natural that microflora grown in these soils are distinct from each other. In order to assess this difference, the microflora in paddyfields was compared with that in upland fields under the same moisturecontent of soil; test materials were drawn from paddyfields in autumn when irrigation water was drained. In this way nearly the same moisture content was assured in both fields.

Following this idea, Ishizawa and Toyoda[4] carried out a paddy-versus upland field comparative study across the country, Hokkaido through Kyushu. The results are shown in Table 1. In the first horizon, i.e. plow layer paddyfields showed a greater number of bacteria and anaerobic bacteria, while a smaller number of actinomycetes and fungi than upland fields respectively. On the other hand, Ishizawa et al.[3] studied effects of moisture content of soils on various types of microorganisms, and found that actinomycetes and fungi were predominant in low moisture and dry condition of soils, and the greater the moisture content of soil was, the more bacteria were found. Takai et al.[8] reported that bacteria were prevailing among microorganisms in water-logged paddy soils. Therefore results shown by Ishizawa et al. were to be interpreted that a water-logged condition of paddy soils which are contrary to that in upland soils did not cease to exist after irrigation water was drained.

In observing horizontal-wise, paddyfields produced a greater number of bacteria in the second and the third horizons, while much less fungi in both horizons than upland field respectively.

Table 1 shows a horizontal distribution of sulfate reducer, an obligate anaerobe; denitrifier which is deemed to be facultative anaerobe; and nitrifier which is an obligate aerobe. In the first horizon of plow layer paddy soil contained pretty much amount of sulfate reducers, more denitrifiersand less nitrifiers than upland soil respectively. The evidences fully illustrate the types of bacteria grown in soils under the unaerated condition of water-logged paddyfield.

It must be noted that considerable amounts of sulfate reducers and denitrifiers are found even in the lower horizons of paddy soil, II and III. This is the feature which distinguishes paddy soil from upland soil. Supplies of irrigation water amount to 900 cubic meter per 10 ares during summer, and water permeated thereout leach bacteria and their basic food, i.e. organic matters, with the result that these are deposited in the lower horizons. Takai *et al.*[7] observed organic carbon, iron and bacteria in their leached state in the permeated water which