SOILS & FERTILIZERS

Soil samples are regularly collected and analyzed for their contents of both major and minor elements. The results, together with the recommendation of fertilizer application, are transferred to the farmers immediately.

Diagnosis of nutrient deficiency by leaf analysis is also conducted. Studies on the physico-chemical properties of poor soils and low-yielding lands are made frequently. The measures to upgrade the productivity for these soils are proposed and notified to the respective farmers. The efficient methods of fertilizer application such as deep placing, splitted top dressing and the combined application of chemical fertilizer with green manure, are also recommended to maintain the soil fertility. Studies on soil pollution due to the polluted irrigation water have become an important task of this station. A test to determine the degree of resistance of crops(wheat, rice, vegetables, etc.)to air pollutants has also been conducted.

A. Soil and Fertilizer Experiments

1. Utilization of Azolla as N-source for rice

The relative growth rates of Azolla decreased in the following sequence: A. pinnata, A. caroliniana, A. filiculoides, A. mexicana. It also showed that 40 ton/ha of fresh Azolla incorporation had the same effect as 80 kg/ha and 65 kg/ha chemical fertilizer application for rice grown in sandstone & shale and slate alluvial soils, respectively. However, the highest yield cannot be obtained by Azolla incorporation alone. Azolla monoculture in combination with N-chemical fertilizer application may be the most practical method to save chemical fertilizer without affecting rice yield.

2. Improving the Efficiency of Nitrogen Fertilizer in Flooded Rice Soil

The surface broadcasting of nitrogen fertilizer caused much losses and thus had higher requirement for nitrogen fertilizer to achieve the same yield level as the mudball or tissue paper treatment. The efficiency of nitrogen fertilizer (urea) was significantly increased by wrapping the fertilizer in mudball or tissue paper and then applying to the reduced layer of the soil between two hills of rice plants. The grain yields of the treatments accepted 60% of standard rate of nitrogen fertilizer in mudball or tissue paper were as high as those of the treatments accepted 100% of standard rate of nitrogen fertilizer broadcasted in 4 splits. It is also necessary to develop some labor-saving methods to make the mudball method more practical.

3. Fertilization of Hill-Side Paddy

Experiments were carried out at 3 hill-side paddies with strongly acidic shallow soil. Results showed the application of 3 ton/ha slag increased rice grain yield by 4.2 - 2.5% in the 1st and 2nd crop respectively. Optimum nitrogen fertilizer for the 1st and 2nd crop of rice were 80 - 105 and 70-90 kg/ha, of N. The recommended N-fertilizer application method was basal 25%, 1st top dressing 20%, 2nd top-dressing 30% and 3rd top-dressing 25% (at panicle-initation stage).

4. Nitrogen Fertilizer and Delaying Harvest on the Recovery Rate of Ratoon Rice

This experiment showed that among the 3 (N,P,K) elements, N was the only one effective in promoting the growth of ratoon tiller. Applying 25% of additional N fertilizer at yellow maturing stage helped Tainung No. 67, a japonica rice, induce ratoon tiller at the normal harvesting stage. It also showed that applying 50% of additional nitrogen fertilizer for the ratoon rice helped the ratoon rice to get similar or even higher grain yield than that of conventional first crop of rice.

5. Fertilizer Experiment for Badila Cane (Saccharum officinarum L.)

Field experiments were carried out at Puli during 1979-1981. It was found that the application of 30 ton/ha of compost significantly increased stem yield from 13.5-15.1%. Compost also induced better plant height, stem diameter, internode length and number. The proper fertilization for Badila cane might be recommended as 30 ton/ha compost, 750kg/ha N, 54 kg/ha P_2O_5 and 250-500 kg/ha K_2O.

6. Effects of Rice Hull, Lime and Nitrogen Fertilizer on the Silica Content and Growth of Rice in Strongly Acid Sandshale Alluvial Soil

The results showed that low water soluble silica and exchangeable bases were the two main factors that limited the normal growth and caused the lodge and blast in rice plants at high level of nitrogen fertilizer in this strongly acid sand-shale alluvial soil. Liming helped reduce the blast and promote the continuous growth of rice plants at high nitrogen level. Soil treatment with rice hull and limestone significantly increased the silica contents in rice plant, resistance to neck blast and lodge, and panicle number. However, for obtaining the best grown rice plants to perform the highest grain yield in this stronly acid sand-shale alluvial soil, it is not only necessary to apply lime and rice hull to raise silica and basic ions in the soil, but also necessary to provide enough nitrogen fertilizer for the requirement of the good performance of rice plants.

7. Fertilizer Experiment for Job's Tears (Coix lacryma–jobi L.)

Job's tears was tested in the spring and fall crops, 1983 with ten treatments of N. P. K. -fertilizers (N=60, 100, 140, 180 kg/ha, P_2O_5 = 0, 45, 90 kg/ha, K_2O = 0, 45, 90, 135 kg/ha). The best fertilizer combination for commercial production was found to be 180, 90, 135 kg/ha in the spring crop and 100-140, 90, 135 kg/ha of N, P_2O_5, K_2O, in the fall crop respectively. It was found that potassium played an important role on the grain yield of Job's tears.

8. Effect of N. P. K. -Fertilizers on the Yield of Buckwheat (Fagopyrum esculentum Moench.)

Buckwheat is grown for human consumption as a kind of health-care after properly processed. The fertilizer experiment were conducted at Erhlin and Chutang townships during the winter cropping season from 1981-1983. The results showed that the optimum rates of N, P_2O_5, and K_2O for grain yield of buckwheat were 60, 18, 30 kg/ha.

9. Fertilizer Experiment for Tuber and Starch Production of Edible Canna

Edible canna has been cultivated in Nantou County as a kind of starch crops which has high yield of tuber and excellent quality of starch after processing. Field experiments were conducted in Chungliao during 1982-1983. Nine treatments of N. P. K. -fertilizers (N: 0, 40, 80, 130, 160 kg/ha, P_2O_5: 0, 36, 54, 72 kg/ha, K_2O : 0, 120, 180, 240 kg/ha) were adopted, and the fresh tuber yield and starch content as well as the fertilizer responses were studied. The optimum rates of N, P_2O_5 and K_2O for the starch production were 120-160, 36-54 and 180-240 kg/ha, respectively.

10. Accumulative and Residual Effect of Slag on Rice

During 1977-1982, continuous experiments were carried out at Houli and Puli where the soils are strongly acid and low in available silica. The results indicated that the initial application of slag helped increase the grain yield by 3.3 - 6.6% in the 1st crop. The effect of slag application in the 1st crop was greater than in the 2nd crop. Continuous application got better effects on yield increasing up to 18%. The slag raised soil pH and increased the soil available silica, exchangeable Ca, and Mg.

11. Constructing Corrugated Drainage Pipe Lines in Poorly Drained Soils

Field experiment indicated that the poor growth of rice plants in poorly drained paddy soil was mainly caused by the excessive sulfur and iron in the soil, and the tiny brown spots on the old leaves of rice plants was the symptoms of iron toxicity which was also the possible factor to induce the deficiencies of K and Cu in rice plants.

Burying 4" of corrugated drainage pipe at the depth of 60cm from soil surface was very effective for removing off the excessive water, iron, sulfur and thus reduced the Fe content and increased the K and Cu contents in the rice plant for the normal growth of rice plants.

12. Poorly Drained Acid Sulfate Soils in the Coast of Central Taiwan

This survey was conducted to study the characters and distribution of acid sulfate soils. It was found that acid sulfate soils were widely distributed in the coastal township, Ta-an, in the west coast of Taiwan. The total acreage was estimated above 500 ha. Lots of them were poorly drained all around the year, and became a special kind of abnormally low-yielding problem soils.

The results of chemical analysis for the air-dried soils showed that the pH of many soils sharply declined from 6.7–7.5 to 2.7–6.6, the EC abruptly rised from 1.0 - 2.7 mmhos/cm to 1.3 - 15.7 mmhos/cm, and the soluble ions including SO_4, Fe, Mn and Al, etc., had become toxic to the crops upon air-drying. Applying limestone (quick lime) at the rate of 4 ton/ha will be enough for raising the soil pH to a favorable value for the growth of crops. Rice yields were often doubled or tripled after the establishment of drainage system.

13. Adjusting the Transplanting Time of Rice Plants for Preventing Brickfactory Gaseous Injury

The injury of brickfactory waste gases on rice plants in Huatan area mainly occurred in the early stage of growth in the 1st crop and in the late stage of growth in the 2nd crop.

In order to maintain two crops of rice at a considerable high grain yield with minimum injury by waste gases, it was recommended to transplant indica varieties of rice after mid-March in the 1st crop, and before mid-July in the 2nd crop. The 1st crop should be transplanted at the rate of 12 plants per hill, and 2nd crop at the rate of 6 plants per hill will be enough.

14. Response of Rice to P. K. Fertilization in Soil Fertility Classification.

Field experiments were conducted in 7 different types of soils with different limiting factors and P. K. levels in Changhua County to study the requirements of rice for P. K. fertilizers for the maximum economic returns in relation to the soil fertility classification.

Acid soils with low levels of P. K. and coarse subsoil required higher rates of P. K. fertilizers (80, 60 kg/ha for the 1st crop; 60, 80 kg/ha for the 2nd crop, respectively).Good responses of grain yield to additional applications of P. K. fertilizers were also obtained in poorly drained soils. Regardless of the levels of P. K. in soil, it is more economical to apply only moderate amounts of P. K. fertilizers for the soils of other fertility class in which the optimum rates of P. K. fertilizers at 40, and 30 kg/ha for the 1st crop; and 30, and 40 kg/ha for the 2nd crop were recommended.

15. Effects of Different Application Methods and Rates of Nitrogen Fertilizer on Grain Quality and Flour Characteristics of Spring Wheat (Triticum aestivum L.,)

Two spring wheat varieties Taichung 31 and Taichung S-2 were treated with three nitrogen rates (85, 125, 165 kg/ha) and two application methods (A_1 : basal and one sidedressing, A_2: basal and two sidedressings) in winter season, 1984 for studying their effects in grain quality and flour characteristics.

Both two varieties showed a similar response of decreasing in the yield rates of flour when N-fertilizer was increased, but increased in the protein contents of flour. So far as the effects of two nitrogen applications on flour were concerned, the yield rates and yields of flour with A_2 application method were higher than that with A_1 application method.

The series of farinograph curves and quality data indicated that the higher the N-fertilizer applied, the weaker the flour of Taichung 31 became. On the contrary, the flour of Taichung S-2 was slightly stronger with the increasing of N-fertilizer. It was also found that both two varieties got a similar response in the strength of

flour from the two nitrogen application methods, i. e., A_2 method got a stronger flour than A_1 method. The physical dough characteristics of Taichung 31 was more markedly influenced by the nitrogen application method.

16. Responses of Corn to Different Kinds and Rates of Fertilizers

Field experiments were conducted at Erhlin (Changhua Hsien) and Waipu (Taichung Hsien) in the fall crop season, 1984 to study the effects of fertilizers N, P, K, and Mg on the growth and yield as well as on the nutrient uptake of corn cv. Tainung No. 351. The results were summarized as follows:

A significant reduction in grain yield was found in the treatments of low rates of nitrogen, phosphorus and potassium. The effect of magnesium fertilizer on grain yield was not significant due to adequate magnesium content in the soil. The optimum rates of N, P_2O_5, and K_2O for corn in paddy field were 150-200, 90, 50-100 kg/ha, respectively.

Highly significantly positive correlation between grain yield and P content in the plant at the age of 5 weeks and K content in the ear-leaf at silking stage were observed. These results indicated that P uptake by corn during the early growth stage and K concentration in the leaves at silking stage played an important role on the grain production.

Generally, the grain yield increased with the increase of N concentration in the whole plant or leaf, i. e., nitrogen content in the ear-leaf at silking stage was closely related to grain yield.

17. Effects of Different Application Methods and Rates of Nitrogen on the Milling Quality and Flour Characteristics of Spring Wheat (Triticum aestivum L.)

Two spring wheat varieties, Taichung 31 and Taichung S-2, were treated with three nitrogen rates (85, 125, 165 kg/ha) and two application methods (A_1: basal and one side-dressing, A_2: basal and two side-dressing) in winter season, 1984 for studying their effects on milling quality and flour characteristics.

For both varieties, yield rate of flour decreased while protein content increased as the amount of N-fertilizer applied was increased. A_2 application method also gave a higher yield rate and absolute yield of flour than A_1 method.

The series of farinograph curves and quality data indicated that the higher the N-fertilizer applied, the weaker the flour on Taichung 31 became. On the contrary, the flour of Taichung S-2 was slightly stronger with the increasing of N-fertilizer. It was also found that both varieties had a similar response in the strength of flour from the two nitrogen application methods, i. e., A_2 method produced a stronger flour than A_1 method. The physical dough characteristics of Taichung 31 was more markedly influenced by the nitrogen application method.

18. Studies on the Cultivation of Corn in Paddy Field
III. Responses of corn to different kinds and rates of fertilizers

Field experiments were conducted at Erhlin (Changhua Hsien) and Waipu (Taichung Hsien) in the fall crop season, 1984 to study the effects of fertilizers N, P, K and Mg on the growth and yield as well as on the nutrient uptake of corn cv. Tainung No. 351. The results were summarized as follows:

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19. Introduction of Soil or Treatment of Rice Hull for the Restoration of the Productivity of the Copper Contaminated Soil

This experiment was carried out in a paddy field in central Taiwan where the soil was rendered unproductive due to the contamination by copper in the waste water from the brass spare parts manufacturing factory. The results are summarized as follows:

1. Excessively higher concentration of copper in the soils mainly retarded the growth of rice roots, and hence affected the nutrient uptake and the normal growth of the whole rice plants. In the extreme cases, the rice roots were completly inhibited in growth and thickened with branched root tip.

2. Soil treatment of sulfuric acid at the rate of 1000 l/ha was ineffective for leaching out the excessive copper in the soils, however, rice hull at the rate of 20 tons/ha significanthy retarded the uptake of copper by the rice plants, and the rice plants were able to grow normally under the higher concentration of copper in the soils.

3. The rice plants looked growing almost normal in the 5 and 10 cm top layers and completely normal in the 15 cm top layer of the normal soils introduced to the copper contaminated paddy field, however, the growth and yield components of rice plants among the three different depths of soil introduction were not significantly different.

4. The pollutant, copper, was mainly concentrated in the rice roots, and the copper content in the rice grain was not increased, therefore, the rice grain from the copper contaminated plots was still suitable for human consumption.

20. Restoration of the Productivity of Paddy Field Contaminated by the Acid Waste-Water from the Wire Smelter

The experiment plot is located at a lower place with about 30 m distance from a wire smelter. The acid wastewater from the factory seeped through the soils to the plot to cause the serious wilting of rice plants, and the plot was unable to grow any more crops again without thorough land reclamation. The results of the anaylses for the samples of wastewater, contaminated soils, and wilting plants suggested that the abnormal growth and wilting of rice plants in the plot was mainly caused by the abrupt decrease in pH, the abnormally high salinity and the toxicities of iron and hydrogen sulphide in the soils that rendered an inhibiting and harmful effects on the roots.

Broadcasting calcium carbonate at the rate of 5 tons per hectare, and constructing 4" corrugated drainage pipelines in accordance with the 0.5% decreasing slope, 50 cm depth, and 15m interval, significantly raised the soil pH, and reduced the soil salinity, extractable iron and sulfur to the levels that were suitable for the normal growth of rice plants.

21. Experiments of Fertilization on Edible Canna (Canna edulis Ker.)

Two varieties of edible canna were tested in the field with nine treatments of N, P, K, fertilizers (N: 0, 40, 80, 120, 160 kg/ha, P_2O_5 : 0, 36, 54, 72 kg/ha, and K_2O: 0, 120, 180, 240 kg/ha) at Jiji in Nantou Prefecture during 1982-1984.

Nitrogen had the largest effect on the yield of edible canna and then, K and P, respectively.

The application of nitrogen at the rate of 120 kg/ha and phosphorus at the rate of 54 kg/ha raised the yield of fresh tubers and starch and gave better net benefit. It was also found that the increased amount of potassium fertilizer had positive effect on the production of edible canna. The results indicated that the best fertilizer combination for commercial production of edible canna was 120-160: 36-54: 180-240 kg/ha of N: P_2O_5: K_2O.

B. Diagnosis of Soil and Plant Nutrition and Fertilizer Recommendation

1. Soil Test

Soil samples from paddy field, upland field, vegetable garden and fruit tree orchard are collected and analyzed for their physico-chemical properties. The results together with the recommendation of proper fertilizer management were made known to the farmers concerned immediately.

2. Plant Analysis

Diagnosis of nutrient deficiency by leaf analysis, especially for fruit tree is also conducted. The nutrient contents varied with the kinds as well as the growth stage of crops. The results were sent to the farmers as a reference for the application of fertilizers and soil amendments. About 3000 soil and plant samples were analyzed each year in this laboratory.

3. Extension of Fertilization Management on Rice

In order to teach farmer the correct use of fertilizers for rice, 32 places of field demonstration were established at the main area of rice cultivation. Results showed that the currently recommended method of fertilization according to varieties, soils, climatic conditions and plant performances for adjustment of fertilizer was feasible for rice cultivation. The paddy rice grain yield in the demonstration plots from 32 places averaged 7161 kg/ha and the rates of N, P_2O_5, K_2O, were 127, 55, 57 hg/ha respectively. While yield in the check plot was 6601 kg/ha and the rates of fertilizers were 161, 56, 86 kg/ha. It was obviously that the recommended method increased fertilizer efficiencies, and grain yield. Most farmers didn't apply fertilizer at land

preparation and panicle initation stage were the main reasons why they applied a lot of fertilizers and couldn't get better yields in the paddy. Soil texture, and soil reaction are the two main factors affected both grain yield and rates of fertilizers, especially nitrogen fertilizer.